DEPARTMENT OF AGRICULTURE,

NEW SOUTH WALES.

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COIMBATORE

The Farmers' Handbook

[FIFTH EDITION.]

Issued by direction of the Minister of Agriculture,
The Hon. H. V. C. THORBY, M.L.A.

K. SYNNOTT, *Editor of Publications.*

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Typical Wheat Country in New South Wales.

PREFACE TO FIFTH EDITION.

A book that has reached its fifth edition, with sales totalling about 13,000 copies since the appearance of the first edition in 1911, certainly needs no detailed introduction as to its scope. It will suffice to state that the balance between agricultural practice and theory has been well maintained—an essential feature in a book that claims to be invaluable to both farmer and student.

Chief interest in this edition will centre in the points of difference between it and preceding editions. And in this connection no better indication could be given of the progress that has been made during the last five years in the acquisition of knowledge of farming under New South Wales conditions than the fact that practically the whole of the crop section has had to be re-written, and those portions that did not call for re-writing have had to be thoroughly revised, more thoroughly, it is claimed, than in any of the previous editions. On the other hand, some chapters, because of their very general nature, have not changed at all in the last decade, and although they may appear perhaps monotoniously familiar, there was nothing to be gained by merely re-writing those sections for the purpose of making them different in appearance only.

New items of particular interest are those treating with rice, wheat-growing in the mallee country, farm measurements and handy tables, tank-making, and what might be called a practical soil survey of agricultural areas of the State, which appears under the caption, "Soils of New South Wales," in Section I. While not claiming that this survey is complete or that it entirely fills the long-felt want of a detailed soil survey, it is, in a practical way, as useful as anything of the kind so far attempted. A more informative and up-to-date crop map of New South Wales than that included in this edition of the Farmers' Handbook is not in existence; the mallee areas—potential wheat-growing country of immense importance—being plotted for the first time.

The compilation of such a vast amount of information on so great a variety of farm topics has only been made possible by the whole-hearted co-operation of officers of the Department of Agriculture and others outside that Department. Those contributing new articles or revising old matter for the present edition include:—

Departmental Officers.

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The District Surveyors, Lands Department.

The members of the Western Lands Board.

While every credit is due to the foregoing authors, they, in turn, will, I have not the least doubt, ungrudgingly recognise the valuable assistance given them in the preparation of their sections by Mr. O. G. Ferns, of this Branch, to whom was entrusted the work of sub-editing this edition.

K. SYNNOTT,

Sydney, August, 1929. Editor of Publications.

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THE FARMERS' HANDBOOK.

SECTION I.

Farm Lands of New South Wales.

Armidale Land Board District.

Includes Armidale, Uralla, Walcha, Guyra, Bundarra, Tingha, Inverell, Ashford, Glen Innes, Tenterfield.

THIS district is, in general, hilly to mountainous, with tablelands and valleys, the Great Dividing Range, average height, 3,200 feet above sea level, and its spurs running right through the centre. Basalt, granite, and trap are the prevailing rocks. Much of the soil is inferior, and suitable only for grazing, with rich patches of alluvial and basaltic soils. The richest soil is generally found in the valleys and basalt tablelands.

East and south-east of Armidale and Walcha, the tableland ends abruptly in steep falls. This "falls" country covers a considerable area, and consists mainly of precipitous slopes and rocky gorges. Some cattle are grazed there, but generally the country is almost useless.

The climate is excellent, and very healthy both for human beings and stock. The New England district is a favourite summer health resort. The mean annual temperature for the district is about 61 deg. Fah. The mean summer temperature is about 71 deg. Fah. The summer temperature in Armidale is 85 deg. Fah.

The winters are cold, with occasional falls of snow on the highlands. The mean winter temperature for the district is about 46 deg. Fah.

The average rainfall is 33 to 35 inches, about one-third of which falls between December and February.

The roads are for the most part hilly, with fair gradients as a rule. In ordinary seasons they are hard. The cost of transport is from 1s. to 2s. per ton per mile.

Timber is plentiful throughout the district. Of the softwoods, pine, cedar, rosewood, silky oak, and coachwood were the most common, with blackwood, tallow, woollybutt, grey and red gum, peppermint and stringybark among the hardwoods, but, except in the inaccessible places, these timbers have been well culled.

In the Inverell district, box, apple and ironbark are the principal timber trees; in the Tingha district, stringybark, red and white gum, peppermint, box, and pine; and in the Bundarra and Ashford districts ironbark, gum, box, and apple are the common timbers.

With the exception of box, all the New England timbers are very hard to burn, and the cost of clearing is thereby much increased. Ringing and killing costs from 10s. to 25s. per acre. The preparation of land containing dead timber for the plough costs from £2 to £5 per acre. When not ring-barked, the timber, being mostly hardwood, is usually grubbed, felled, and cut up.

The supply of fencing material is good, on the whole; scarce in parts. The best woods for posts are ironbark, stringybark, oak, blackbutt, and red gum. Posts should not be too light, should have as little sapwood as possible, and the bark should be removed from most timbers to prevent the sapwood rotting.

The Land Board District is mainly pastoral, and it is considered one of the best wool-growing districts in the State. Some dairying is carried on, principally in the northern parts of the district.

West of Glen Innes and in the Inverell district there are extensive areas of cultivable land. About Tenterfield the country is granite, and suited for maize and English fruits. To the south and east of Glen Innes the country is mountainous with ridges and fairly level areas suitable for agriculture, especially about Ben Lomond, Glencoe, Stonehenge, Glen Innes and Red Range.

In the Inverell district the country is generally level to hilly basalt, with red and black soils merging into granite and trap country.

The principal crops are wheat in the Inverell district, potatoes around Guyra, Ben Lomond and Ebor, and fruits such as apples, cherries, and pears at Uralla and Kentucky. Owing to the uncertain rainfall of recent years, mixed farming is proving more profitable than wheat only, in the Inverell district. The agricultural possibilities of the Guy Fawkes district around Ebor are limited by the difficulty of access.

The native grasses are good, but, except on the highlands, rather course. The herbage is greatly improved after ringbarking. The best English and other imported grasses do well on the basalt country.

The whole district is generally well watered, and except in the Inverell locality there are not a great number of wells to be found. The cost of well-sinking runs from £1 per foot. Excavating for tanks costs from 1s. 6d. to 2s. per cubic yard.

Rabbits are fairly common throughout the whole region. Prickly-pear is prevalent in certain districts, notably west of Ashford, north-west of Bundarra, and along the head waters of the Clarence. Blackberry is found in patches all over the highland. Some dingoes are also to be found, principally in the "gulf" country and in the north-west. Many settlers who formerly ran cattle only, are dog-netting their holdings in order to run sheep.

The town of Inverell provides a good centre for marketing produce in the west. The northern railway line runs through the centre of the district, and this main line will, doubtless, eventually be connected with the coast via Dorrigo, and with Inverell from Guyra, thus giving ready access for starving stock in drought times to and from the coast, and affording facilities for agriculture in localities where it is not at present profitable.

Dubbo Land Board District.

Includes Dubbo, Gilgandra, Narromine, Warren, Nyngan, Nevertire, Tottenham, Girilambone, Coonamble.

Nyngan and Warren Districts.—The country is for the most part level; about one-fifth consists of gravelly ridges to gently undulating country, the remainder being rich black and red soil country. West of the Bogan the country is heavily timbered; east of the Bogan it is mostly plain country with heavily timbered areas. West of the Bogan the soil is mainly red and partly gravelly; elsewhere, it is black, red, and chocolate heavy soil with sandy patches. The heavy soil is extremely fertile, and generally carries a prolific growth of herbage in autumn and winter, and in good seasons is also heavily grassed; but in summer it may be looked upon as a semi-arid area.

The climate is dry, very hot in summer and mild in winter, with occasional frosts.

The rainfall is about 17 inches annually, of which about a third falls during January, February, and March.

The average temperature is about 80 degrees Fah. in summer and 51 degrees in winter.

The district is partly within the artesian area, within which water can always be obtained by boring, the average depths being 2,000 to 2,500 feet. Sub-artesian water is also obtainable in parts.

Wheat-growing—and it only to a very limited extent—is the only class of farming carried on, the district being essentially a pastoral one.

The principal timbers are box, pine, belar, myall, yarran, supplejack, and rosewood.

The grasses are all of good fattening qualities, and this is one of the best stock districts in the State, though in parts not heavy carrying. West of the Bogan the chief grasses are corkscrew, spear grass, kangaroo, blue, weeping love, and star grass. East of the Bogan, creeping salt bush, Mitchell grass, blue grass, star, couch, and umbrella grasses predominate. Barley grass is also in evidence.

Clearing of dead timber costs about 20s. per acre, varying with the nature and density of the timber. Most of the timbers are easily killed except gum and box.

Timber for fencing is plentiful in the Nyngan district; limited about Warren. The timbers best adapted for posts are yarran, box, gum, and pine, *with pine and yarran for rails, but rails are not largely* used.

White ants attack the hardwoods where they are sappy, the best ant-resister apparently being the pine. There is very little charring done now.

The cost of well-sinking runs from 15s. per foot for the first 50 feet, up to 30s. for greater depths. Excavation for tanks costs from 1s. to 1s. 3d. per cubic yard.

Transport is for the most part over level country on black or red soils, which are very soft in wet weather.

The Dubbo District.—The country in the Dubbo district, which includes the southern and eastern portion of the Land Board District, varies in character. To the north of Dubbo, towards Nevertire and Gilgandra, it is *generally undulating to flat, whilst to the south, towards Wellington, it is* hilly in character, and towards Tomingley very hilly.

The soils vary from sandy loams to rich red and chocolate loams and black soil plains, the latter with clay subsoils. On the higher levels the soil is red and of a more loamy nature, and sandy to gravelly on the ridges.

The climate is hot and dry, especially in the western part of the district. In the eastern portion the climate is milder, with a better rainfall. It is very hot in the summer; the winters are mild and bracing. The mean summer temperature for this district is about 76 deg. Fah., with a winter average of 49 degrees.

The rainfall at Dubbo is 22 inches annually.

The principal crop is wheat, which is grown extensively about Narromine, Eumungerie and Dubbo, and in the southern parts of the district. Lucerne is also grown, and does splendidly on the river flats.

The principal timbers are box, pine, buddah, wilga, mallee, ironbark, yarran, gum, myall, coolabah, belar, bull oak, currawong, red box, ironwood, a little kurrajong (fodder tree), whitewood (fodder tree), needlewood, &c.

The grasses are of good fattening quality, and include umbrella grass, corkscrew, wallaby, crowfoot, and barley grass.

For clearing dead timber the cost is from 7s. 6d. to 25s. per acre; green timber costs from £1 10s. to £4. Yankee grubbing is not extensively practised. The cost would be from 10s. to 15s. per acre.

Fencing material is fairly abundant and in most parts good. For posts, box, pine, ironbark, yarran, and buddah are chiefly used. Pine posts withstand white ant best, but yarran and buddah are exceptionally lasting. Charring butts is resorted to in some cases to protect posts from white ant and rot, but it is not a general practice.

Post and rail fences are hardly ever used. Their cost would be prohibitive for general use. *Cattle-proof fences cost from £40 to £60 per mile* for 4-wire fences, but these fences are little used. The cost of 6-wire sheep fences most generally in use is from £50 to £70 per mile. Rabbit-proof fencing costs from £100 to £140 per mile. For well-sinking the price is from (say) 20s. per foot for the first 50 feet, the cost increasing with the depth up to 25s. to 30s. per foot.

The cost of excavating for tanks, which is now chiefly done with scoops, is from 1s. per cubic yard.

The transport is level in the western part and hilly in the eastern parts of the district. The roads are for the most part good and hard except in wet weather.

The Coonamble District embraces the northern and eastern part of the Dubbo Land Board District. Except for the Warrumbungle Mountains in the east, the country is flat in character, with rich black and red soils, alternating with belts of sandy soil. The climate is hot and dry, with a rainfall of from 17 to 25 inches annually. The average temperature in summer is 80 deg. Fah., and in winter 51 deg. Fah. It is at present mainly a pastoral district. Agriculture has considerably increased in the south-eastern part and overshadows pastoral pursuits in a limited area in the locality of Gilgandra and the eastern side of the railway between Dubbo and Gular. Maize is grown under irrigation, but only in small areas.

The chief timbers are yarran, box, pine, belar, gum, buddah, and ironbark, with plenty of edible scrubs such as myall, wilga, kurrajong, rosewood, wild orange, whitewood, and leopard-wood.

The grasses are Mitchell, wallaby, blue, sugar, umbrella, star and barley grass, with winter and spring herbage, saltbush and cotton bush.

Yankee grubbing, except in grazing areas, is on the decrease. The present cost of ordinary clearing is about 15s. per acre in dead country. An estimate for green country is not reliable, as so little is done, but probable cost ranges up to £3 per acre. About three-fourths of the district is plain country or open forest.

The supply of fencing material is ample in most of the timbered parts of the district; box, pine, buddah, yarran, ironbark, and gum are used for posts. White ants are said not to be troublesome in this district.

Neither post and rail, nor ordinary wire cattle-proof fences are used. The cost of a 2-wire (No. 8), with barbed wire on the top, would be from £38 per mile.

For a 6-wire (No. 10) sheep-proof fence with 11-foot panels, the cost would be from £40 per mile upwards.

For rabbit-proof fencing, 42 in. netting on sheep fence, up to £140 per mile.

Wells cost from 15s. to 30s. per foot, according to the depth. The cost of artesian boring is 20s. to 25s. per foot. Excavating for tanks runs from 1s. per cubic yard.

Transport is mostly over level and soft country, except in the eastern part, which is somewhat hilly.

The district includes extremely good pastoral country, the grasses are fattening, and disease amongst stock, with the exception of sheep blow-flies, is almost unknown. The area is within the artesian basin and artesian water is obtainable by boring.

Forbes Land Board District.

Includes Forbes, Parkes, Grenfell, Barmedman, Temora, Wyalong, Ardlethan, Ariah Park, Eugowra, Condobolin, Trundle, Peak Hill, Bogan Gate, Tullamore.

The country comprised in this district is of fairly uniform character, being for the most part undulating to flat. There is some hilly country at the eastern end of the district. In the western and southern parts the country is for the most part flat. The soil varies—the typical soil being a rich red loam, generally with a rather stiff subsoil; chocolate loams, clayey loams, black clayey loams and sandy loams of a light colour are represented, and black alluvial soils are found on the river flats.

The climate is fairly even over the district, the average summer temperature being about 76 deg. Fah., with a winter average of 56 deg. Fah., the western portion being somewhat hotter in summer. The district generally may be described as rather dry; the mean annual rainfall varies from 24 inches on the east to 17½ inches on the west. It is a good, healthy climate.

A considerable area is cultivated in the eastern and southern part of the Land Board District; the western part is used chiefly for grazing, but even here mixed farming is gradually increasing. The principal cereals cultivated are wheat and oats, both for grain and hay. Mixed farming is generally followed. Lucerne, sorghum, Sudan grass, &c., are grown on some of the alluvial flats. All kinds of fruit grow well throughout the district, and especially about Grenfell and Forbes, and generally in the more eastern

part of the district. The river country is extremely well adapted for irrigation, and the further development of this district depends largely on the closer settlement of these rich lands, which are capable of carrying a big farming population.

The principal timbers are pine, white box, yellow box, red gum, ironbark, kurrajong, myall, belar, wilga, and yarran. In the western part there are fairly large areas of mallee country.

The grasses in general are of a good fattening nature—corkscrew, silver grass, blue grass, panic and umbrella being the principal summer grasses, with barley and other grasses in the winter. Crowfoot, trefoil, clover, &c., are also fairly abundant. Generally the country is good, sound pastoral country.

The greater part of the district has been improved by ringbarking and scrubbing, the present cost of which, exclusive of suckering, would be 1s. to 3s. 6d. per acre.

To clear dead timber for the plough costs from 10s. up to 30s. per acre, according to the density and nature of the timber.

Yankee grubbing is extensively adopted, and costs from 5s. to 17s. 6d. per acre, according to the density and nature of the timber.

To clear green timber for the plough the cost varies from £2 up to £5 per acre. In the case of mallee scrub this can be rolled down at a cost of about 15s. per acre, and then burnt off.

The supply of timber suitable for fencing is still fairly good in most parts, though it is diminishing, especially in the eastern part of the district. For posts, ironbark, white and yellow box, pine, red gum, and yarran are the best timbers. Pine, yarran, red gum, and ironbark are said to be immune from the attacks of white ant, which is plentiful over the greater part of the district. The best fence for all kinds of stock is said to be one made of split posts 8" x 4" or 10" x 3", 22 inches in the ground, with five wires and one barbed wire on top; the height of the top wire should be about 3 feet 7 inches from the ground. The cost for such a fence would be about £52 per mile. For sheep the fence may be lower and the posts further apart.

Other estimates for sheep fencing vary from £38 up to £52 per mile.

Rabbit-proof fencing costs from £90 to £135 per mile.

The Lachlan River contains permanent water, and on most of the river country good water can be obtained from wells, at depths up to about 40 feet. A number of bores have been put down to tap the sub-artesian supply, with varying success; in some instances the water has been found too brackish for general use. In the eastern part of the district there are occasional springs, but speaking generally, and excluding the country with river frontage, tanks, and in some cases, dams, are relied upon for water supply.

Nearly all over the district there is good holding ground for tanks, and sinking is fairly easy.

For excavating tanks the cost varies from 10d. to 1s. 4d. per cubic yard; the average cost in good seasons would be about 1s. per cubic yard.

The district is well served by railways. Access by road is generally good, except during wet weather and a few days thereafter; where the roads are unformed, and more especially on the river country, they become very heavy. The roads generally are level or of easy gradients; a fair amount of formation has been effected on the main roads and near the towns.

Goulburn Land Board District.

Situated in the south-eastern corner of the State; extending westerly to the Snowy Mountains, Kiandra, Burrinjuck Dam, Jugiong, and Galong, and northerly to the Lachlan and Crookwell Rivers, and the head of the Abercrombie River; embracing the Southern Tableland to as far north as Mittagong, and part of the South Coast from Durra Water, near Bateman's Bay, to Cape Howe, and including the following towns and districts, viz.:—

1. *Southern Tableland.*—Robertson, Mittagong, Bowral, Moss Vale, Taralga, Crookwell, Goulburn (City), Bungendore, The Federal Territory, Queanbeyan, Braidwood, Cooma, and Bombala.
2. *Western Slopes.*—Gunning, Yass, Galong, Boorowa.
3. *Coastal.*—Eden, Bega, Bodalla, and Moruya.

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1. *The Southern Tableland* occupies the bulk of the Land Board District, and is traversed throughout its length by the Main Dividing Range. The country is mostly undulating to hilly, with mountains in places. The southern end is known as Monaro. The formation is granite, basalt, slate, and sandstone with outcrops of limestone.

Soils vary from light sandy to dark chocolate loam, with some alluvial on the river banks.

There are areas of plain and very thinly timbered country around Goulburn, Queanbeyan, Cooma, Bombala, and Breadalbane, the soils being of granitic and basaltic origin.

The climate is mild in summer and somewhat cold in winter. Frosts occur from May to October, but on the mountains, particularly on the Southern Alps, the period of liability is longer. The average rainfall varies from 20 inches at Cooma to 40 at Moss Vale, but at Robertson the average is 69 inches, and at Kiandra 63 inches, the excess being due to coastal and mountain influences respectively. The ruling average is, however, about 24 inches per year. The altitude varies from 2,000 to 3,000 feet above sea level.

The tablelands are served by the Main southern railway, and by the branch lines Goulburn to Bombala and Goulburn to Crookwell and Taralga.

The road systems are extensive and convenient, the surface and grades being generally good.

The principal industries are grazing, sheep and cattle. The tablelands are suitable for the production of strong Merino and crossbred wool, and mutton sheep. The carrying capacity is from 1 to 2 acres per sheep on the improved lands.

Dairying is carried on extensively in the Moss Vale, Bowral, Robertson, Taralga, and Crookwell districts, and parts of Monaro; potato and mixed farming at Moss Vale, Crookwell, and Taralga, and part of Goulburn district; vegetables are grown extensively around Moss Vale and Bowral; wheat and oats for grain, and hay practically throughout the tablelands in moderate degree; lucerne in small patches on river and creek flats, especially near Cooma, Bombala, and Crookwell. Cold climate fruits do well throughout, especially between Goulburn and Moss Vale.

Goulburn is an important store stock market, and local markets are established at all the principal towns.

Butter factories are established in the Moss Vale, Bowral, Crookwell, Taralga, and Goulburn districts.

A flour mill is established at Goulburn.

There are large areas of inferior and undeveloped country throughout the tablelands, the better parts of which, together with the Snow B lt, are largely availed of for relief purposes in time of drought.

The prevailing timbers are brittle, blue, ribbon, and red gum, stringybark, yellow box, messmate, peppermint, argyle apple, bastard apple, mountain ash, (gigantea and brown barrel), pine, sallee, wattle, and oak Milling timber is obtained in the Moss Vale end of the district, around Braidwood and parts of the Snowy Mountains and along the coast ranges. Suitable fencing timber is conveniently obtainable in most districts. The main timb r areas are included in the State forest reservations.

The classes of fencing mostly adopted are 4, 5, 6, and 7 wires and rabbit-proof netting. Split rail fencing is scarcely ever erected now. Fencing costs from £45 to £70 per mile for wire fencing, and from £90 to £150 for netting, according to the class of material used.

Ringbarking and killing timber and destruction of aftergrowth for grazing costs from 5s. to 25s. per acre. Clearing for cultivation costs from £1 to £5 per acre for dead timber, and from £8 to £40 per acre for green timber.

There is extensive tourist traffic throughout the tablelands, the principal items of attraction being Wombeyan Caves, waterfalls in Moss Vale district, Lake George, the Snowy Mountains, trout fishing, and the Federal capital.

A natural water supply is provided by Wollondilly, Shoalhaven, Upper Murrumbidgee and Snowy Rivers, with their tributaries, and, in addition, springs are fairly plentiful. Tanks are necessary in some localities. The cost of excavation varies from 1s. 3d. to 2s. per cubic yard.

There are large areas of Crown lands available, mostly of inferior grazing capacity and suitable only for grazing, and, although a great proportion is sound for sheep, the cost of improvements and liability to rabbit infestation detract from its value.

The Western Slopes extend roughly from Gunning to Harden, and include Yass, Boorowa, Binalong, and Galong. The country is generally undulating to hilly, but mountainous country fringes the area in parts. The formation is principally granite, with small patches of slate and a little basalt and limestone. The soil is gritty or clayey loam. There are considerable areas of country the timber on which is very open. Timber is generally white and yellow box, bastard apple, stringybark, pine, oak, and ironbark.

Water supply is partly provided by the Boorowa and Upper Lachlan Rivers, their tributaries, and streams feeding the Murrumbidgee River. Tanks are necessary in many parts, costing 1s. 3d. to 2s. per cubic yard to excavate. The climate is moderate to warm; the altitude varies from 1,200 to 1,700 feet above sea level. Average rainfall varies from 20 to 25 inches.

The district is served by the Main southern railway and the Boorowa branch line. The road systems are convenient, the roads being generally good and on moderate grades.

The principal industries are grazing and some wheat-farming. Lucerne is grown in small quantities. The secured lands have a capacity of from $\frac{3}{4}$ to $2\frac{1}{2}$ acres per sheep. Wheat yields average about 15 to 20 bushels.

Stock markets are established at the principal towns, and provision has been made for stacking wheat at convenient railway sidings.

There is a flour mill at Yass and another at Murrumburrah just outside the district. There is a comparatively small area of inferior and undeveloped Crown lands. Timber for fencing is fairly plentiful and of very good lasting

quality. There are a few forest reservations to provide for the future. The natural grasses are relied upon for pasture purposes; they being generally of high nutritive value. The country fattens stock readily in fair seasons. The principal tourist attraction of the district is the Burrinjuck dam situated on the Murrumbidgee River. Improving land for grazing costs from 5s. to 25s. per acre, subsequent picking up and burning off 10s. to £2 per acre. Clearing green timber for cultivation costs £3 to £10 per acre according to density. The timbers generally are very hard, but burn readily when killed. The class of fencing now adopted is six or seven wires, costing from £50 to £70, and wire netting costing from £90 to £150 per mile.

South Coast.—Undulating and hilly, rising to mountainous approaching the tableland. The formation is mostly granite and slate, with basalt and diorite patches. The soils vary from sandy and light loam to chocolate and clayey with rich alluvial on river flats. The climate is even and moderate. Rainfall averages about 35 inches per annum. The South Coast is served by the ports of Twofold Bay (Eden), Merimbula, Tathra, Bermagui, Moruya, and Bateman's Bay, and is well intersected by good roads with regular motor services—Nowra to Eden extending to Orbost (rail terminus Vic.), Cooma to Bega, Braidwood to Moruya, Braidwood to Bateman's Bay, and Bombala to Panbula.

The principal industries are dairying, mixed farming, grazing, pig-raising, timber-getting, fishing and oyster culture. Sheepbreeding and woolgrowing are increasing in favour. The South Coast is noted for its dairy pastures, while maize, lucerne, hay, fodder, fruit and vegetable crops do well. Butter factories are established at Panbula, Bimbaya (Candelo), South Wolumla, Bega, Bemboka, and Cobargo; cheese factories at Kamaruka, Tilba, Forster's Bay (Nooroooma), Bodalla, Moruya, and Mosquito Bay. There is a bacon factory at Merimbula.

The timbers are mostly spotted, grey, and red gum, box, black-butt, apple, bloodwood, ironbark, woollybutt, stringybark, mountain ash, peppermint, oak, mahogany, tea-tree, honeysuckle and wattle. Wattle culture for tan bark is carried on in different parts of the district to a moderate extent. A limited quantity of eucalyptus oil is produced at Nerrigundah. The district is well watered by rivers and permanent creeks. There are considerable areas of inferior and undeveloped country behind the settled districts and along the coast line.

There is extensive tourist traffic along the coast. Bateman's Bay, Nooroooma, Bermaguee, Eden, and other fishing, surfing, and beauty spots are popular with holiday camping parties. The Prince's Highway (Main South Coast road) is considerably used, and is developing as a main route between Sydney and Melbourne.

Grafton Land Board District.

The principal towns of the district are Murwillumbah and Tweed Heads (on the Tweed River); Mullumbimby (on the Brunswick River); Byron Bay, a seaport; Lismore, Casino, Kyogle, Ballina, Coraki and Woodburn (on the Richmond River); Grafton, Maclean, Lawrence, Ulmarra and Copmanhurst (on the Clarence River); Dorrigo and Coff's Harbour (both on railways); Bellingen and Urunga (on the Bellingen River); Macksville and Bowra (on the Nambucca River); Kempsey, Smithtown and Gladstone (on the Macleay).

The district embraces the north-east part of the State, extending from the Tweed Heads to a point on the coast about 12 miles north of Port Macquarie; length about 212 miles, average width about 56 miles, area about

7½ million acres. It embraces the counties of Rous, Richmond, Clarence, Drake, Raleigh, Dudley, and parts of Buller, Gresham, Fitroy, and Macquarie. The district includes the valleys of the following coastal rivers, viz., Tweed, Brunswick, Richmond, Clarence, Bellingen, Nambucca, and Macleay. The upper reaches of the Clarence and Macleay rivers are not included in this district.

On most of these rivers there are considerable areas of alluvial flats with easily-worked and fertile loamy soils, eminently suited for cultivation. The Macleay and Clarence alluvial flats are the best in quality and the most extensive. On the Richmond River the area of loamy alluvial flats is restricted, and generally consist of narrow strips along the banks of the river and creeks, running back into heavy black soil flats.

A fringe along the coast is poor, sandy country, with fairly extensive swamps near the rivers. Some of these swamps have been drained and have proved very fertile, more especially some of the peaty swamps on the Tweed River and the Mooball Swamp.

The Tweed, Brunswick, and Richmond valleys, apart from the flats, consist of undulating to steep and mountainous country, mainly of basaltic formation. The basaltic country has excellent to very fair red and chocolate to brown and black soils, well suited for dairying. This type includes the famous "big scrub" country in the Richmond River. There are smaller areas of sandstone, slate, and metamorphic formation where the soils are fair to poor, and the country more adapted for grazing. The southern part of the Richmond River watershed is largely sandstone country.

The Clarence River valley, apart from its splendid flats, is mostly of sandstone formation, with some granite, slate, and basalt. The country is undulating to steep and mountainous, the soils poor to fair, and the country adapted for grazing, and in parts for dairying in conjunction with the flats.

The valleys of the Bellingen, Nambucca, and Macleay Rivers, apart from the flats, consist of some undulating, but mostly steep and hilly country of slate and metamorphic formation with some sandstone, basalt, diorite. The soils of the Bellingen and Nambucca are generally fair, except where too steep, and when improved and grassed with paspalum are suitable for dairying. In parts this would apply to the Macleay, but the proportion of purely grazing land is much higher and the country naturally more open.

The Dorrigo plateau is situated about 20 miles from Bellingen. It is 2,000 feet and upwards in elevation, heavy brush country now partly cleared, of mixed basaltic and metamorphic formation. The basaltic country gives rise to a very good red to chocolate soil, well suited for dairying. The metamorphic country is not so good, but when improved and grassed is suitable for dairying. The water supply is excellent.

Means of access to the district are good. The main North Coast line traverses practically the whole length of the district with branch lines from Casino to Kyogle and Glenreagh to Dorrigo. From the various railway towns, road systems radiate to practically all parts of the district; the main roads and a large number of the branch roads are well metalled. Service cars

and cream lorries and vans furnish efficient means of passenger and freight transport. Modern and efficient butter factories are established in the main centres on each river.

The rainfall of the district varies from 35 to 80 inches—the heavier rainfall being on the coast and the Dorrigo, and decreasing as one travels inland.

The natural water supply is very good, being generally abundant and of good quality. Some of the lower stretches of river plains and parts of the inferior country are not naturally watered, but water can generally be obtained by sinking wells, the cost of which is 20s. per foot and upwards according to material and depth.

The district is essentially a dairying one, and is probably the best dairying district in Australia. The better parts are, with very few exceptions, closely subdivided into dairy farms and well improved. The quantity of unimproved brush and jungle country capable of profitable improvement is not considerable, and this should only be undertaken by people experienced *in that type of work. The cost of killing the jungle and brush growth, and* grassing the land varies from £6 to £12 per acre. Forest country is not so expensive to improve.

Paspalum is the main dairying grass of the district; other grasses are couch, Rhodes, water couch, cocksfoot, rye, and clovers. Recently the paspalum pastures have become more or less root bound and matted, and experiments have demonstrated that top-dressing and renovation of the paspalum are distinctly profitable. A more diverse mixture of grass is also to be desired. Kikuyu is a grass that has lately found favour, and is being used fairly extensively in the northern end of the district.

Pig-raising is the almost inseparable adjunct to dairying, and probably the second industry in importance. Generally speaking, the farmers go in for good, healthy types of pigs and the income from this source is a very helpful addition to the cream cheques.

Sugar-cane growing is an important industry in the northern end of the district. The areas used for cultivation of cane are the lower reaches of *the Tweed River (including Mooball), Richmond River, and Clarence* River. The Colonial Sugar Refining Co., Ltd., has mills at Condong, on the Tweed, Broadwater on the Richmond, and Harwood on the Clarence River. The capacity of each mill is approximately 100,000 tons of cane per annum. The industry is a prosperous one.

Apart from cane, the main crops grown are maize, potatoes, lucerne, and various fodder crops for dairy herds and pigs. Vegetables do well, also some fruits. Efforts are being made to grow passion fruit on a considerable scale at the northern end of the district, where pawpaws, mangoes, and custard apples also do well. Early beans are a profitable crop in the north-eastern corner of the district.

The cattle industry (apart from dairying) has not been prosperous recently, but recent developments indicate an improvement in this direction.

Considerable money was made in the northern part of the district out of bananas a few years back, but the bunchy-top disease ruined the industry and a number of the people engaged in it. After expert investigation a method of coping with the disease has been inaugurated, and with these restrictions the industry will probably be re-established on a smaller scale.

A quantity of bananas is still being cut, and in the vicinity of Coff's Harbour, where a number of plantations have been recently established, there is no trace of the disease.

The timber industry is still a considerable one; the timber is cut for mill logs, sleepers, girders, piles, &c. A 3-ply factory has been established at Kyogle, and is doing well.

Timber for farm improvements is generally plentiful except on the densely settled areas. The usual type of fence is of three barbed wires, and costs from £60 to £90 per mile.

The district is often referred to as the "Garden of New South Wales," and the term is apt and not misapplied.

Hay Land Board District.

Includes Hay, Carrathool, Narrandera, Barellan, Cargelligo, Hillston, Gunbar, Booligal, Moulamein, Barham, Mathoura, Deniliquin, Conargo.

This district, embracing the south-western and southern portion of the Central Division, is principally occupied as grazing country, Barellan, Yanco, Hillston, Lake Cargelligo, Narrandera, Deniliquin, Moama, Mathoura, and Barham being the chief agricultural centres. Except on the Irrigation Areas, the principal cultivated crop is wheat, for which soil and climate are admirably suited, the only drawback being the comparatively low rainfall, 12 to 18 inches, and the danger of droughts. Other cereals do well where they have been tried, and excellent malting barley is obtainable. Warm climate fruits all thrive to perfection, and good crops are always assured of citrus fruits, peaches, apricots, grapes, figs, and passion-fruit, provided a sufficiency of water is available either naturally or by irrigation. The Yanco and Mirrool Irrigation Areas are becoming important cultivated districts.

The country is for the most part flat, with a few sand-hills. Towards Narrandera and in the northern portion of the district, in the neighbourhood of Bootheragandra and Conapaira, the country is more rocky and hilly in nature. The soil varies from black and grey stiff clays to reddish sandy loams.

In the Jerilderie district the country north of the Billabong Creek is a heavy reddish soil, with the exception of the boree country, not very suitable for agriculture, whilst the better-class farming land is found south of the creek, where the soil is of a better nature.

To the north of the Murrumbidgee at Narrandera are ranges of conglomerate rock, with level country, whilst open plain country predominates south of the river. In the Narrandera district south of the Murrumbidgee, red and grey soil plains predominate. The country is for the most part open plain, sparsely timbered, except in the neighbourhood of Narrandera and towards Hillston, where it is heavily timbered. The principal timbers are pine and box, with red gum near the rivers, oak, yarran, and boree (mallee in the Narrandera, Hillston, and Balranald South districts).

The climate is exceedingly healthy, with a mean summer temperature of about 75 deg. Fah., and a mean winter temperature of 49 deg. Fah. Hot dry winds are prevalent in the summer, and the south and south-west winds in winter are frequently very cold. The extreme temperatures recorded are 122 deg. for summer and 28 deg. for winter.

The grasses are of a nutritious kind, and in good years produce as good grazing as is to be found in the State. The best winter feed is trefoil, barley grass, and crowfoot. The best grasses are white top and spear grass; other grasses are umbrella and timothy. Good summer and winter feed is saltbush and cotton-bush.

Timber for fencing is very scarce in the Hay district. Generally speaking, box, gum, and pine are the best timbers for posts. For rails timber is not used in this district. Pine is practically immune from white ant. Clearing is generally done by poisoning, fire sapping or deep ringbarking, and burning-off after four or five months, on forest country; by rolling and burning in mallee.

Timber for fencing posts costs £4 to £6 per 100 in the Hay district, whereas near Gunbar and Hillston the cost is about £2 to £3 per 100.

The cost of clearing varies a good deal; roughly, it averages 4s. 6d. per acre for grazing to 10s. to £1 for the plough, running to as high as 40s. per acre in the Narrandera district in the case of green timber. This includes ringing, scrubbing, picking-up, and burning off.

The cost of fencing is—for sheep-proof fence, £50 to £60 per mile; for rabbit-proof fencing, £80 to £100. Post and rail fences are not used.

The cost of well-sinking is about 25s. per foot up to 100 feet, including timbering and centering. There are few wells sunk in the district, water being chiefly obtained by boring. The cost of sinking a 4-inch bore with tank and windmill would be about £300. Permanent water is generally found at a depth of from 80 to 400 feet.

It is a sound, healthy district for sheep, there being practically no disease. Rabbits are well in hand, and the country carries on the average about a sheep to 3 acres improved.

There is good railway communication both with Sydney and Melbourne in the eastern and central parts of the district. The Moama to Deniliquin Railway connects the southern portion of the district with Melbourne. *Railway lines from Griffith to Hillston, and another from Barmedman to* Rankin's Springs have been completed. The cost of transportation is about 1s. per ton per mile, the roads being good natural roads, level, hard, and dry in the dry weather, soft and often exceedingly heavy when wet.

The Crown lands in the district are being measured for alienation where not reserved for specific purposes. The Murray red gum forests are a profitable asset of this State.

Maitland Land Board District.

Includes Maitland, Singleton, Muswellbrook, Scone, Merriwa, Wingen, Gloucester, Camden Haven, Wauchope, Port Macquarie, Beechwood, Taree, Stroud, Raymond Terrace, Morpeth, Cessnock, Kurri Kurri, Weston, Newcastle, Wyong, Gosford, Wollombi, Dungog.

The district embraces the coast line from Broken Bay to Race Course Headland, some 12 miles north of Port Macquarie, and stretches inland westwards along the Hunter, Manning, and Hastings Rivers. It includes a very considerable variety of country and all classes of soils. The land varies from river flats to undulating and hilly country, the latter with a general easterly slope towards the coast. The geological formation is, for the most part, carboniferous or permo-carboniferous, and includes the Newcastle coal measures. There are frequent outcrops of granite and basalt,

and occasional patches of limestone. The district is well watered by the Hunter, Manning, and Hastings Rivers and their tributaries, and the river flats are among the most fertile soils in the State. On the ridges the soil varies considerably in character, including nearly all types, from sandy or gravelly loam to heavy clay. South and west of Wollombi the soils become poorer and more sandy in character.

The climate is mild, having a mean summer temperature of about 74 deg. Fah. and a winter mean of about 53 deg. Fah. The nights in summer are usually cool, and in winter cold and frosty. The mean annual rainfall varies considerably throughout the district, being 24 inches at Scone, 34 at Maitland West, 45 at Taree, and 60 inches at Port Macquarie.

The natural water supply is good throughout the greater part of the district. In those localities not watered by running streams water can be readily conserved or obtained by sinking.

A great variety of farming is carried on, and the district is suitable for almost every kind of cultivation. The principal crops are lucerne, maize, sorghum, millet, grapes, oranges, peaches, passion-fruit, and all kinds of vegetables. Wheat is grown principally in County Brisbane, in the western part of the district. Dairying is carried on extensively in all parts of the district, and there are several large butter factories in operation.

This is one of the finest wine-growing districts of the State; and the Hunter River wines have a deservedly high popularity. The principal vineyards are in the Pokolbin and Allandale districts, County Northumberland, in which about 2,000 acres of the 7,000 acres of wine grapes of the whole State are situated.

In the country towards Wollombi grazing and dairying are carried on. The whole of the district, except near the coast, is from fair to good fattening country.

The Hunter River flats are extremely fertile, and being subject to floods their fertility is frequently renewed by the rich deposits left by the inundations.

The principal hardwoods are ironbark, tallow-wood, spotted gum, brush box, red and blue gums, bloodwood, turpentine, mahogany, blackbutt, stringybark and box. The principal softwood is pine. Beech, silky oak, coachwood, cedar, and other soft woods are also found.

The cost of clearing varies very considerably, and no very accurate data are available. Ringbarking alone costs from 2s. 6d. to 5s. per acre; ringbarking, falling, and scrubbing for pastoral occupation, from 10s. to £1. The usual practice in softwood country is to fall, and when sufficiently dry burn off. The stumps soon rot and are readily burnt off. Grubbing is not much practised in this district, except on the alluvial flats and orchard areas.

To clear the land for the plough costs, according to the nature of the timber, from £5 to £15 per acre. In heavily-timbered country it reaches as high as £40 per acre Fencing material is abundant. For posts, the woods most in favour are ironbark, bloodwood, white mahogany, box, turpentine, and grey and red gums. For rails, stringybark, ironbark, blackbutt, tallow-wood, and flooded gum. White ant is prevalent in the district. Turpentine timber is partially immune from its attacks.

The cost of a post and 2-rail fence—640 posts to the mile—is from £80 to £100 per mile.

Cattle fence—4-wire (No. 8), with 480 posts to the mile—from £50 to £80 per mile.

Sheep-proof fence—7-wire (No. 8), with 480 posts to the mile with droppers—from £50 to £80 per mile.

Rabbit-proof fence—4-wire (No. 8) with netting, 480 posts to the mile, and droppers—£120 to £200 per mile. Rabbits are plentiful in the western parts of the district.

The cost of excavating dams is from 1s. to 2s. per yard, the latter price being for deeper dams. For wells, including timbering, the cost is about £1 per foot, the price varying according to the depth.

Facilities for transport are good in the settled districts. Car services extend wherever any inducement offers, and good provision is made in town and village centres for conveyance by cars for those desiring to visit the more outlying areas. In the Maitland, Muswellbrook, Hastings, and Taree districts the roads are generally good, but soft and rough off the main tracks, and steep, but hard, at the heads of rivers. Towards the coast they are good but hilly. On the whole, the roads are fairly hard and good. Most of the available land suitable for occupation in the district is alienated.

Moree Land Board District.

Includes Moree, Warialda, Bingara, Narrabri, Pilliga, Wee Waa, Carinda, Walgett, Boggabilla and Mungindi.

Very little farming is carried on in the land district of Moree, except in the vicinity of Pallamallawa, where considerable areas are put under wheat each year. Farming is fairly extensively carried on in the south-western, southern, and eastern portions of the Warialda land district, also to a limited extent in the Bingara land district, more particularly around the town of Bingara, and fairly extensively in the eastern and central portions of the land district of Narrabri, within a 15 miles radius of the railway from Werris Creek to Narrabri, and Narrabri to Wee Waa. No farming is carried on in the land district of Walgett.

Farmers throughout this land board district, in practically every instance, combine sheep-raising with wheat-growing, as the seasons are not sufficiently certain to rely on wheat crops for a livelihood. Other than in the localities mentioned, this land board district is devoted to sheep and cattle raising. The railway communication is from Werris Creek to Narrabri, Narrabri to Burren Junction, with branches thence to Walgett and Pokataroo; from Narrabri to Moree and branches thence to Inverell and Mungindi.

The rainfall varies in different parts of the district, the western portion being the driest with an average annual rainfall of about 18 inches, whilst in the eastern (Warialda) district it is about 29 inches. Most of the rain falls during the summer months, January to March.

The temperature is fairly constant over the district, the mean for the year being about 63 deg. Fah., with a mean temperature in summer of 80 degrees, and in winter of about 52 deg. Fah.

From these figures it will be seen that the climate is hot in summer and mild in winter. Generally speaking it is hot and dry, but healthy both for human beings and stock. In the more elevated regions about Warialda and Bingara the nights are almost always cool.

The Warialda district includes flat country and rolling downs to hilly; the hilly country lies chiefly in the eastern portion of the district, and is principally basalt. In the centre are undulating downs merging into black soil plains in the west of the district. In the plain country are numerous sandy ridges where the soil is not so good, but for the most part the soil on the plains is first-class, and carries heavy belts of belar and brigalow.

A fair amount of wheat is grown in the Warialda land district in the centres previously referred to. Heavy crops are obtainable in favourable seasons, but the seasons are not sufficiently certain to rely on farming entirely. Mixed farming, sheep and wheat, is carried on with success. Very little other farming is done, except in the vicinity of the railway, as the want of easy communication prevents cultivation, except for home use. A little maize and lucerne is grown along the rivers.

The Bingara district (county Murchison) is more hilly, and even mountainous in character, and the general contour of the country is hilly to undulating, with level to undulating areas along the Gwydir, Horton, and other watercourses. The soil is principally red to chocolate, with black soil on the plains. On the hills it is more or less stony in character. Sheep and cattle fatten on the flats, but the country is used more for breeding and wool-growing than for fattening. What farming there is is mostly mixed—sheep, cattle, wheat, and a little maize.

In the Narrabri district the spurs of the Nandewar Ranges render the eastern portion hilly to mountainous, the rest of the district being mostly level plains in the western portion and level to undulating in the centre. The plain country north of the Namoi River and the western part of the district is black soil. In the Pilliga scrub country red soil predominates, a good deal of which is sandy in character with patches of grey or black soil. On the foothills in the eastern part good loamy soil is found. Wheat-farming is fairly extensively carried on between Narrabri and Boggabri, and Narrabri and Wee Waa, including the northern part of the Pilliga scrub. Successful wheat growing largely depends on the adoption of proved dry-farming methods, coupled with the running of a certain number of sheep. Liberal areas are permitted as the seasons are not sufficiently regular to rely on wheat growing or other farming entirely. Clearing dead timber in this district costs from 15s. to 30s. per acre; clearing green timber is not done and not recommended. These latter remarks would apply to the Warialda and Bingara districts.

In the Moree and Walgett districts (west and north of the Land Board District) there is some hilly to undulating country south of Moree, the remainder being plain country with heavy black soil in the north and west, and red and chocolate in the south. On the hills the land is more stony. Good wheat and hay are grown in this district in small quantities in favourable seasons, especially in the eastern portion, also citrus and summer fruit, but the country is practically given over to sheep farming. The living area for closer pastoral settlement is calculated at 3,000 to 5,000 acres.

In the Warialda district, box, ironbark, and pine are the principal timbers, with gum, apple, myall, wilga, and thick belts of belar and brigalow.

In the Narrabri district the hilly country to the east, and the Pilliga scrub carry box, pine, ironbark, belar, bloodwood, gum, and sandalwood, with coolabah, box, and belar on the plains. Considerable quantities of pine and ironbark are of commercial value in this district.

Box, ironbark, with coolabah, belar, brigalow, pine, wilga, and sandalwood are the principal timbers in the Moree and Walgett districts. Generally the timber in the district is stunted, but a fair percentage is good for commercial purposes.

The grass in the black-soil country is good and fattening, generally poor in the timbered country until ringbarked, when it is good. The principal grasses are blue, Mitchell, kangaroo, star, coolah, and wire, besides which there are many nutritious and fattening herbages during the winter months.

Ringbarking only can be done for 3s. per acre in the case of box and ironbark, rising to 7s. per acre for belar and brigalow.

Firing can be done cheaply and easily, and without danger. All the timbers burn easily, except bloodwood and gum.

Fencing material is plentiful, except in the open plains, and from fair to good in quality.

Ironbark, box, belar, coolabah, sandalwood or buddah, and pine are the best timbers for posts.

White ants are not troublesome in this district if split posts are used. Round posts with hollow centres or small hollows are readily attacked. The holes through which the wires of fences pass through the posts, are frequently attacked, and the excrement deposited by the white ant, when damp, tends to rust the wires.

Post and rail fences are not used, and cattle-proof fences are not common. The cost for a three-wire cattle-fence would be about £32 per mile. Sheep-proof fence (six-wire) costs about £50 to £70, and rabbit-proof fencing, 42-inch netting with three wires in netting and one barbed wire, from £120 to £160 per mile, the cost varying according to distance of cartage, and the facility of obtaining suitable timber. Very little wire-netting fencing is being done.

Well-sinking, including timbering, varies in cost from 20s. to 30s. per foot according to the depth. The cost of excavating for tanks runs from 1s. 3d. to 1s. 9d. per cubic yard. Excavating for bore drains costs from £15 to £20 a mile if ploughs and delvers are used.

The roads in the Moree and Walgett districts, and generally in the flat country, are fairly hard and good when dry, but bad in wet weather, and sometimes impassable. In the eastern part the roads are better, and in the ridges often hard and stony. The main roads in the hilly country are metalled.

There is very little land available for settlement in this district except of inferior quality. The extension of the railway would encourage the increase of cultivation, as there are extensive areas of rich country in all parts of the district suitable for cereals; and wheat, maize, oats, and lucerne, all give good results when cultivated.

There is a great deal of land infested by the prickly-pear in the Moree, Warialda, and Bingara land districts, with a much smaller proportion in the Narrabri district, and only a limited area infested in the Walgett district.

The price of land in the Warialda district is from £2 to £3 per acre on a freehold basis for conditional purchase. Land for settlement lease is from 10s. to 35s. per acre, carrying rental of from 1½d. to 5d. an acre.

For agricultural land in the Bingara district £4 and upwards per acre is paid on a freehold basis, and for mixed lands £2 10s. to £3 10s. The average carrying capacity of the country is one sheep to 2 acres in the Moree district, and one sheep to 2½ acres in the Walgett district.

In the Narrabri district, the neighbourhood of Narrabri itself is the most suitable for the man with limited capital, both because of the proximity to market and because water can generally be obtained in shallow wells.

In the western part of the district water is conserved in tanks or obtained from artesian bores. There is little surface water except along the Namoi, the frontage of which is alienated. The black soil should grow good wheat. The herbage makes excellent silage.

Orange Land Board District.

Includes Orange, Bathurst, Wellington, Lithgow to Blackheath, Molong, Cumnock, Millthorpe, Blayney, Carcoar, Canowindra, Cowra, Koorawatha, Eugowra, Manildra, Cudal, Mudgee, Gulgong, Dunedoo, Merrygoen, Coolah, Cassilis, Rylstone, Hillend, Wallerawang, Portland, Kandos, Burraga, Trunkey, Tuena, Rockley, Yeoval, Oberon, Wollar, Mendooran.

The district is well watered through the centre and north by the Macquarie River and its tributaries, chiefly the Cudgegong, Turon, Talleragar, Fish, Campbell, and Bell rivers, and on the south and south-west by the Lachlan river, with the Abercrombie and Belubula. It is well served with railways; the main western line passes through the centre of the district, and the Blayney-Harden line through the south-western portion, while the Molong-Forbes line, via Bumberry, connects the western part with the main line. A line from Molong to Dubbo, via Cumnock and Yeoval is now completed and open to traffic. An extension from Cowra to Canowindra to Eugowra is now completed, and has opened up further agricultural land in the south-western corner. There is also the railway line branching off the western line from Wallerawang which runs northerly via Mudgee and Merrygoen to Coonabarabran and Gwabegar, with a connecting line from Merrygoen to Dubbo, and a branch from Graboon to Coolah. The proposed railway from Maryvale to Sandy Hollow via Gulgong and Wollar will also traverse a considerable area of the district.

Bathurst lies in the centre of an undulating plain, and there is a good deal of gently undulating country south and west of the Canoblas Range from Molong to the south-west limit of the district, and also around Wellington.

The remainder is from undulating to hilly and mountainous. Near the extreme east lies the great dividing range, stretching northwards through counties Bligh and Phillip. The south-eastern corner is also mountainous, while in the north is the Liverpool connecting range to the Warrumbungles, and in the centre the Sofala, Hillend, and Hargreaves spurs; in the western portion are the Canoblas Ranges and the Harvey and Bumberry Ridges.

The climate may be classed as temperate over the whole district, being mild in summer and cold in winter, when snow is not unusual, especially on the Great Dividing Range, the highest points of which in this district are over 4,000 feet in the south-east and Canoblas areas.

The average summer temperature is about 70 degrees Fah., with a winter average of about 44 degrees Fah., the average for the whole year being between 56 degrees and 58 degrees Fah. The annual rainfall is from 26 to 31½ inches, which is very evenly distributed over the twelve months, except in extreme north and north-west centres.

The country in the neighbourhood of Orange and Millthorpe is undulating to hilly, the formation being largely basaltic, with some granite in places. The soils in this neighbourhood are, on the whole, rich red and chocolate loams, of a rather heavy type, with black soil in the valleys. Mixed and intense farming is carried on, principally sheep, cattle, pigs, oats, wheat, hay, fruit (chiefly cherries, apples, pears, grapes, plums, &c.), potatoes, peas, and dairying. Marble quarries exist at Borenore, near Molong, and at Caloola.

East from Orange and towards Lewis Ponds and Ophir the land becomes more stony and shingly on the hills, with black soil in the valleys. The principal farming here is sheep and potatoes, and access is somewhat difficult.

Towards Wellington the country is more open, with low ridges and broad valleys. A good deal of wheat cultivation is carried on here. The soil is variable, changing from good rich limestone and basalt soils to poor sandy granite soils. Slate and dioritic marble are to be found near Mullion. Limestone caves are situated near Wellington and at Borenore, near Orange. The limestone country is excellent for stud stock.

Round Molong the country varies from undulating to fairly level mixed limestone, basalt, and granite country. Works are being established for limestone. To the south and south-west of Molong the country varies from flat to undulating and hilly, with rich, red volcanic soil on the flats, and black soils in the valleys. On the higher hills the land is suited for grazing only, being generally poor, stony, and scrubby. There is plenty of very fertile soil in this part of the district, especially round Manildra, Eugowra, and Canowindra to Cowra. Promising shows of phosphate apatite are being explored on Gamboola, near Molong. Orchard areas are increasing around Molong, especially for vines, apples, pears, and stone fruits. The limestone country is excellent for horse-breeding.

In the south-western corner of the Land Board District the country ranges from rich river flats to undulating and hilly, basalt and granite being the principal soil-forming rocks. In the lower portions the soils are fairly rich to rich red and chocolate loams, with black soil in the valleys. The land here is principally used for grazing, fattening, and breeding sheep and the cultivation of wheat, maize, and oats. Lucerne does well, and is cultivated on the flats along the Lachlan. Fruits, barley, vines, rye, potatoes, and pumpkins are also cultivated in this district, and do well. This is a very progressive area.

Round Carcoar and along the Blayney line the country is undulating to hilly, with odd mountains, chiefly slate formation, with ironstone and volcanic outcrops. On the hills the soil is stony, but the lower country carries considerable areas of rich red or chocolate loam. Good black marble exists at Rockley.

Farming in this district is principally confined to sheep (crossbred lamb-raising), wheat, fruit, and potatoes. There is a good deal of first-class wheat land about Lyndhurst and Mandurama. About Forest Reef a considerable area of potatoes is grown. Grazing lucerne is being extensively sown, and values are increasing.

About Bathurst the country varies from slaty ridges with granite to undulating to flat along rivers and creeks. The soil varies from light, sandy loam to stiff clay, with occasional pipeclay. The chief crops are potatoes, tomatoes, wheat, oats, cauliflowers, asparagus, and tobacco, with maize and

lucerne on the river flats. There are some good orchards in this district, which is especially suited to cool climate fruits, such as apples, pears, &c. Gooseberries, currants, and similar fruits also do well. The climate is not first-class for cherries and grapes.

In the north-eastern portion of the district, including Mudgee and Rylstone, there is a large area of rough country on the ranges, with fertile valleys, merging into undulating and flat country. East of the Dividing Range the country rock is sandstone; to the west, slate and basalt predominate. *In county Bligh (in the northern part) basalt is the principal* soil-forming rock on the high land, the valleys having rich flats. There is also a good deal of sandstone in this district. Round Mudgee itself the country is undulating to hilly, with good fertile valleys. A little wine is made from grapes grown about Mudgee. For the most part sheep are grazed in this district, with some cattle and dairy-farming. On the flats, lucerne, maize, and wheat are cultivated, and in the cooler parts oats, potatoes, and apples. *Large cement works exist at Portland, and others at Kandos.*

Between this district and Bathurst there is a great deal of rough, mountainous *country, unsuitable for cultivation, but which when developed is* good wool country. There are arable land patches in the valleys in this district, which includes Crudine Valley, Wattle Flat, Hill End, and Sofala, where mining operations are carried on.

The eastern portion of the Orange Land Board district includes the Blue Mountains and spurs. The country is principally sandstone, high, rough to mountainous. The soil is poor and sandy, generally stony. Some fruit is cultivated in the valleys, but grazing is the principal occupation. This is fast advancing as an industrial area for cement, iron, coal, &c.

In the south-east corner, including Burraga, Tuena, and Bigga, the land is only fit for cultivation in patches, the greater portion being steep, broken, and mountainous country, which is given over exclusively to sheep grazing, good, fine wool being produced. The area around Oberon and Swatchfield is *progressing for sheep-raising, and for potatoes, peas, &c.*

Timber is fairly plentiful over the most of the district. White and yellow box are represented throughout, and are generally indicative of the better-class country. On the Dividing Range the typical Blue Mountain timbers are found, viz.:—stringybark, peppermint, messmate, black ash, mountain ash, blackbutt, apple, and white gum, red box, &c.

Over the rest of the district, in addition to white, and yellow box, the most common trees are red box, stringybark, apple, peppermint, ironbark, woolly butt; red and white gum, with pine in the Mudgee, Cowra, and Molong districts.

The grasses are generally good on ringbarked country, and include kangaroo, barley, and crowfoot. The herbage is generally stunted on the hills but good in the lowlands, and very good in the improved country. Lucerne, clovers, &c., on top-dressed land do excellently.

The cost of clearing varies a good deal, according to the district. For pastoral occupation, ringing, suckering, and scrubbing cost from 5s. to 15s. per acre. The cost is rather higher in the eastern and hilly districts, running from about 6s. per acre for white box up to 15s. to 20s. per acre for other timbers.

For cultivation, clearing dead timber runs from 20s. up to 60s. per acre. Country is very seldom cleared in the green.

Except in cleared country fencing material is plentiful. The best timbers for posts are ironbark, red box, red gum, and stringybark. White ants are not troublesome. Post and rail fences are hardly used in the district. The cost of post and split-rail fencing would be from £100 per mile.

The cost of a five-wire cattle fence is about £50 to £60 per mile; for a six-wire sheep-proof fence about £50, and for a seven-wire fence about £55 per mile.

Rabbit-proof fencing costs £100 to £120 per mile.

The cost of well-sinking varies from 5s. per foot for the first 50 feet in soft ground. This price does not include slabbing; slab wells run from 20s. per foot upwards.

Excavating for tanks costs from 1s. 6d. to 2s. per cubic yard. Neither wells nor tanks are much used in this district, as the country is generally well watered.

The cost of transport is also very variable. Motor lorry service is becoming very general. East of the Dividing Range the roads are heavy, but in nearly all the country west of the range the roads are good and hard, with the exception of the northern portion (County Bligh), where the black soil roads are troublesome in wet weather unless metalled.

The cost of transport of wool and merchandise is being reduced to a minimum under motor conditions of to-day, and the service is becoming general among settlers..

There is no available Crown land in the plain districts, and the price of good land is very high, running up to £8 to £15 per acre for the best land; river flats reaching even £40 to £50 per acre. Land suitable for mixed farming brings £4 to £7 per acre. Lower priced land is generally poor and undeveloped, with variable and reduced carrying capacities.

In addition to pastoral pursuits, generally speaking, the following are the crops principally grown in the different districts, or for which those districts are particularly suitable:—

Orange.—Apples and pears, cherries, grapes, and other cold country fruit, and potatoes, peas, vegetables, &c. Potatoes are extensively cultivated about Millthorpe.

Carcoar.—Wheat, fruit and potatoes.

Cowra.—Wheat, oats, fruit, and vines; lucerne, on the river flats. This district is well watered by the Lachlan and permanent creeks.

Molong.—Wheat, oats, fruit, and vines; lucerne on flats.
There is plenty of first-class privately-owned wheat land around Eugowra and Canowindra. The Belubula River flats about Canowindra are specially adapted for lucerne, and command high prices.

Sydney (Metropolitan) Land Board District.

Includes the coast from Broken Bay to Bateman's Bay; the Metropolitan Area, the townships and districts of Windsor, Richmond, Penrith, Parramatta, Picton, Wollongong, Kiama, Nowra, Milton, and Ulladulla.

This district includes a considerable stretch of the coast south of Broken Bay, and the country to the east of the Main Dividing Range. The formation is for the most part derived from the Hawkesbury sandstone and Wianamatta shale formations, with granite and basic outcrops. The soil

embraces almost every type represented in the State, from sandy soils to heavy clays derived from slate and basalt, with alluvial flats upon the rivers. The climate is temperate and the rainfall good. The latter may be given as 30 inches annually on the average. Being the oldest settled district in the State, all land of productive value has been taken up.

The farming carried on is chiefly dairying, fruit-culture (especially citrus fruits in the Windsor and Metropolitan districts), poultry, market-gardening, and the ordinary cereal fodder plants and roots.

There is a fair amount of timber in the district, and representatives of most of the best Australian hardwoods are still to be found. Clearing and grubbing may be put down at £10 to £25 per acre, the cost varying with the locality and the timber. For grazing, ringbarking, felling, and cleaning up the cost would be from 12s. 6d. to 40s. per acre.

Timber for fencing is still fairly abundant in the coastal districts, except in parts of the Illawarra district.

For posts red and grey gum, ironbark, box, turpentine, mahogany, bloodwood, peppermint, and redwood are all used.

For rails the best timbers are blackbutt, grey gum, stringybark, and red gum.

Turpentine is rarely attacked by white ant, which is prevalent in the district.

Post and rail fences, two-rail, 640 posts to the mile, can be erected for from £80 to £120 per mile.

Four-wire (No. 8) cattle fence, 640 posts to the mile, costs £55 to £80; and seven-wire sheep-proof fence, No. 8 wire, 528 posts to the mile, with droppers, will cost £70 to £90 per mile.

For rabbit-proof fencing, six-wire, with 42-inch netting, 440 posts to the mile, and droppers, the cost would be from £90 to £120 per mile.

Well-sinking in alluvial costs from 15s. to 25s. per foot, and excavating for tanks from 1s. 6d. to 3s. per cubic yard.

The prices are necessarily approximate, as the conditions of settlement and trade vary in this district very much, as will be realised by contrasting Central Cumberland with such places as Putty, Hawkesbury River, Burragorang, and the lower South Coast.

The transport varies considerably from level to hilly and mountainous with roads both hard and soft.

The district, both on account of its nature and its proximity to market, is better adapted to mixed farming, such as dairying, fruit-growing, poultry-raising, beekeeping, market-gardening, pig-keeping, &c., rather than to one crop.

Tamworth Land Board District.

Includes Tamworth, Manilla, Barraba, Nundle, Werris Creek, Quirindi, Bindella, *Tambar Springs, Coonabarabran, Barradine, Gunnedah,* and *Boggabri.*

The district may be conveniently divided into three divisions for the purpose of description: The eastern portion, east and west of a line through Barraba, Manilla, Tamworth, Murrurundi; the western division, with Coonabarabran as the centre; and the central or Gunnedah division.

The climate of this district is generally temperate, fairly warm in summer, with occasional frosts in winter. The coldest parts of the district are the ranges to the west of Coonabarabran, with an altitude of 4,000 feet.

The mean annual temperature varies between 57 degrees and 64 degrees Fah., according to the locality. With the same reservation, the mean summer temperature is from 68 degrees to 78 degrees Fah., and the winter from 46 degrees to 50 degrees Fah. The average annual rainfall is about 27 inches, being fairly evenly distributed. July, August, and September are the driest months.

The country round Tamworth, and in the eastern division, is undulating to steep, being composed chiefly of slate, conglomerate, granite, and sandstone. In the centre of this district, and towards the west and south of Tamworth, the country may be described as undulating to flat, with slate, basalt, and sandstone.

The soil varies over the area from chocolate and reddish soil on the hills to black soil on the plains, and light sandy loam in the scrubs.

Some limestone occurs in the neighbourhood of Tamworth.

In the western portion of the district, with Coonabarabran as the centre, the country varies from undulating table tops to rough and mountainous (the Warrumbungle Ranges are from 3,000 to 4,000 feet high); it is of sandstone and basalt formation, with a reddish sandy loam and clay soils on the ridges, interspersed with a good many patches of raw sand and black-soil plains on east and west.

The country lying between the above divisions, and in the centre of the Land Board District from Boggabri on the north, and stretching southward through Gunnedah and Bundella, is for the most part black soil plain country, with well-timbered basalt rocky nobs and undulations here and there rising to mountain ranges in the south. This portion is bounded on the north-east by the Nandewar Range, in the neighbourhood of which the prevalent soil is of a reddish or chocolate coloured sandy loam.

All classes of farming are carried on. Wheat is the principal crop in the neighbourhood of Tamworth, Manilla, Quirindi, Gunnedah, and the eastern portion of the district. There are two flour mills at Gunnedah, two at Tamworth, and one at Quirindi. Lucerne is grown extensively in counties Parry and Inglis. In this district (the south-east portion of the Land Board district), maize and barley are also cultivated. The barley is particularly good for malting purposes. Tobacco is extensively cultivated near Tamworth and Manilla. Cauliflowers and other vegetables are also grown commercially, and broom millet.

Round Tamworth, Quirindi, and Manilla there is some dairying, and butter factories have been established at Gunnedah, Tamworth, and Quirindi, which promise to become important dairying districts.

In the western portion of the district mixed farming is carried on over the greater part of the area. The black soil plains are chiefly devoted to wool and fattening, the natural grasses having good fattening qualities. Wheat and to a lesser extent maize are cultivated, the area being extended annually. Lucerne is being more extensively grown with considerable advantages on grazing areas, and fruit is successful and of first-class quality wherever it has been tried, especially round the town of Coonabarabran, with 30 inches average rainfall.

Fruit crops are only grown for local requirements, as the distance from the market is against crop production on any extensive scale. There is a flour mill at Coonabarabran, a butter factory at Coolah, and freezing works at Coonabarabran and Binnaway.

There are at present considerable areas under cultivation with a 25-inch rainfall, which is the lowest in the district, the average being 27 inches. Yields are invariably good, and absolute failure of crops is unknown, where proper farming methods are adopted.

The railway lines serving the district are Gilgandra to Coonamble, Merrygoen to Gwabegar, Werris Creek to Binnaway, Blandford to Woolbrook (part of main northern line), Werris Creek to Boggabri, and Tamworth to Barraba.

Generally speaking, water is obtainable by sinking in the Tamworth district, at depths of from 20 to 150 feet. In the Gunnedah district it is stated to be found at an average depth of 80 feet, and in the Coonabarabran district at from 40 feet to 150 feet. The cost of well-sinking is about £1 per foot. Boring plants are coming into use in the Coonabarabran district at a cost of from 15s. 6d. to 20s. per foot. The cost of excavating tanks runs from 1s per cubic yard for large tanks to 1s. 6d. for smaller ones. The cost is somewhat higher in the hilly country than on the plains.

There is plenty of timber in the district, especially on the ridges, and a great variety of timber is represented. In the eastern portion box, apple, red gum, stringybark, peppermint, yellow jacket, and a little pine and ironbark are the principal timbers.

In the Coonabarabran district, box, pine, gum, apple, ironbark, bloodwood, yellow jacket, and peppermint, with ironbark on the ridges are obtainable.

The black soil plains about Gunnedah originally carried myall, which is now dead; the balance of the flat country is principally pine, box, and scrub, such as belah, &c., with ironbark and gum on the sandy country.

Clearing costs from 10s. to 15s. per acre in old dead box country; and from 20s. to 25s. in recently dead timber. In green country clearing costs from £2 to £5 per acre, according to the timber. Ringbarking costs from 1s. to 5s. per acre. In nearly all cases the country is ringberked some time before clearing. In the Gunnedah and Quirindi districts traction engines have been tried and found to be a cheap and effective means of pulling down both dry and green timber.

The supply of fencing material is generally fair. In the eastern part of the district it is becoming somewhat scarce. There are hardly any post and rail fences except in paddocks about dwellings. Ironbark, bloodwood, and box are the best for posts, and are not attacked by white ant in this district. Belah may be used for rails, but is no good for posts.

Cattle and sheep proof fences (six-wire) cost from £45 per mile and upwards; rabbit-proof fencing from £85. Rabbits are prevalent throughout the central and western portions of the district.

Transport is fairly good over the whole district. The main roads are good, and transportation is easy, except in the mountainous country and in wet weather on the black soil plains, which are impassable when wet. The gradients are not steep, and the roads are for the most part fairly hard.

Wagga Land Board District.

This district includes the Riverina, and is bounded on the south by the Murray. It includes Young, Cootamundra, Junee, Gundagai, Tumut, Tumbarumba, Albury, Corowa, Berrigan, Finley, Jerilderie, Urana, Wagga, Koorowatha, Murrungo, Harden, Murrumburrah, and Stockinbingal.

Wagga Land District.—This district includes a variety of country, from the mountainous country on the Great Dividing Range in the eastern part to the plain country in the west. It is watered by the Murray and Murrumbidgee Rivers and creeks such as the Billabong and Yanco.

About Wagga itself, and in the portion to the north and north-east, including Junee, and Young, the country is fairly uniform, being for the most part gently undulating, with ranges, hills, and stony ridges, but no mountains. About 80 per cent. of this country is level to moderately undulating, and can be profitably cultivated. The remainder is fair to poor grazing country.

The soil over the greater part is a red clayey loam, with a deep clay subsoil. In the western portion there is a good deal of black stiff "puggy" soil, with "gilgais" or "Coolamon holes," which is better suited for grazing than agriculture.

The cultivation of wheat, oats, and barley is very successful in the district, these cereals constituting the principal crops. Sorghum, rape, lucerne, and fruit are also successfully cultivated, but to specialise in any of these products recourse must be had to irrigation, which is now being successfully carried out on the Murrumbidgee in the neighbourhood of Wagga. The number of irrigation plants on the river is rapidly increasing. The fodder crops referred to are mostly grown under irrigation on the Murrumbidgee, but there is an increasing tendency to cultivate lucerne on the higher lands as well as the river and creek flats, without artificial watering.

The climate is hot and dry in the summer, with cold and bracing winters. Frosts are frequent. The average summer temperature is about 72 deg. Fah., the winter average being about 47 degrees. The average annual rainfall is about 26 inches, and is very evenly distributed throughout the year, June being the wettest month.

The chief timbers are grey and yellow box with white pine, ironbark, stringybark, and kurrajong. On the flats, red gum and apple are the principal timbers. The hills are mostly lightly timbered with stringybark, ironbark, stunted gum, red box, she-oak, and black pine.

The grasses are good. The principal native growths are corkscrew, umbrella grass, and geranium. Barley grass and trefoil are also plentiful. Dandelion is spreading. The top-dressing of pastures with superphosphate is being practised with considerable success, and there are indications that the method will increase in popularity as results become more widely known.

The cost of clearing for agricultural purposes varies considerably; from 30s. an acre for thick and heavy box timber which has been dead for five years, down to 10s., or even less in the case of timber of lighter growth dead for twenty years. For grazing, the cost is less than half the above.

In the case of green timber, clearing for the plough will cost from 50s. to 60s. per acre. The usual procedure is to ringbark and sucker till dead, and then burn out the dead timber. Box burns most easily of any of the timbers. After the burning of the tree butt the roots have to be grubbed before ploughing can be carried out. Yankee grubbing is also practised occasionally.

Timber for fencing is fairly plentiful in places, but is being rapidly denuded and is becoming scarce in the agricultural districts.

For posts, white pine, red gum, box, and ironbark are the best timbers. White pine is the only wood that is immune from the attacks of the white ant, which is prevalent in the district. No special precautions are taken against it.

Post and rail fences are not used in this district except in short lengths where wire straining is impracticable. The cost of a six-wire stock-proof (two wires barbed) is about £70 per mile, and of a first-wire rabbit-proof fence with 42-inch netting, about £140 per mile.

The cost of well sinking is about 20s. per foot up to 50 feet. For deeper wells the cost is greater. For the Wagga Stock District the cost is given at 20s. Tanks up to 2,000 cubic yards capacity cost about 1s. per cubic yard; for very large tanks the cost would be lower.

With the exception of the south-east part of the Wagga Stock District, where some hilly country is met with, the transport is good and easy, the soil being firm and fairly hard, except on the flats, where the roads are wet and sticky in winter. Transport generally is good and easy, the soil setting firm and hard under prevailing traffic conditions, but there are many instances in the hilly parts of long and heavy grades, necessitating the employment of five horses to draw a three-ton load. The local shire councils, however, are gradually effecting improvements in grades and road surfaces, and many deviations have already been made.

The whole of the country is good for fruit-growing and general agriculture, the soil being strong and rich. The country is healthy for stock of all kinds.

The Urana District is for the most part level country, and from light boree to box and pine country within the wheat belt. About one-third *of the area is good agricultural land, and the district is well watered* by creeks, such as the Billabong and others, which, although not permanent, afford good facilities for water conservation. Good stock water is obtainable over the greater part of the district by boring to a depth of about 120 feet. The soil is for the most part a heavy loam, and in parts a stiff clay of a rich nature which is good for agriculture, and grows fattening grasses.

The climate is good and temperate, though subject to dry spells, with an average rainfall of about 18½ inches, December to March being the driest months. The average summer temperature is 75 degrees Fah., and in winter 48 degrees.

Wheat is successfully grown in the eastern and southern parts. A good deal of cultivation is carried on about Lockhart. The western part of the district is for the most part grazing country.

Box and pine are general over the whole district, with stunted red gum along the creeks.

The western part of the district is mostly plain country, with timber along the creeks. The grasses are fairly fattening, and the country carries one sheep to 2 acres.

To clear dead timber for cultivation costs from 10s. to 25s. per acre; and for grazing about 4s. per acre. These prices apply to box and pine.

The supply of timber for fencing is limited; box and pine are used for posts. The fencing is generally light in character, with fewer posts than is usual in other parts of the district. For six-wire cattle- and sheep-proof fence with posts 16 to 18 feet apart, and wooden or patent droppers, the cost is about £75 per mile.

Rabbit fences, with 12-foot panels, four-wire (one barbed), and 42-inch netting, £160 per mile.

Well sinking, with timber, costs about 10s. per foot, and tanks about 1s. per cubic yard; 2s. 6d. per chain is paid for tank drains.

Generally speaking, the eastern part of the district is the richest and most suitable for agriculture. The extension of the railway from Lockhart has promoted agricultural settlement. In the western portion, with its much lower rainfall, irrigation from the natural watercourses will be needed to render agriculture remunerative.

Corowa Land District.—One quarter of this district is undulating, the rest level. There are no creeks but it is watered by the Murray. The soil is a rich loam for the most part, in part heavy loam. On the low sand hills there is sandy loam. It is mostly all good agricultural land.

The climate is warm in the western portion, being about the same as the Urana district. Cold in winter. Rainfall about 20 inches.

Sheep farming and wheat growing are the principal agricultural operations. A good deal of wine is made, and some of the principal vineyards in the State are situated here. Orchards are also plentiful, and fruit does well. It is a good agricultural district, especially suited for mixed farming. Lucerne is grown for a considerable distance along the Murray frontage. The principal timbers are grey and yellow box, gum, and pine, with red gum on the Murray flats. The grasses are good; trefoil is especially good. Barley grass is plentiful but not much thought of in this district.

The cost of clearing dead timber for grazing is about 4s. per acre. For the plough, dead box costs about 17s. 6d. to 30s., and dead pine about 20s. per acre. With green timber no return can be expected for three years, and it would thus cost about 30s. per acre to bring it under cultivation. The supply of fencing timber is only fair. For posts, grey box, red gum, and pine are all good.

Cattle and sheep fence (six-wire), costs £75 per mile. Rabbit-proof fencing, four-wire (one barbed) with 42-inch netting, costs £160 per mile.

Well-sinking costs 15s. to 20s. per foot with timber. Tanks, 1s. per cubic yard for excavating; drains, 2s. 6d. per chain upwards.

For transport most of the district is level and firm, with good bottom in wet weather.

It is now watered by tanks, wells, and bores. It is a good wheat district, but subject to dry spells. Good stock water is obtainable over about half the district by boring to a depth of about 120 feet. Near the Murray good water is obtainable at depths of 20 to 50 feet.

Albury Land District.—About a quarter of this district is high land and hilly, becoming mountainous in the eastern portion. It is fairly watered by the Murray and by billabongs and other creeks. The balance is undulating with fairly rich grazing and agricultural land. The soil varies a good deal, being derived from granite, slate, and basalt. There are also rich alluvial flats along the rivers and creeks. The climate is temperate, very healthy, and the rainfall is regular and assured, the average being 22–24 inches. On the western side the rainfall is less certain, but absolute failure of crops from drought is unknown.

This is an old settled district; wheat, and all cereals except maize are grown successfully; fruit, vines, and mixed farming are carried on, as well as grazing.

There is a great variety of timber of good quality, the principal being box, messmate, stringybark, peppermint, gum, and pine, with red gum on the Murray.

Clearing for agricultural purposes costs about 15s. to 17s. 6d. per acre in dead pine or box country.

For grazing, about 4s. to 5s. for the above timbers, and from 7s. 6d. up to 10s. for other timbers, or in denser country.

In green timber clearing costs about 40s. to 45s. per acre in ordinary country, and up to £3 5s. in stringybark country.

The usual practice is to ringbark so as to kill slowly, keeping the suckers down.

Fencing timber is still plentiful, but becoming limited around agricultural centres.

For posts, red gum, yellow box, red box, and stringybark, are the best timbers.

White ants are very bad, but no precautions appear to be taken against them.

Cattle- and sheep-proof fences (six-wire), with 9-foot panels, cost £75 per mile; rabbit-proof fencing up to £160.

Well-sinking costs 15s. per foot timbered; tanks 1s. per cubic yard: drains 3s. 6d. to 5s. per chain.

The transport is generally good. It is a good district for mixed farming, orchards, wine grapes, and poultry: all do well. It is very healthy for stock, and the market facilities are good.

Tumbarumba Land District.—Half of this district is mountainous, the other half hilly, with good rich river flats on the Murray. The soil varies from very poor to rich, with patches of alluvial and a fair extent volcanic. The climate is good. There is usually snow on the mountains in winter.

The mean annual temperature varies from 72 degrees in summer to 46 degrees in winter. Rainfall about 35 inches. Taking the mean average of the whole district it is probably higher. Roughly it would range from 30 inches to 50 inches.

Dairying is in its infancy, but making good progress. The chief occupation is sheep and cattle grazing, but the area is suitable for fruit, apples, roots, cereals, pigs, and mixed farming.

The chief timbers are messmate, stringybark and gum, with mountain ash, mountain gum, and eurabbie on the hills. The timber is suitable for building and fencing. The flats carry fattening grasses. Those on the hills are inferior.

Cost of clearing for grazing, 10s. to 22s. 6d. per acre; cost of clearing green timber for cultivation varies considerably, being from £2 to £20 per acre. Timber takes six to ten years to kill by ringing. The timber suckers very freely, often producing a dense scrub of suckers and seedlings. The ringing has, therefore, to be done so that the timber is killed slowly, and then the existing suckers and seedlings destroyed every year.

Timber for fencing is good. For posts stringybark is mostly used away from the Murray, and red gum on the Murray.

The cost of cattle fencing (six-wire and one barbed) is about £70 per mile (without clearing the line); of sheep-proof (six-wire, No. 8) about £60. Rabbit fencing with 42-inch netting costs about £130 per mile.

Well-sinking costs 20s. per foot with timber. Tank excavation about 1s. per cubic yard.

The country is hilly and mountainous, and the transport consequently hard, though the roads are for the most part fairly good. The railway from Wagga to Tumbarumba has now been completed.

The district is well suited for mixed farming, and for intense culture. Deciduous fruits and English grasses do well. It is a favourite health resort.

Tumut District.—The Tumut River Valley is exceptionally fertile and picturesque, and compares favourably with some of the best land in the State. Maize and tobacco growing and dairying are its most thriving industries. The country immediately to the east and beyond changes abruptly into high, rough, steep, and mountainous, the geological formation, for the most part, being slate, with large intrusions of limestone at Yarrangobilly, and basalt and granite further out. This part of the Tumut district is very interesting in that it possesses some of the finest snow-clad belts and scenery in Australia, and in which is situate the highest mountain, Kosciusko, to the south-east of Tumbarumba. These hills are practically immune from droughts, and are in big request for relief grazing in times of stress elsewhere. The pasturage, however, is unsound and fluky.

The chief timbers are messmate, mountain gum, snow gum, mountain ash, stringybark, and highland apple on the hills. On the lowlands the timber consists principally of box, lowland apple, stringybark, and red gum. Of all these timbers, only the following make good fencing posts and stand satisfactorily in the ground :—Red gum, box, stringybark, and snow gum. The others mentioned are useless for that purpose.

The cost of clearing green timber for the plough is so high that it becomes unprofitable and prohibitive, being as much as £40 per acre about Batlow. To clear old rung country for cultivation varies, according to the density of the timber and the locality, from 20s. to 30s. per acre on the lowlands, and up to £10 per acre on the highlands.

A good 6-wire fence now costs about £60 per mile, and a good rabbit-proof fence about £150 per mile. The Tumut district is magnificently watered by running streams and springs, and consequently there is no need for artificial supplies by well sinking, dams, tanks, &c.

Gundagai District.—This is mostly hilly to undulating good grazing and agricultural land, with rich soil flats along both sides of the Murrumbidgee River, which river is also its main water supply, together with permanent creeks and gullies. Consequently, there is very little artificial water-supply in the district.

The timber is mostly box and stringybark on the hills, and red gum on the flats. Around Gundagai the timber is scarce, but is plentiful further out, and being of a kind which is durable in the ground, it makes good fencing posts.

The cost of a good six-wire fence is about £60 per mile, and of a good rabbit-proof fence about £150 per mile.

Western Division.

Including the country to the west of an irregular line from Mungindi through Walgett, Coolabah, Eualalong, Booligal, Balranald, and extending to the Queensland, South Australian, and Victorian borders.

The country is nearly all flat, chiefly open plains, with red sandy soil, or black-soil plains along the watercourses. There are the Barrier Ranges and some undulating country in the western portion, and some low ranges of hills to the east of Wilcannia; also north and west of this place. There are stony ridges in the north of the district. The district is lightly timbered with rather small trees. On the open plain country the red soil is very often wind-swept, and the surface soil carried away by the strong westerly winds.

The climate is very hot and exceedingly dry. The mean summer temperature in the Bourke district is 80 degrees to 83 degrees, sometimes going as high as 120 degrees. The winters are mild and occasionally cold, with an average temperature of 52 degrees to 54 degrees Fah.

The annual average rainfall varies from 18½ inches in the eastern portion to as low as 10 in the western part. At Bourke and in the eastern district quite one-third of the 18½ inches falls during January, February, and March.

It is essentially a pastoral district. Cultivation under a system of irrigation, for the production of fruit and vegetables, is confined to small areas of rich frontage land, generally in the vicinity of towns and homesteads. Mallee lands such as in the Benanee district on the Murray River, are adapted for the cultivation of wheat without irrigation.

But, on the whole, there is no prospect of cultivation becoming general for many years, and until some scheme of irrigation is adopted which will enable the country to be irrigated more cheaply than is at present possible.

The principal timbers are box, gum, pine, mulga, gidgea, wilga, yarran, coolabah, kurrajong, leopard-wood, and white-wood.

Red gum and box are the chief timbers on the river flats.

The grasses are wire grass, spear grass, barley grass, corkscrew, umbrella grass, Mitchell, cockspur, kangaroo, blue grass, and mulga grass.

Many of the scrubs are edible.

There is no clearing to speak of in the district. Ringbarking costs from 9d. to 2s. 6d. per acre, the cost varying according to the nature of the timber.

In the mallee country in the southern part of the district, the initial cost of killing the timber for grazing is said to be about 10s. per acre.

Timber for fencing is fairly plentiful and sufficient in the eastern part of the Division, generally scanty elsewhere.

Mulga and gidgea are considered to be the best timber for posts. Belar, box, pine, and beefwood are also good.

Wire fencing is in general use throughout the division.

A six-wire fence would cost £40 per mile, and more if remote from rail or river.

Rabbit-proof fencing costs £100 to £150 per mile.

The cost of well-sinking averages, for the first 50 feet, if no blasting is required, about 20s.

Artesian bores cost 15s. per foot upwards according to depth.

Tank excavation costs from 1s. per cubic yard. If through rock, much more.

Transport is, on the whole, easy, the country being flat and the roads good in dry weather; in some parts, however, the roads are heavy, being either deep sand or sandy hills. The heavy river flats are fairly good in dry weather, but impassable when wet. Motor vehicles are superseding all transport by camels, horses and bullocks.

Surface water is scarce in times of drought all over the division, but much permanent water is being obtained by boring. Many of the deep bores produce large flows; the shallow bores are chiefly pumping supplies.

Rainfall and Temperature Table.

District	Altitude above Sea Level.	Number of Years Records.	Average Monthly Rainfall.												Average Annual Rainfall.	Extreme Temperatures.		Frosts.	
			Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		Max.	Min.	Earliest Recorded	Latest Recorded.
	ft.		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	deg.	deg.		
Albury	512	69	1·53	1·69	1·97	2·01	2·60	3·49	2·86	2·88	2·02	2·57	1·92	1·73	27·87	117·4	19·9	24 March ..	6 November.
Armidale	3212	64	3·01	3·27	2·74	1·94	1·72	2·03	2·04	1·83	2·13	2·59	3·19	3·53	31·21	105·2	11·2	27 January ..	6 December.
Barnedman ..	788	40	1·59	1·26	1·43	1·33	1·25	2·11	1·67	1·51	1·58	1·55	1·35	1·97	18·44	114·3	15·5	27 April ..	26 September.
Bathurst	2206	68	2·43	2·14	2·01	1·62	1·78	1·99	1·76	1·72	1·72	2·16	2·24	2·78	23·55	112·9	13·0	11 March ..	4 December.
Bega	50	44	3·65	3·34	3·81	2·15	2·87	3·32	2·57	1·97	2·29	2·38	1·96	3·28	33·57	110·0	20·0	18 April ..	16 October.
Berrigan	388	52	1·62	1·19	1·45	1·46	1·82	2·14	1·44	1·80	1·64	1·62	1·24	1·46	17·08	112·0	24·9	13 ,, ..	16 December.
Berry	24	49	6·12	4·82	6·30	5·44	5·60	5·17	5·69	3·20	3·43	2·98	3·23	5·19	57·17	109·8	27·2	29 ,, ..	1 November.
Blayney	2844	41	2·66	1·64	2·47	1·88	2·11	3·38	3·11	2·95	2·59	2·59	2·40	2·97	29·95	....	....	1 February ..	25 December.
Bodalla	40	51	3·98	3·75	4·05	2·68	3·14	2·95	2·65	1·98	2·84	2·68	2·55	3·44	36·29	108·0	25·5	18 April ..	16 October.
Boulbala	3001	42	2·62	1·86	2·14	1·40	1·59	2·25	1·97	1·46	1·84	1·92	1·79	2·46	23·50	101·5	17·0	6 January ..	14 December.
Bourke	301	54	1·45	1·03	1·28	1·15	1·03	1·20	·90	·84	·83	·97	1·24	1·38	13·01	127·0	25·0	8 May ..	17 September.
Bowral	2171	42	3·79	2·72	4·00	2·90	3·09	3·66	3·93	2·37	2·18	2·99	3·43	3·40	38·82	104·0	18·0	16 March ..	3 December.
Braidwood ..	3157	49	2·77	2·52	2·43	2·00	2·55	2·47	2·24	1·81	1·83	2·20	2·08	2·56	27·53	105·0	16·0	2 January ..	27 ,, ..
Brewarrina ..	430	52	1·99	1·63	1·52	1·05	1·05	1·59	1·04	·93	1·14	·98	1·26	1·55	15·53	130·0	28·0	18 February ..	1 September
Bundarra	2900	41	2·63	2·43	2·82	1·88	1·66	2·38	1·78	1·95	2·04	2·61	2·96	3·49	29·74	106·0	14·0	10 ,, ..	2 November.
Carcoar	2325	46	2·53	1·69	2·06	1·88	2·13	3·80	3·08	2·95	2·79	2·73	2·39	3·40	30·10	105·0	18·9	2 January ..	3 December.
Casino	82	53	5·18	5·58	6·84	3·07	3·12	2·59	2·53	2·01	2·11	2·89	3·56	4·03	43·20	112·0	21·0	15 April ..	12 October.
Cassilis	1500	55	2·47	2·25	2·13	1·47	1·68	1·93	1·70	1·70	1·74	1·67	1·97	2·45	23·16	109·5	19·0	10 March ..	30 November.
Coltsencleh ..	471	42	2·05	2·00	1·86	1·16	1·61	1·36	1·13	1·08	1·28	1·57	2·10	1·86	18·90	115·5	19·0	13 May ..	12 October.
Condobolin ..	700	46	1·70	1·26	1·49	1·28	1·42	1·68	1·28	1·50	1·23	1·35	1·23	1·65	17·07	115·0	20·0	26 April ..	12 ,, ..
Coolamon	823	39	1·43	1·40	1·53	1·55	1·72	2·46	1·96	1·74	1·97	1·89	1·35	1·39	20·06	118·5	25·0	25 ,, ..	2 ,, ..
Cooma	2617	61	2·10	2·01	1·86	1·23	1·24	1·39	1·15	·90	1·61	1·67	1·73	1·89	18·22	112·0	11·0	5 January ..	24 December.
Coonamble ..	590	47	1·98	2·00	1·89	1·49	1·52	1·63	1·37	1·23	1·38	1·41	1·64	1·89	19·54	115·0	21·0	9 April ..	10 October.
Cootamundra ..	1082	38	1·78	1·25	1·74	1·85	1·95	2·84	2·25	2·28	2·02	2·07	1·64	1·82	23·49	112·0	19·2	25 February ..	7 November.
Corowa	503	37	1·29	1·16	1·49	1·31	1·78	2·70	2·02	2·02	1·90	1·76	1·41	1·40	20·24	112·0	21·0	4 April ..	15 and 16 October.
Cowra	978	42	2·22	1·48	1·91	1·76	1·68	2·62	1·95	2·02	2·08	2·01	1·59	2·40	23·72	113·0	21·0	16 ,, ..	24 November.
Crookwell ..	2900	42	2·95	1·63	2·49	2·10	2·42	4·18	3·56	3·39	2·99	2·78	2·97	2·58	32·75	100·0	18·0	16 January ..	15 December.
Deniliquin ..	311	67	·90	1·07	1·33	1·33	1·07	1·87	1·30	1·44	1·61	1·49	1·14	·96	16·20	116·5	22·0	23 March ..	6 October.
Dubbo	870	54	2·06	1·63	1·99	1·75	1·83	2·09	1·66	1·74	1·75	1·55	1·99	2·19	22·14	115·4	16·2	14 ,, ..	1 November.
Eden	107	55	3·45	3·08	3·32	2·69	3·29	3·21	2·46	2·12	2·59	2·63	2·38	2·43	33·76	106·0	29·3	Not reported.	Not reported.
Forbes	781	51	1·66	1·51	1·59	1·57	1·64	1·95	1·59	1·73	1·76	1·67	1·31	1·76	19·74	111·0	23·0	6 May ..	5 November.

RAINFALL AND TEMPERATURE TABLE—*continued.*

District.	Altitude above Sea Level.	Number of Years' Records.	Average Monthly Rainfall.												Average Annual Rainfall.	Extreme Temperatures.		Frosts.	
			Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		Max.	Min.	Earliest Recorded.	Latest Recorded.
	ft.		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	deg.	deg.		
Gilgandra	942	43	2·20	1·82	2·05	2·02	1·84	2·18	1·86	1·78	1·54	1·56	1·95	2·48	23·28	*109·0*	*21·0*	*16 April*	20 November.
Glen Innes	3518	45	4·15	2·91	2·81	*1·69*	1·75	2·40	1·98	1·95	2·03	2·88	3·02	4·02	31·50	101·4	16·0	6 February	15 December.
Goulburn	2097	62	2·61	2·20	2·14	1·70	1·98	2·05	1·80	1·80	2·09	2·12	2·10	2·29	24·88	111·0	*13·0*	*19 March*	7 ,,
Grafton (1)	29	54	4·84	4·61	4·42	3·49	2·88	2·93	2·24	1·57	1·92	2·45	3·14	3·71	37·80	114·0	34·9	23 April	*31 October.*
Grenfell	1238	41	1·99	1·62	1·87	1·76	1·84	2·85	2·31	2·19	2·10	1·90	1·63	2·28	24·34	109·0	23·0	25 March	*1 November.*
Gunnedah	874	47	2·31	2·32	2·22	1·53	1·67	1·84	1·61	1·89	1·65	1·89	2·07	2·70	23·70	114·0	19·0	27 April	12 October.
Gulgong	1476	45	2·40	1·93	2·27	1·87	1·82	2·40	1·88	1·80	1·92	1·93	2·20	2·79	23·21	109·0	26·0	20 ,, ..	*14 September.*
Hay	310	46	·82	·91	1·09	1·10	1·47	1·75	1·21	1·39	1·28	1·15	1·02	·98	14·08	117·3	22·9	20 ,, ..	1 November.
Holbrook	858	42	1·68	1·54	1·95	1·80	2·36	3·81	2·90	2·76	2·48	2·32	2·00	2·05	27·71	108·9	20·0	1 ,, ..	29 October.
Inverell	1980	52	3·65	2·80	2·79	1·86	2·01	3·34	2·95	1·92	2·06	2·49	2·68	3·42	30·07	*105·5*	*14·0*	19 January	6 November.
Jerilderie	364	39	1·91	·86	1·65	1·14	1·57	1·91	1·29	1·61	1·33	1·26	1·17	1·01	15·21	....	....	23 May	8 September.
Jerry's Plains ..	150	40	2·91	2·23	2·55	1·80	1·66	1·90	2·12	1·30	1·72	1·69	2·25	2·86	25·09	*118·0*	*19·0*	*29 April*	9 October.
Junee	985	35	1·27	1·16	1·58	1·59	1·78	2·53	1·92	1·91	1·85	1·86	1·56	1·60	20·61	111·9	21·0	7 March	30 November.
Kempsey	30	44	4·57	5·09	5·06	3·85	3·03	3·38	3·28	2·75	2·39	2·74	3·20	4·18	44·42	113·0	21·0	7 April	*1 ,,*
Kiama	18	29	4·18	3·50	4·76	4·46	5·15	7·61	6·52	5·18	5·89	5·61	5·74	4·20	40·78	....	....	25 June	19 July.
Kiandra	*4640*	52	*4·09*	3·02	2·86	4·07	5·72	8·70	6·50	6·03	6·72	6·52	4·63	4·19	64·04	91·0	1·0	6 January	*29 December.*
Kurrajong Heights	1870	58	5·72	5·79	5·99	4·33	4·11	2·95	3·07	2·31	2·75	*3·01*	*4·01*	4·98	49·02	....	....	.....	.....
Lismore	52	43	5·60	*6·44*	7·34	4·73	4·03	3·41	3·58	2·60	2·56	2·41	3·55	4·36	51·21	113·0	23·0	28 April	17 October.
Maitland, West ..	40	59	3·31	3·23	3·72	2·96	2·76	2·51	2·87	2·11	2·63	2·18	2·34	3·26	33·88	*114·0*	28·0	10 May	9 November.
Manilla	1287	43	3·21	2·22	2·31	*1·77*	1·50	2·06	1·62	1·18	1·73	2·15	2·55	2·97	25·58	....	....	24 April	11 October.
Molong	1736	42	2·46	1·77	2·34	2·13	2·17	2·89	2·40	2·50	2·25	2·15	2·05	2·75	27·06	*109·0*	18·0	28 March	6 November.
Moree	680	47	2·67	2·03	2·45	1·26	*1·70*	1·95	1·48	1·33	1·44	1·81	1·99	2·38	23·09	117·3	19·0	22 April	12 October.
Moruya Heads ..	55	51	3·75	3·16	3·99	3·97	3·23	2·59	2·56	1·96	2·73	2·60	2·29	2·80	35·03	114·8	22·6	29 May	8 ,,
Moss Vale	2205	54	3·77	3·25	3·69	3·20	3·55	5·67	4·07	2·45	2·40	2·82	2·58	3·04	38·47	106·0	18·9	19 January	30 November.
Mudgee	*1636*	52	2·15	2·07	1·97	1·77	1·98	2·61	1·97	1·99	2·18	2·09	2·08	2·70	25·56	108·0	15·0	22 March	*3 December.*
Murrumburrah ..	1268	42	2·06	1·32	1·91	1·90	1·78	2·81	2·21	2·22	2·05	*1·88*	1·63	2·14	23·91	114·9	16·0	25 February	19 ,,
Murrurundi	1546	55	2·92	2·78	2·48	2·13	2·04	3·03	2·48	2·51	2·32	2·35	3·01	3·37	31·02	109·0	18·0	30 March	9 November.
Murwillumbah ..	19	33	9·48	8·44	9·81	5·92	5·61	4·57	3·82	3·52	3·95	3·27	4·16	5·74	*66·29*	....	....	8 May	13 August.
Muswellbrook ..	477	56	2·36	2·23	2·29	*1·67*	1·72	2·06	1·96	1·58	1·66	1·68	2·05	2·62	23·79	117·6	19·0	21 April	21 October.
Nagandera	576	46	1·37	1·08	1·32	1·35	1·55	2·11	1·45	1·60	1·46	1·59	1·23	1·04	17·15	114·5	21·0	*20* ,, ..	*16* ,,
Narrabri	697	56	2·70	2·62	2·53	1·62	1·95	2·35	1·87	1·65	1·85	1·81	2·27	2·74	25·76	119·9	18·4	19 March	4 November.
Narromine	783	34	1·84	1·24	1·63	1·48	1·42	2·17	1·57	1·69	1·27	1·14	1·53	1·68	18·57	....	....	24 April	26 September.

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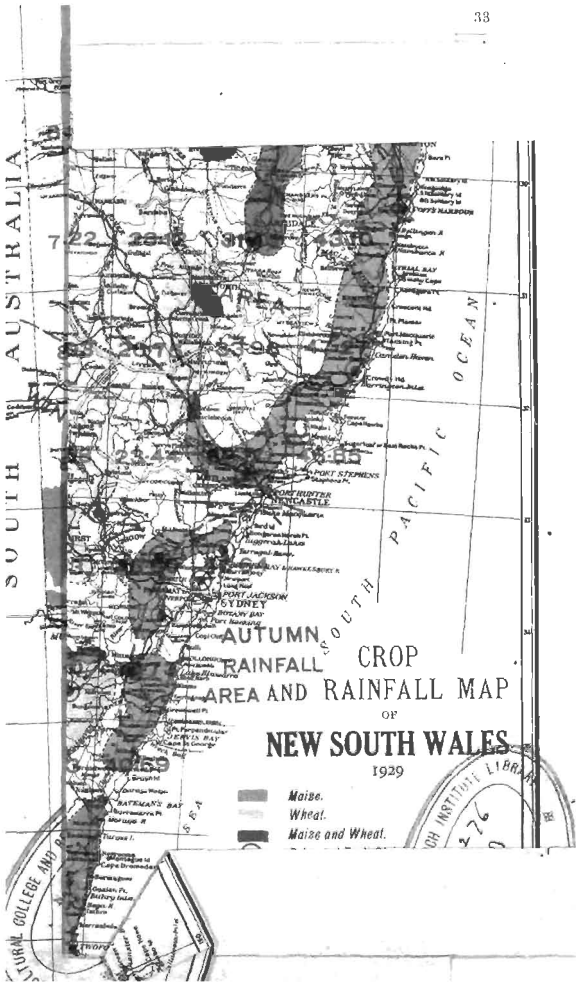
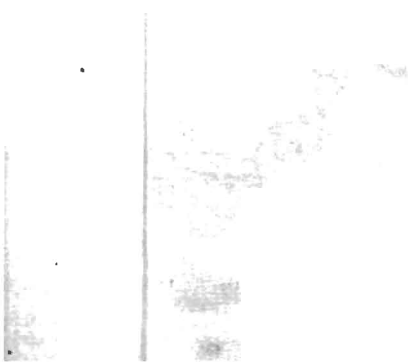

SOUTH AUSTRALIA
SOUTH PACIFIC OCEAN
AREA
PORT STEPHENS
NEWCASTLE
PORT JACKSON
SYDNEY
BATEMAN'S BAY
AUTUMN
RAINFALL
AREA AND RAINFALL MAP
OF
NEW SOUTH WALES
1929
Maize.
Wheat.
Maize and Wheat.



RAINFALL AND TEMPERATURE TABLE—*continued.*

District.	Altitude above Sea Level.	Number of Years Record.	Average Monthly Rainfall.												Average Annual Rainfall.	Extreme Temperatures.		Frosts.	
			Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		Max.	Min.	Earliest Recorded.	Latest Recorded.
	ft.		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	deg.	deg.		
Nyngan	581	44	1·91	1·77	1·44	1·32	1·62	1·41	1·12	1·24	0·97	0·95	1·29	1·79	16·55	110·0	26·8	24 April ..	21 September.
Orange	2843	54	2·05	2·39	2·64	2·46	2·90	4·33	3·39	3·40	2·98	2·97	2·69	2·74	34·96	1·6·0	19·0	10 January ..	16 December.
Parkes	1035	37	2·11	1·40	1·84	1·51	1·04	2·36	1·86	1·86	1·98	1·51	1·78	1·96	21·11	109·0	27·0	28 April ..	13 October.
Parramatta.. ..	49	69	3·49	3·51	4·18	3·21	3·02	2·88	3·02	2·39	2·42	2·21	2·86	2·92	35·65	109·0	36·8	25 May	8 September.
Penrith	89	50	2·84	2·39	2·92	2·41	2·42	1·98	3·25	1·79	1·62	1·92	2·29	3·51	29·11	.....	.....	.....	.....
Picton	552	47	3·27	2·53	3·42	2·84	2·36	2·39	2·04	1·66	1·85	2·19	2·10	3·02	30·24	114·0	19·7	27 March ..	30 November.
Pilliga	773	44	2·30	1·89	1·59	1·32	1·76	1·88	1·54	1·26	1·15	1·37	1·59	2·19	20·59	116·9	23·9	11 May	24 September.
Port Macquarie ..	44	65	5·58	6·81	6·23	6·03	6·11	4·41	4·40	3·64	3·85	3·95	5·09	5·31	60·33	105·5	24·8	31	19 .. ..
Queanbeyan	1859	56	2·25	1·93	2·04	1·99	1·82	2·01	1·54	1·59	1·89	2·11	2·06	2·67	25·64	109·4	15·8	*31 January* ..	*21 December.*
Quirindi	1278	43	2·89	2·31	2·45	1·75	1·82	2·14	1·88	1·91	1·82	2·06	2·46	3·08	27·06	107·0	13·0	10 February ..	6 November.
Richmond (H. A. College)	73	40	3·29	2·59	3·14	2·37	2·49	2·22	2·39	1·59	1·79	1·99	2·29	3·06	29·42	113·0	21·0	15 April	1 .. ..
Scone	680	59	2·66	2·42	2·19	1·49	1·55	1·70	1·77	1·73	1·52	1·95	2·09	2·90	25·05	113·4	19·0	28 March	5 .. ..
Singleton	135	44	2·81	2·67	2·78	2·42	1·98	2·21	2·47	1·57	1·92	1·93	2·42	3·10	28·62	113·9	22·0	5 May	15 September.
Tamworth	1240	46	2·86	2·52	2·11	1·89	1·70	2·28	1·84	1·88	1·74	2·18	2·24	2·97	26·98	110·0	20·0	24 April	18 October.
Taree	30	43	4·42	5·41	4·78	4·33	4·04	3·45	3·62	2·76	2·95	3·51	3·91	4·61	45·25	111·0	25·0	30	18 .. ..
Temora	958	47	1·65	1·49	1·48	1·43	1·66	2·35	1·75	1·84	1·79	1·91	1·67	1·80	20·43	.....	.....	Not reported.	Not reported
Tenterfield	2837	56	4·32	3·95	3·93	1·73	1·75	2·24	2·22	1·81	2·33	2·58	3·15	3·81	32·03	101·0	18·0	29 March	6 November.
Tumut	923	41	2·14	1·48	2·26	2·24	2·67	4·19	3·24	2·24	2·88	2·96	2·62	3·25	31·98	.....	.....	24 April	2 October.
Uralla	3335	24	3·19	2·51	2·45	1·69	1·73	2·71	2·39	2·08	2·43	2·53	2·95	3·54	29·72	102·0	15·0	10 January ..	5 December.
Urana	460	55	1·10	1·26	1·38	1·24	1·83	2·20	1·46	1·56	1·54	1·42	1·24	1·10	17·33	112·0	28·0	29 April	26 .. ..
Wagga	612	55	1·41	1·20	1·95	1·58	1·91	2·74	1·89	1·99	1·99	2·03	1·56	1·42	21·44	110·8	22·0	27	18 November.
Walcha	3396	47	3·41	2·88	2·71	1·87	1·78	2·71	2·10	2·06	2·33	2·61	3·32	3·60	31·37	104·0	10·0	14 February ..	3 December.
Walgett	436	48	2·13	2·03	1·47	1·31	1·59	1·69	1·30	1·30	1·41	1·21	1·56	1·79	18·30	122·5	23·2	29 April	9 October.
Warialda	1106	48	3·30	3·21	2·74	1·93	1·85	2·16	1·78	1·75	1·88	2·06	2·51	2·88	27·36	111·0	16·0	18 March	2 November.
Warren	645	37	1·96	1·69	1·70	1·73	1·45	1·85	1·48	1·45	1·03	1·12	1·55	2·01	19·03	.....	.....	Not reported.	Not reported.
Wellington	995	45	1·96	1·44	1·86	1·70	1·90	2·96	1·84	1·94	1·70	1·89	2·44	2·83	24·83	112·0	23·0	9 April	6 November.
Westworth	126	50	0·85	0·81	0·84	0·76	1·34	1·31	0·91	1·09	1·20	1·16	0·91	0·86	11·93	117·0	21·0	.....	16 .. ..
Werris Creek ..	1245	36	2·90	2·43	2·35	1·73	1·46	2·22	2·01	1·92	1·71	1·87	2·38	3·22	25·80	107·5	20·0	18 May	28 September.
Windsor	58	97	2·83	2·13	2·71	2·04	2·89	1·98	2·04	1·83	1·91	1·87	1·98	2·83	26·99	.....	.....	.....	.....
Wollongong	33	54	4·21	4·40	4·75	4·85	4·74	4·07	3·99	3·37	3·71	3·68	3·65	3·67	44·93	108·0	33·6	25 June	6 August.
Wyalong	831	39	1·66	1·33	1·40	1·12	1·30	2·15	1·58	1·55	1·41	1·37	1·27	1·60	17·03	.....	.....	25 February ..	24 October.
Yass	1615	27	1·72	0·97	1·30	1·71	1·90	2·02	2·48	2·10	2·20	2·07	1·69	1·98	23·03	108·0	21·0	22 March	3 December.
Young	1416	55	1·90	1·53	1·87	1·88	2·05	3·07	2·40	2·33	2·23	2·17	1·71	2·07	25·16	109·0	20·3	31	27 .. ..

THE SOILS OF THE STATE.

It is a matter for regret that there has been no soil survey of this State as there has been of some other countries. Such a survey would establish soil types in different districts, and soils referred for examination could be placed in one or other of such types, the characteristics of which had been previously established. Such surveys would be of particular value in determining the nature of the soils in areas made available for cultivation and in valuing soil from the point of view of its agricultural possibilities.

The brief descriptions of the soils of the districts given on the following pages have been supplied by the Agricultural Instructors of the Department. They should constitute a useful guide as to the principal soil types that occur and their utility from an agricultural viewpoint.

THE UPPER NORTH COAST DISTRICT.

In the northern part of the district, including the Tweed, Brunswick, and Richmond Rivers, and extending back to the head waters of the Clarence, the country varies from flat and undulating to hilly and mountainous.

On the upper reaches of the Tweed the hills are mostly of a yellowish clay formation, small flats, which are used for cultivation, occurring on the creek banks. Down the river nearer to Murwillumbah the flats become more extensive. Because in the process of their formation the water flow was fairly rapid, these soils are fairly light and loamy; excellent crops of maize and potatoes are grown—particularly potatoes for the early markets in both Brisbane and Sydney. These alluvial flats extend along the river banks and become somewhat heavier in texture but less extensive in area lower down the river.

Just below Murwillumbah is the Condong Plain, the soil of which is of a black peaty nature and is used almost entirely for growing sugar cane, though small areas of maize and other crops are occasionally grown. The soil has a very loose physical condition, and is worked fairly deeply. The subsoil is clay and is often found at a depth of 10 to 14 inches. When such is the case, a little clay is occasionally brought to the surface in ploughing and mixed with the surface soil to improve the physical condition.

Nearer the coast are the Terranora Hills on the north side, and the Cudgen Headland on the south side of the river. Both of these areas are of basaltic formation—the soil being a friable, red loam—and are of sufficient elevation to be practically free from frosts. The Cudgen Headland is used almost entirely for sugar cane. On the Terranora Hills a certain amount of cane is grown, the remainder being used for dairying and vegetable crops. Large areas of French beans are grown during the winter months (being frost-free areas) for the city markets. These friable, basaltic soils, being very open and porous, permit rapid oxidation to take place, thus depleting the supply of humus in the soil. Under cultivation, therefore, it is necessary to maintain the supplies of organic matter by growing and ploughing-in leguminous green manure crops. Phosphatic fertilisers also give good results.

From the Tweed to the Brunswick the country is hilly, the soil being a yellowish clay with occasional basaltic outcrops. There is an area of peat near the coast on Crabbes Creek where sugar cane is grown. On the

Brunswick there are small flats of a yellowish clay loam formation, which are mostly used for pasture, though small areas are cultivated for fodder crops. The soil on these flats "sets" very hard, but when ploughed breaks down into a fine tilth very easily.

Coming south the hilly country is somewhat similar to that on the Brunswick River until the "Big Scrub Country" is reached. This includes a large area of fertile, friable, red volcanic soil of basaltic formation, and is fairly elevated in situation. The whole areas is used almost entirely for dairying, for which it is ideal, and is mostly under paspalum pastures, with small areas under cultivation for fodder crops. Owing to the open, porous nature of the soil, grain crops do not do well, but excellent fodder crops are grown. Cultivation paddocks are generally turned out to pasture after two or three years and fresh areas brought under cultivation owing to the rapid depletion of organic matter.

On the upper reaches of the Richmond River beyond Kyogle the country is hilly, the soil generally being a gravelly clay loam. Although the country is hilly, there are considerable areas of alluvial flats along the various creeks which are very fertile and grow excellent crops of maize and lucerne. These flats will, undoubtedly, in the future become great lucerne-growing areas for supplying the dairymen in the surrounding districts with lucerne hay. At present they are not very well supplied with means of transit, and only sufficient lucerne is grown which can be used on the farms.

At Kyogle the soil is a very heavy black "pug" of volcanic formation, with only small areas of alluvial flats. This heavy soil grows good crops of maize, fodder crops and excellent pastures. The soil is very heavy and puggy to work; the plough generally leaves it in a very rough state, but the clods soon break down with the weather, though it is almost impossible to break them down with cultural implements. The springtooth cultivator is the best implement to bring the soil, which has thoroughly weathered, down into good seed-bed condition for planting.

Coming down the Richmond to Casino, the soil is also fairly heavy with limited areas of alluvial flats.

At Coraki the soil is fairly heavy, the area of alluvial soil increasing somewhat. A large portion of the country round Coraki is low-lying and is subject to frequent inundation by flood waters, and cannot, therefore, be used for cultivation. Back from the river are some extensive swamps which have been drained and are very fertile.

At Woodburn the sugar-cane growing area commences; it is confined mainly to the alluvial soil along the river banks. Near the coast is the heath country, which is very infertile.

Between the Richmond and Clarence Rivers the country is undulating to hilly, chiefly of sandstone formation. This is very poor forest country and is only used in favourable seasons for grazing.

The Clarence River district includes extensive areas of good alluvial soil along the river frontage, and, to a less extent, to the main tributaries, the remainder of the country being undulating to hilly, and steep mountainous country, chiefly sandstone and slate formation, with basalt, granite, and ironstone in parts. The alluvial soil on the flats is an easily worked, fertile loam, and excellent crops, particularly maize, lucerne, and early potatoes, are grown. On low-lying situations and along the river banks the more recent flood deposits are much heavier in texture and more difficult to work, but are very fertile.

On the lower reaches of the river sugar cane is extensively grown, and many of the islands which occur in this vicinity are also used for growing this crop. Swamps occur in part of the district, some of which are very fertile and provide excellent grazing during dry periods.

On the Orara River the hills are a yellowish clay with outcrops of red basaltic soil. The flats are regarded as second-class alluvial and produce good crops of maize, potatoes, and fodder crops.

Between the Orara and the Bellinger Rivers the country is hilly and suitable only for grazing. There are occasional outcrops of basaltic soil which are used for cultivation. Near the coast the country is very poor and low-lying.

In the Bellinger River valley the soil is very rich and fertile; the area, however, is not extensive. Excellent crops of maize and lucerne are produced. The hilly country is of a clayey nature, not very fertile and used only for grazing.

The Dorrigo Plateau is hilly to mountainous, and was originally heavily covered with soft-woods. The country is now mostly cleared and is used principally for dairying. Potato-growing is also fairly extensive around Ebor and Tyringham, and limited areas are grown at Dorrigo. Maize is grown in small areas for use on the farms. The soil is a friable, red, volcanic loam of basaltic origin, and is very fertile. It is, however, deficient in phosphates, and the humus in the soil, although in good supply, is deficient in organic nitrogen. There are also considerable areas of inferior land suitable only for grazing.

THE LOWER NORTH COAST.

On the Nambucca the area of good agricultural land is not extensive, being confined to the narrow flats along Taylor's Arm and the Nambucca River. In some of the hilly country between these arms there are fairly extensive areas of good basaltic country that are well grassed, chiefly with paspalum. The remainder of the hilly areas is of a poorer nature and is in some places gravelly. The lower river country is mostly of poorer type.

Between the Nambucca and Macleay Rivers there is an area of poor forest country, although here and there are patches of basalt country, good for dairying, much of which is cleared and grassed.

Below Kempsey, on the Macleay, there is a very extensive area of rich alluvial soil, of great depth near the courses of the Macleay and Belmore Rivers, but tapering off to a shallower depth towards the swampy regions and the sea. In very wet seasons extensive areas of the swamps are under water for considerable periods, notably the Frogmore swamp, the Tennessee, &c. In dry periods these areas carry a good coat of swamp couch and paspalum, and large numbers of cattle are depastured on them. Above Kempsey along the river almost to the tablelands, rich flats are to be seen, being smaller in area towards the head of the river. Along the upper reaches the highlands are poorish, yet fairly well grassed with natural pastures. Nearer Kempsey, and east, there are poor, stoney, gravelly and clayey areas, which for the most part are poorly timbered and poorly grassed.

Between the Macleay and Hastings, but nearer Kempsey, there is a strip of poor country—gravelly hills and low flats—which is poorly timbered and poorly grassed, except along the creek banks where some agriculture is carried on. Further south, the country opens out into low, swampy areas

here and there along the Wilson and Maria Rivers and the creeks around Telegraph Point, which are well grassed where cleared. Dairying is the main pursuit. From there to the Hastings similar country is met with.

The Hastings, east of the neighbourhood of Wauchope, is composed of fairly rich alluvial flats tapering off here and there into ti-tree swampy areas or to poorer country nearer the hills. Lower down the river the soil is poorer and less extensive in area—the land for the most part, too, is flatter and sourer. Above Wauchope the lands bordering the river are composed of rich alluvial flats, but these areas are not extensive. The bulk of the country is hilly, well timbered, fairly well grassed, mostly with native pastures and paspalum.

Between the Hastings and Manning there is the Comboyne Plateau composed for the most part of red to blackish-red volcanic soil and well grassed —with paspalum chiefly and here and there sown English grasses. The plateau is now mostly cleared on top, the ridges leading to the lower lands alone being fairly heavily timbered. The Comboyne is watered by a number of small streams. Very little farming, apart from dairying, is carried out.

Continuing along this plateau in a north-westerly direction is the Bulga Plateau, somewhat similar to the Comboyne, but not so extensive and more heavily timbered.

Between the plateau and the sea the country is fairly well watered by a number of little streams. The soil along the banks of these streams is mostly of a blackish, peaty nature and is used for agricultural purposes. The surrounding areas are poor; fairly well grassed where cleared, but mostly heavily timbered.

Along the lower Manning River and tributaries are fairly extensive areas given over to dairying, though agriculture is conducted to a more or less extent near the watercourses and on the better soil. The country, however, is mostly under pasture—paspalum on the lower areas and swampy regions, of which there are a fair number. There are also large areas under forest. Along the whole course of the Manning are fairly extensive areas of rich alluvial soil, and agricultural pursuits and dairying are conducted. The highlands around the immediate vicinity of Taree and Wingham are mostly poor; further out, however, and especially along the upper tributaries, the land is of better quality, being well grassed and given up chiefly to cattle-raising. Along the Barrington and Gloucester Rivers (tributaries of the Manning) agriculture and dairying are conducted on the river flats and dairying on the well-grassed higher lands.

Between Taree and the coast (south) there is a vast area of timber country. The Wallamba River runs through a portion of this country and along its banks agriculture and dairying are practised, the soil being of a sandy to peaty nature. On the upper reaches and tributaries of this river are some good red soil areas (Bulby and Tipperary), and dairying and cattle-raising are the main pursuits.

South and east of Gloucester are large areas of medium-quality undulating country fairly well grassed and used chiefly for cattle-raising (around Gloucester) and sheep- and cattle-raising (around Copeland and Rawdon Vale).

Following the railway south as far as Dungog is a tract of fair, grass country. East of the rail from Stroud to the coast, at Bulahdelah at first, similar country is met, with better patches along the Kuruah River, but it tapers off to very poor, rocky, and gravelly country nearer the coast.

Along the Williams and Chichester Rivers (tributaries of the Paterson) are fair to rich alluvial flats given over to agriculture and dairying. The undulating country away from the rivers is mostly good quality grazing land—well grassed and used extensively for cattle-raising.

Between Dungog and the Paterson is fair to medium quality grass country, with poorer hilly country here and there; a little dairying and cattle-raising are practised.

Around Paterson the country on the hillsides is of good quality and produces very good pasture—native grasses and couch. Along the Allyn River at Gresford, Allynbrook and Eccleston are some very good quality uplands with rich alluvial patches along the river banks. Dairying is the main pursuit, although these parts are also renowned for the Paterson River oranges which thrive on these better quality ridges.

Between Paterson and the rich alluvial flats of the lower Hunter is a medium to poor strip of upland country.

THE CENTRAL COAST.

The alluvial flats around Maitland constitute perhaps the richest land in New South Wales, and several large areas are banked off from floods. On the lower Hunter River around Morpeth, Hinton, and Raymond Terrace, the land is nearly all subject to flooding, and the periodic deposition of rich silt tends to increase the fertility of the soil. The whole of these alluvial flats are eminently suited to the production of lucerne, maize and millets, while large areas are devoted to vegetable crops such as potatoes, pumpkins, melons, onions, cabbages, &c. The land away from the Hunter River flats is typical inter-river country and is patchy; on the whole it is only suitable for stock-raising.

There are several islands in the Hunter River, Ash Island being the largest, and these are devoted to dairying and vegetable culture. Portions of these islands are very fertile, being low-lying and subject to flooding.

On the southern side of Port Stephens small flats are cultivated, as at Salt Ash, or used for the grazing of dairy stock. These are the main sources of supply of early tomatoes for the Newcastle and Maitland markets.

The country around Newcastle is very patchy, and any cultivation takes the form of orchards or vegetable areas. The soil is a gravelly loam, and that portion near the sea is suitable for the production of early crops. Typical areas of this class of country occur at Cardiff and Catherine Hill Bay.

The whole of the country around Wyong Creek, which empties into Tuggerah Lake, is devoted to dairying, orcharding, and maize and vegetable growing. Citrus and early stone fruits do exceptionally well on this creek. The soil is very light and sandy, with a few fertile alluvial flats. On the flat and sandy country around the shores of the Tuggerah lakes, large areas are devoted to early beans, &c.

Between Wyong and Gosford the country is very broken, but contains a fair area of sandy loam, which, even in elevated positions, constitutes perhaps the best citrus and vegetable country close to Sydney. The sandy loam lies above a layer of gravel, and a very heavy clay subsoil which retains the moisture. The majority of the area is frost free, and the rainfall is very great.

The area extends from Kincumber to Terrigal, Wamberal, and to the Tuggerah Lakes, and as far back as Mangrove Mountain. From it the Sydney and Newcastle markets are supplied with the bulk of the early vegetable crops, such as beans, cucumbers, rock melons, and tomatoes.

The country around Penrith, Emu Plains, &c., is nearly all occupied by dairy-farmers, orchardists, and maize and vegetable growers. The soil varies from a pipeclay loam to rich flats on the river. Lower down the Hawkesbury at Richmond and Windsor the alluvial flats are much wider and large areas of maize, and potatoes and other vegetable crops are grown. Around Windsor, where the flats are perhaps the richest on the river, irrigation is practised, and large areas of potatoes, pumpkins, melons, cauliflowers, and cabbages are raised. Windsor is splendidly situated about 40 miles from Sydney, and is well served by the railway and an excellent road.

Further down the river around Freeman's Reach and Lower Portland the flats are small in area, and are largely devoted to fruit culture with a little vegetable growing. This part of the river is served by a steamer service which transports the produce to the Hawkesbury River railway station.

One of the most outstanding settlements in this district is the Kurrajong Heights, situated a few miles from the Nepean River, near Richmond. The country is of a light loamy nature, elevated, and in many localities, frost free. Large areas are devoted to citrus and stone fruit culture, and the frost-free areas are sown during the winter months to peas, which are sent to the Sydney markets in large quantities.

The largest and most consistent supply of fresh vegetables for the Sydney market is grown within a radius of 20 miles of the harbour. The growers work very small areas, and, generally speaking, do well from their activities. Their success is largely due to the fact that they sell their own produce direct in the markets. The soil in these districts varies considerably. Along the waterfront from Mona Vale to Manly, around the shores of Botany Bay and through to Miranda the soil is very sandy, but is exceptionally early, and with the addition of organic manure and water will produce excellent crops of all vegetables.

The remainder of the country in the metropolitan area is naturally infertile, with the exception of a few very small flat areas. The soil varies from raw sand to white pipeclay, and red clay strewn with ironstone. A good deal of brown loam suitable for trees, &c., is found scattered throughout the district at localities such as Castle Hill, Parramatta, Penrith, Liverpool, &c.

THE SOUTH COAST.

Commencing with the locality around Camden, and including the districts of Liverpool, Campbelltown, Camden, Menangle, Picton, and The Oaks, the soils are formed chiefly from Wianamatta shale. This class of soil may be classed as light. It is variable in depth and quality; the better class loams produce excellent crops—of vegetable crops, peas are largely grown on the hills in frost-free situations.

Burragorang soils are sandstone, and those of the Illawarra, including the Wollongong, Unanderra, Dapto, and Albion Park districts are chiefly formed from sandstone with basaltic outcrops, chiefly on the slopes of the Illawarra Range.

Shellharbour, Kiama, Gerringong, and Berry soils are of a basalt formation which is really a continuation of the Robertson formation. With good rainfall these soils are highly productive.

The rich soil of the Nowra district is built up on the river flats of sedimentary deposits brought down by the Shoalhaven River. At Kangaroo Valley, sandstone and basalt country are to be found, with very fertile flats on either side of the Kangaroo River.

Milton district consists of a very fertile spot of several thousand acres of basalt—mostly a black loam. The surrounding country for miles around is sandstone.

The Far South Coast.

The predominating soil in this district is a comparatively shallow granite.

Along the Deua River at Moruya, Tuross River at Bodalla, Bega River at Bega, Pambula River at Pambula, and Towamba River at Kiah, narrow strips of rich, alluvial flats are to be found, which have a monetary value of £60 to £100 per acre. These flats consist of detritus washed from the hills, and are particularly rich, comparing favourably (although the wash from only fair quality granite hills) with other rich alluvial flats found in this State.

At Tilba is found a small area of rich, dark soil of diorite (a particularly rich type of granite) origin. This area is by far the richest, outside the alluvial flats to be found in the district. It is a heavy loam, deep, friable, with good water-holding and capillary power, rich in plant-food, fairly warm and early, and carries a good body of pasture.

At Brogo, between Bega and Cobargo, a small area of country, similar in origin and with similar qualities to Tilba, although not quite so rich, is to be found.

Between Moruya and Bateman's Bay is an area of poor country, consisting of soil weathered from slate and schist, which is stoney, shallow, and practically useless. Most of this area is very rugged and covered with spotted gum and zamia. Similar country is found between 7 miles south of Bodalla to Brogo, although interspersed through it at Tilba is the richer diorite area, and at Cobargo and Verona, granite soil. The country is less rugged, but the soil is rather poor, although not so poor as that north of Moruya. The predominating timbers are spotted gum, mountain ash, and stringybark, while, on the better-class areas, apple and box are to be found.

At Nethercote and Lochiel (west of Pambula), and Tanja (near Bega) are small areas of country of basaltic origin; these are comparable to the average basalt soils found elsewhere on the coast, and are much richer than the granite soils in this district.

The remainder of the soils on the far South Coast are different quality granites. These soils are mainly from acid granite rocks, many outcrops and dykes of which are to be seen throughout the district.

At Bergalia this granite has an overlying strata of another rock—andesite —which is similar to diorite, but much finer-grained. The resultant soil is dark-coloured, but rather shallow; however, it grows fair crops.

The Bega valley, where the largest area under farming is to be found, is all granite country, and it is typical of areas elsewhere in the district. Granite is a coarse, light-coloured rock, and gives rise to light loams, which

are apt, on the coast, to become exhausted of plant-food rather early in cultivation. Granite soils in this district have fair potash content, but are rather poor in humus, lime and phosphoric acid. The drainage is excellent, and as a result, although light-coloured, the soils warm up fairly early in the spring. The chief forest trees found are spotted gum, stringybark, ironbark, blackbutt, and, on the better class soils, apple and box.

The soils on the far South Coast are, except for the area of slate and schist country, well adapted for winter and summer crops or grazing. The main consideration in this district is not the soil, but the ease with which a certain area may be cultivated. It may be safely stated that 25 per cent. of the country with suitable soil is unfit for cultivation because of the excessive degree of slope, and the accompanying risk of washing of the soil if cultivated, and another 5 per cent. of the area is precluded owing to rocky outcrops.

The granite soils will not stand continued cultivation, especially the poorer quality ones, and require to be handled carefully by spelling to pasture after a few seasons. Osteo-malacia or "bone-chewing," found on the lighter-coloured, heavier, finer-textured soils, as at South Wolumla, is an indication of impoverishment of the soil. This is brought about by removing the mineral plant-food from a soil already poor in it and which has not the power, found in other soils, of replenishing this deficiency. Without careful treatment the richer hills may also become similarly deficient, in time.

Although a large area is suitable for cultivation, the area actually under cultivation is a very small percentage of what it should be.

THE NORTHERN DISTRICT.

With Singleton as a centre, the upland soils are chiefly of sandstone and shale formation of moderate to fair quality. They extend to midway to the Hawkesbury River on the south (from there on to the Hawkesbury the country is steeper and poorer); to the east to West Maitland; north to the Bean Bean Mountains; and west to a few miles from Muswellbrook. The lowlands, especially Patrick Plains and the alluvial soils about the Hunter River, are highly fertile soils, which carry a good class of pasture and produce fodder crops, mainly lucerne, prolifically.

From Muswellbrook, east a few miles and north to the Dividing Range, the soil is chiefly from basalt. On the south it is of similar quality to the uplands about Singleton. On the west to Denman the higher hills are chiefly basaltic, and the rest sandstone. Around Denman, through which the Hunter River has a tortuous course, extensive rich alluvial soils occur; the uplands are mainly fair-quality soils from sandstone.

From within 7 miles of Merriwa, basaltic soils mainly occur to Cassilis with stretches of sandstone country here and there. The basaltic soils, red to black throughout, grow rich herbage and pasture, and have been found suited to the growing of lucerne sown thinly at 3 to 4 lb. per acre for grazing.

Rich alluvial soils occur about Merriwa on creek flats and also on some of the tributaries of the Hunter, especially Baerami Creek, where lucerne for hay is a success.

North of the preceding section to the Liverpool Range at Murrurundi, the upland soils are from sandstone, basalt, and boulder formation, and generally afford good quality grazing. The Page River, about Segenhoe, has fairly extensive alluvial flats where lucerne grows prolifically.

From Murrurundi to Quirindi the country is chiefly suited for grazing, consisting of rocky, hilly, and steep slopes of basaltic formation, with black to brown soils.

About Willow Tree and for about 20 miles to the west, a fairly extensive area of red to black basaltic soils and soils from altered sandstone occur, which are very fertile and on which wheat is grown fairly extensively.

From Quirindi, west 30 miles, occasional red sandstone hills occur, but mainly the country is deep black soil plains. Herbage, thistles, and pasturage (mainly plains grass) grow prolifically in good season on the plains, and, in parts, especially on the creek flats and about depressions, lucerne is successfully grown.

From Quirindi east for about 20 miles arable country, interspersed with steep hills, occurs. The soil is mainly rich red to black loam from basalt. Jacob and Joseph Creek winds through this area on the east, and Borambil and other creeks on the west, from which have been formed deep alluvial soils, very fertile, suited in most locations to the growing of lucerne.

From Quirindi to Duri, on a front of about 15 miles, the country is undulating to hilly, with good quality soils mainly from basalt. Cereal-growing is largely conducted, and dairy farming and fattening stock to a lesser extent. From Duri to the foothills of the Moonbi Range—north of Tamworth—the country is undulating and the greater part of it is suited to cultivation, mainly cereal-growing. The soil is from basalt and shale chiefly, and varies from self-mulching clay loams to light red and grey shallow loams which have a tendency to run together and set after rain or when tramped.

With Manilla as a centre and joining up to the Tamworth zone on the east, Gunnedah, Barraba, and Bingara on the west and north-west, the country is mainly from shale and is undulating and arable; increasingly hilly west of Manilla. Some good grazing country and wheat lands occur in this zone. Cassilis, Muswellbrook to Tamworth, and Nundle is mostly good fattening country, and suited to lucerne.

From north of a line Barraba to Nundle, the country rises rapidly to the Moonbi Ranges and to Walcha, and is then hilly to undulating to Armidale. The soils in this zone vary, being granite, shale, diorite, and basalt formation, of from moderate to good quality. This country is at an elevation of about 3,300 feet, and produces good-quality wool, as does that extending to Tenterfield. At Uralla and Armidale, cropping is carried out fairly extensively, mainly on the basaltic soils, potatoes and maize and hay crops being profitably produced.

From Armidale to Black Mountain the elevation increases to 4,300 feet; it rises to 4,500 feet at Ben Lomond, and falls to 3,500 feet at Glen Innes. For about 15 miles either side of a line Armidale to Glen Innes the country is either of basaltic or dioritic (trap) formation, generally forming fertile soils productive of a miscellany of crops, such as potatoes, maize, wheat, oats, turnips, mangolds, lucerne, clover, and good pasturage. Fat cattle, dairy cattle, pigs, and sheep do well on this country. The rainfall is generally ample, and there is a considerable area of cheap available lands for closer settlement.

From Glen Innes to Tenterfield the country is largely of granitic formation, but trap and basalt outcrop in parts. The soils are, as a rule, of moderate to very fair quality, and the rainfall generally satisfactory. Sheep and cattle rearing are more dominant here, but crops, as on the higher tableland, are grown, and with fertiliser in small quantity give a profitable return.

THE SOUTHERN TABLELAND.

Commencing at Tahmoor on the Main Southern railway line where soils of sandstone origin are met, a continuation of this class of country is found through Bargo, Aylmerton, Mittagong, Berrima, Moss Vale, Bowral, until the basalts are met, which run from Bowral through Kangaloon, Burrawang, Robertson, and Exeter with occasional outcrops in other parts.

At Bundanoon the sandstone formation again occurs and stretches through Penrose to Wingello, where there is another outcrop of basalt. These outcrops occur more or less through to Goulburn being interspersed with granite.

At Braidwood and Araluen there are extensive areas of granite of varying fertility, whilst fair to really good class basalt loams are found in the Goulburn, Crookwell, and Taralga districts. The red loams of Crookwell and Taralga, under good farming methods, produce excellent potato crops.

The soils of the Binda and Bigga districts are of granite formation, producing for the most part good pasture; the country is nicely undulating.

Soils of the Monaro.

The predominating type of soil on the Monaro Tableland is basaltic. Basalt, the parent rock, is fine grained and of volcanic origin. The resultant soils are excellent in quality, and are mainly fairly heavy loams of red, brown, or black colour.

On some parts of Monaro are elevated areas with particularly poor drainage. These areas are practically bogs, and the soil is cold, sour, and heavily charged with mineral salts. A peculiar feature of these large basalt plateaux on Monaro is their treeless condition. This is all the more astonishing as these areas are much richer in plant-food than the surrounding granite country, which invariably carries a fair amount of forest. Various reasons have been assigned for this scarcity of forest, the most accepted being that the Monaro basalt soils, with a high water capacity and low capillary power, suffer the two extreme conditions, becoming waterlogged after a heavy rainfall, and drought stricken as the result of a dry spell.

As regards richness in plant-food, the basalt soils could not be better; it is their mechanical condition which is adverse to good results. Basalt soils are warm, if well drained, but very cold when saturated with water.

The main areas of heavy black basalt soils are to be found in the Nimmitabel, Cooma, and Bombala districts, though in these districts are also areas of lighter red basalt soils.

Typical granite areas are to be found at Queanbeyan, Michelago, Adaminaby, Jindabyne, Dalgety, and Bombala. At Delegate the chief soil is of slate origin, resulting in a rather heavy clay soil, poor in quality when compared to the richer basalt areas.

For sheep-raising, which is the main industry, this district is well adapted. It is particularly safe, and the land carries a good coat of sheep feed, droughts being practically unknown.

Very little area is under cultivation, but potatoes can be successfully grown throughout the district, particularly on the lighter red soil. In fact, this type of soil can be recommended to grow any crop desired, the limiting factor being the climatic conditions and the impossibility of working many areas owing to stone being on the surface.

Monaro has vast possibilities in the future, as it is so safe from a grazier's point of view, and the soil in most cases is capable of heavy production of many varieties of crops, including particularly lucerne, potatoes, and oats for hay or silage. The heavy black soils are not as well suited to cultivation as the lighter soils, and this former type should only be used when the red basalt areas are not available or cannot be cultivated. The granite soils are not as safe or quite so rich as the basalt soils, but in fair seasons give good returns, being much richer than the coastal granites, which have in most cases been heavily leached.

THE NORTH-WEST.

The soils of the Inverell district (including Nullamanna, Oakwood, Auburn Vale, Mount Russell, and Delungra) consist principally of black to red basaltic loams. These are deep and friable, and are somewhat of a self-mulching nature. They are suited to the production of wheat and maize, and are also devoted to sheep-raising. Areas of soil derived from granite occur throughout the district.

At Warialda and Bingara the soils vary from light red to chocolate loams, carrying ironbark, box, and pine. To the west of these centres the country opens on to plains, carrying belar and brigalow. The lighter country is suited for the production of wheat, but except for those areas within reasonable distance of the railway the country is mostly utilised for sheep-raising.

The soils at Pallamallawa and northward consist of free-working, greyish to red loams carrying belar, pine, and brigalow. This is good grazing country, and the soils are very suitable to the production of wheat.

To the north and west of Moree the country consists of black soil plains, and is used principally for sheep-raising.

Areas consisting of red to chocolate loams occur on the eastern side of the line from Moree to Narrabri—at Bellata and Edgeroi—and are devoted to sheep-raising and wheat-growing.

To the east of Narrabri the soils consist of light-red to chocolate loams, overlying a clay subsoil. They are well suited to wheat-growing and grazing.

To the west of Narrabri, on the fringe of the Pilliga scrub, the soils are of a light sandy nature. Areas of greyish loam carrying belar also occur.

At Wee Waa the soils, apart from the black soils to the north and west, are of a light sandy nature, and vary in colour from red to light-brown. Patches of greyish to black soil also occur. To the east of Wee Waa wheat is grown with success in conjunction with sheep-raising.

The soils to the west of Boggabri consist of red to chocolate loams of volcanic origin. The country is timbered with box, ironbark, and pine, interspersed with kurrajong. The soils contain a certain amount of gravel, but are admirably suited to wheat-growing. To the south-west areas of land of a sandy nature occur, also medium-heavy brown loams.

On the eastern side of Boggabri the soils consist of red gravelly loams, chocolate loams and medium-heavy brown loams. A stretch of country consisting of a greyish to black clay loam occurs in that section of the district. These soils are particularly well suited for wheat-growing.

In the Maule's Creek locality the soils are fine-textured red to brown loams, timbered with box, pine, and yellow jacket. Black, clay, self-mulching loams, carrying box and myall, also occur.

The soils in the Gunnedah district are mostly of volcanic origin, and consist of light sandy to red loams and chocolate to heavy black loams. On the western and southern sides the soils are mostly chocolate loams varying somewhat in colour and texture. Areas of soil of limestone origin are frequently met with. Incorporated in these chocolate loams is a certain amount of gravel, and it also exists in the lighter textured soils.

On the eastern side of the town the country consists of plain and semi-plain, but at Carroll and Kelvin there are areas of red to chocolate loams which are admirably suited to wheat-growing.

THE CENTRAL-WEST (DUBBO CENTRE).

This district, being mainly western slopes, but including portion of the tablelands, and a large area of plain country, is comprised of soils of varying distinct types, with many intermediate compositions, which alter considerably within short distances. Much of the country on the eastern, northern, and southern ends of the district is only suitable for grazing purposes on account of topographical conditions—hilly broken country, with frequent gravelly and stony outcrops—while to the west the rainfall is the limiting factor.

In the south-eastern portion of the district, around Cumnock and Yeoval, the majority of the soil is of sedimentary origin, but there is also a considerable area of granite. Three distinct types occur.

(1) Rich chocolate clay loams of limestone, slate, and shale origin, *belonging to the Silurian period predominate. These are extremely fertile,* and eminently suitable for cultivation of winter cereals, lucerne, and maize. Stony limestone out-crops frequently occur. A considerable area of these suitable soils occurs in the district, which has a sound rainfall.

(2) Stony and gravelly ridges of sandstone, quartz, shale, and conglomerate formation, which occur on much of the hilly country, and which are unsuitable for agriculture, being only second-class pastoral country.

(3) Grey clay loams of granite origin, found towards Yeoval, Obley and Baldry. These are fertile and suitable for cultivation, provided heavy rains do not waterlog them, when they become "spewy" and impossible to work.

Around Wellington the soils vary considerably. To the east the country is hilly, and consists of slate and sandstone ridges of low fertility, suitable only for grazing after improvements have been effected, interspersed with areas of granite and diorite formations, which provide limited areas of

undulating to level country suitable for cultivation including the growing of lucerne. The banks of the Macquarie River, and its tributaries consist of alluvial silt deposits, and they are extremely fertile, being suitable for lucerne, maize and vegetable culture, also horticulture.

To the south, and north of Wellington towards Geurie, the soils are rich chocolate and red clay sedimentary loams derived from limestone, slate, and sandstone, and are very suitable for cereal cultivation. The country is mostly undulating, and mainly used for mixed farming.

Between Geurie and Dubbo, along the Macquarie River, alluvial silts cover extensive areas. Back from the river the majority of the soils are derived from sandstones and shales of triassic origin, which provide light red to grey sandy loams with clay subsoils suitable for wheat-growing, but not extremely fertile. In this locality there are numerous small outcrops of igneous basaltic soils which can be easily recognised by the large number of kurrajong trees growing on them.

These soils vary from heavy black clay loams to chocolate loams, and are very fertile. Basalt outcrops occur at Wongarbon, Eulomogo, east and north of Dubbo, also at Mogriguy. They provide excellent mixed-farming areas.

To the north-east of Dubbo, along the Talbragar River, the soils are much lighter in texture, poorer in fertility, and are mostly of sandstone and shale origin. Light red to grey sandy loams, with clay and sand subsoils, are used for wheat-growing. They are easy soils to work, but are not particularly retentive of moisture, and are seriously affected by any prolonged dry weather conditions. Occasional outcrops of basaltic soils provide a leavening of more fertile, arable areas. The country is undulating, with the ridges consisting of hardy, stony, and gravelly sandstone and shale. On the better country the timber is mainly white and yellow box, white pine and kurrajong, while narrow-leaf ironbark, stringy-bark and black pine are mainly found on poorer sandstone soils.

There is a large area of this class of country extending along the Talbragar to Cobborah, north-east to Mendooran, and Coonabarabran, and north to Gilgandra east of the Coonamble railway line. It varies very considerably in fertility, and much of it is practically useless either for cultivation or grazing. A large portion of it is a State forest under the control of the Forestry Commission.

East of Cobborah and Dunedoo the soil again changes slightly, being of sandstone, shale and conglomerate origin and belonging to the permo-carboniferous group. The soils are red to grey medium sandy loams with clay subsoils suitable for mixed farming and wheat-growing. Occasional granite outcrops occur in this area, while in the Coolah Valley also the alluvial soils are of volcanic origin, and are given over largely to lucerne cultivation for seed purposes, also for hay.

North and east of Coolah, extending over a considerable area, the soils are of basaltic origin, and are extremely fertile, but they are rather too porous, and have low capillary powers, and are not therefore particularly suitable for agricultural purposes.

South of Dubbo, including the Bulga and Harvey ranges, there is a large area of granite country which includes the centres of Obley and Yeoval. Most of this is rough, undulating to hilly country only suitable for grazing after it has been improved by ringbarking, but there are also considerable

areas of rich volcanic chocolate, red and grey clay loams, highly suitable for wheat-growing, as rains are attracted by the hills, thereby making the country sound and safe for mixed farming. In the valleys where the soils are alluvial or drift, lucerne does exceptionally well.

To the north-east of Gilgandra and running north and south are the Warrumbungle Ranges. The geological formation of these is largely volcanic, providing rich soils on the plateaux, and in the valleys, of basaltic and dioritic origin. On the western slopes of these mountains are to be found rich alluvial belts of country formed by centuries of washing of basalt detritus off the hills. These are extremely fertile areas suitable either for cultivation or grazing.

The plain country to the west and north of Dubbo, extending right to the Darling River, and lying east and west of the Macquarie River between the Castlereagh and Bogan Rivers respectively, is all of sedimentary origin, belonging to the more recent Tertiary period. The soils are considered to be of alluvial or drift formation, and have been built up by degrees from deposits brought down by the rivers from the many and varied types of rock formation found in the hill country to the east, including basalts, granites, diorites, slates, shales, limestones, schists, silicious and calcareous sandstones, quartz, conglomerates, &c.

These soils, extending over a very large area of the State, vary considerably in appearance, colour, texture and fertility. There are the black soil plains to be found in the Coonamble, Warren, Collie and Quambone districts also along the east side of the Bogan River. These are heavy clay self-mulching loams with clay subsoils, extremely fertile and retentive of moisture when thoroughly wetted, when they become very sticky. They are not altogether suitable for cultivation without irrigation on account of their low capillary power, and the difficulty of getting them into a good state of tilth for germinating seed and also because they dry out rapidly on the surface and crack badly. In seasons of good rainfall, they are extremely prolific in the growth of herbage, and have an excellent carrying capacity, also stock-fattening propensities. The black soil country is not very heavily timbered and is often treeless. Trees found are white box, box, ironbark, belar, myall and wilga.

Red soils of varying degrees of fertility occupy by far the greater portion of the western plains. They are also of alluvial and drift origin, and their fertility depends largely on their derivation. Some are dark-brown to chocolate in colour, containing much clay and mainly derived from volcanic detritus. These soils are fertile, but difficult to work, as they dry out rapidly on the surface. They have low capillarity, but high moisture retentive powers. Soils in this class are to be found at Eumungerie, Coboco, Coalbaggie, Tomingly and parts of Narromine district.

The majority of the wheat soils of this part of the west are medium, red clay to sandy red loams containing a mixture of sandstone, slates, shales quartz and igneous detritus. They are comparatively easy to work, friable, of good texture, well endowed with plant-foods, usually having good retentive subsoils with adequate natural drainage, have good capillary powers, and are eminently suitable for cereal culture. They also produce good pastures of native grasses, herbages and introductions such as barley grass, wild oats, &c., and are thus excellent for mixed farming. The main timbers which occur are poplar and yellow box, white pine, yarran, wilga, buddah, belar and wattles.

Belts of lighter red to grey sandy loams are interspersed, and these soils are not as fertile, are deeper, and often have no true subsoil. They are more porous and do not retain moisture well. They will produce fair crops in good seasons, and light crops in years of scanty rainfall. The main timbers are box, black pine and wattles. Sand drifts of unlimited depth also frequently occur, and throughout this belt small outcrops of granite occasionally, are to be seen.

Between Nyngan and Cobar, and west of the Bogan River, there is a large tract of country, the soils of which are derived from sandstone, slate and schists *in situ*. The red soils are suitable for agricultural purposes, but rainfall is the limiting factor, and the country is given over mainly to grazing as is practically all country west of the 148th Meridian at present.

THE CENTRAL-WESTERN DISTRICT (ORANGE CENTRE).

The soils in this district vary considerably and the altitude ranges from 900 to 3,000 feet.

The Bathurst, Blayney, and Carcoar district soils range from light sandy loam to stiff clay and are chiefly of granite formation, ranging to slatey ridges. The soil on the Macquarie River banks is black, fertile loam, but *the area is very limited. At Neville, to the south-east of Blayney, a basaltic* outcrop occurs where potatoes, peas, and winter cereals grow particularly well. About Carcoar and Lyndhurst the country is very broken, the soil being poor and gravelly on the hills, but fertile on the lower levels. This country is particularly suitable for oats and wheat which are grown chiefly for hay. Potatoes are extensively grown in Blayney and Carcoar districts, *and to a less extent around Bathurst. On the flats, maize and lucerne are* chiefly grown, and to a very limited extent tobacco. Considerable areas of flats around Bathurst are sown with cauliflowers each year. This section of the tablelands is good, light grazing country, the native grasses, clovers, &c., responding well to top-dressing with superphosphate.

The Tarana-Oberon district is very similar in soil and climate to the one just described, but contains a large area of red soil of basaltic origin, on which potatoes and peas grow exceptionally well. Oberon is a particularly cold centre, where heavy snowstorms occur each year.

In the Bathurst district, and to a lesser extent in the other districts named, fruit-growing is carried on, particularly apples, pears, cherries, plums, &c.

From west of Blayney, around Millthorpe, extending to Orange and the Canobolas Mountains, the country is undulating and the formation basaltic and granite. The soils are chiefly a fertile red loam varying to grey soils and clay loams in the valleys. Around Orange particularly, the soil varies quickly from red to grey loams, the higher levels being particularly red and fertile. Wheat and oats for hay are a never-failing crop in this district, and potatoes are very largely grown. The grey soils are well adapted for oats and of late peas have been largely grown on these soils. Extensive orchards exist on the Canobolas slopes around Orange where pome fruits, cherries, &c., grow to perfection. From a grazing point of view, the country is very sound; it grows excellent grasses and clovers. Perennial Red clover is now being grown largely for grazing in this district.

From Orange north to Wellington the country is very rough and broken, and the soil varies from red loam to poor sandy; slate predominates with granite and basalt outcrops. Wheat for grain and lucerne (on the flats) are grown, but for the most part the country is devoted to grazing.

West of Orange to Molong the country is undulating and the soil chiefly red loam, varying to light loam with black flats. Around Molong the country is more open and a considerable area is devoted to wheat and oat growing.

Between Borenore and to within a few miles of Molong, the country is devoted largely to grazing. East and to the north of Molong limestone exists in large quantities, and the country is very sound grazing and good wheat land.

Between the tableland country of Orange and Molong, stretching towards the Lachlan River, to the south and around Cudal and Cargo, an extensive area of rich, red, basaltic country exists. This is excellent wheat land, which will be more easy of access when the proposed Gregra-Canowindra railway line is constructed. It is excellent grazing country also, very sound, and grows abundance of natural grasses and herbage.

The Lachlan Valley, from Cowra to Forbes, is ideal country for mixed farming—wheat and sheep. The alluvial soil along the Lachlan River banks is very fertile, extensive and grows luxuriant lucerne crops. Maize is grown to a limited extent on the rich alluvial flats. The slopes are medium to light red loams, chiefly of basaltic and granite origin, and ideal land for growing wheat or oats for grain and hay, for grazing lucerne, or, in its cleared and uncultivated state, for grazing. It is excellent country for fat lamb raising.

To the north of Cowra, extending to several miles above Woodstock and west to Canowindra, the country is more undulating, but is excellent red loam soil unsurpassed for wheat-growing.

To the south of Cowra, to Koorawatha, and south-west to the Bumbaldry Range the country is comparatively level and more variable—from strong red loams to very light loams with lower-lying areas of dark-red or grey loams. All are suitable for wheat-growing, the grey loams being particularly good in dry seasons.

The Eugowra wheat soils are lighter red loams than Cowra or Canowindra and somewhat more undulating, except towards Forbes, where the country is comparatively flat.

The Grenfell-Greenethorpe district contains a variety of soils—from a lighter slate soil on the eastern side of Grenfell to strong red loam of basaltic origin to the south and south-east to Greenethorpe and Young. The most favoured portion of this district is around Greenethorpe extending south to Young and west towards Thuddungra and Bimbi. This is undulating to flat country of red loam soil, ideal for wheat-growing and excellent grazing country.

To the west of Grenfell, extending towards the Bland, the country is level to undulating and mostly a light red loam. It is devoted largely to wheat and sheep, but is not so sure as the Greenethorpe section.

To the north of Grenfell, extending to Goolagong on the Lachlan, the country is broken and the soil varies greatly, but it is good wheat-growing and grazing country.

The Mudgee section of the district is more or less broken and undulating, and the hills and slopes, being largely of limestone, sandstone, &c., are comparatively poor. The banks of the Cudgegong River are fertile alluvial loam, which grows lucerne of a quality second to none in the State. The Burrundulla and Lawson Creek flats are most extensive, although the area under lucerne is not large in comparison with Canowindra. The flats, in addition to lucerne, grow maize and pumpkins very successfully. The slopes around Mudgee are suitable for wheat-growing, and grazing country, though not of heavy carrying capacity, is sound and usually well grassed.

Around Gulgong there is an extensive basaltic outcrop where wheat can be grown. The soil is a light red loam for the most part. North of Gulgong, towards Birriwa, the country is somewhat lighter. From Gulgong west to Wellington the country varies from excellent flats around Guntawang, to poor broken country beyond Goolma and to a strong red loam approaching Wellington.

From Mudgee south to Bathurst the country is exceptionally rough and mountainous, and very little cultivation is done.

From Wellington to Molong the soil varies from medium red to light red loams suitable for wheat-growing and grazing.

The most favoured portion of the district was originally white, yellow, and red box, and pine country. The poorer classes of soil and the ranges are mostly timbered with hardwood, ironbark, stringybark, woolly butt, gum, &c.

THE CENTRAL-WESTERN DISTRICT (PARKES CENTRE).

The district to which these notes apply includes the towns of Parkes, Peak Hill, Forbes, Bogan Gate, Trundle, Condobolin, Tullamore, and Albert.

The country is undulating to flat, with stony outcrops at intervals of a few miles, these outcrops west of Bogan Gate and Trundle being responsible for the somewhat lighter and deeper soils now being brought under cultivation in the more western portions of the district.

Although there are small areas of soils of a sedentary character, *i.e.*, partaking of the nature of the parent rock beneath, the greater area comprises soils of transport derived from granite or basaltic formations, with occasional outcrops of limestone, the formation of such soils being due to deposits from flood waters, changing river beds, water erosion, and wind transportation. It is evident, therefore, that there are many diverse types of soil present, each requiring special treatment to obtain maximum crop production.

Generally speaking, on the rises, sedentary soils, red loam in character, usually 9 inches deep, and overlaying a clayey subsoil, are found, ranging into coarser and lighter soils of transport before reaching level country; these latter soils often lack a retentive subsoil. On the level stretches, where the fine soil particles held in suspension have had time to settle, the soil is usually of a clayey loam texture.

A general change in the type of country is apparent when moving from east to west. From the Bumbury Ranges to within a few miles of Parkes

the soil is sandy loam to loam; then until about 10 miles west of Parkes red loams predominate, gradually merging into clayey loams at Nelungaloo and Gunningbland.

For practical wheat-growing purposes the soils of the district may be classified into five distinct types:—

1. Red loam soils, 9 to 12 inches in depth, overlying a clayey retentive subsoil; usually found on the rises and slopes.

2. Deep red loam soils, with no marked change in texture to a depth of more than 2 feet, small areas of which occur to the east of Parkes.

3. Loams to sandy loams, 9 inches in depth, overlying a clayey subsoil, partaking more of the nature of a silty soil, such as occur near Tichborne and Forbes. They set readily after rain.

4. *Deep clayey loams, of the self-mulching type, usually found in myall* and plain country, areas of which occur at Gunningbland, south of Forbes, and west of Bogan Gate. These are very sticky when wet, but the surface crumbles upon drying, and in drought time is often scored with deep cracks.

5. Light to medium loams, ranging from 8 inches to 20 inches in depth, *commencing about 30 miles west of Parkes, and extending west of Condobolin*, Tullamore, and Tottenham.

THE SOUTH WEST.

A great variety of arable soils occur in the south-west, ranging from *light sandy types to heavy pug clay. For discussion the soils can be classified* into the following distinct groups:—

1. Sandy loam.
2. Light friable loam.
3. Medium friable loam.
4. *Medium* heavy loam.
5. Heavy loam.
6. Heavy clay loam (including self-mulching types).
7. Heavy pug clay.
8. Alluvial and semi-alluvial.
9. Miscellaneous types.

Sandy Loams.

Patches of light sandy, light loam mallee occur throughout the western section of the south-west district at Moombooldool, Merriwagga, Hillston, Erigolia, Naradhan, Lake Cargelligo, and Tullibigeal. These soils are described in connection with the growing of wheat on mallee land in Section IV of this Handbook.

Light Friable Loams.

A large percentage of the soils occurring in the Burrowa, Murrumburrah, Young, Wallendbeen, Stockinbingal, Cootamundra, and Junee districts may be classified as light friable loams. They are principally of granitic and basaltic origin. Colours vary from grey to shades of brown and red. The

timber indigenous to the district is mainly grey and yellow box, interspersed with gum, apple, a little pine, and acacia. The depth of soil and type of subsoil varies considerably, but usually a good retentive soil is met with at 6 inches.

These soils are admirably suited for wheat-growing and grazing. The country is mostly undulating, and the soils, due to absence of trees on the hillsides and constant cropping, combined with a favourable rainfall, are prone to surface erosion. With a proper system of rotation, high yielding wheat crops can be grown with little risk of failure.

Medium to Medium Heavy Loams.

These types of soil are met with throughout the districts of Temora, Barmedman, Ariah Park, Ardlethan, Tallimba, Rankin's Springs, Barellan, Hillston, Wyalong, Ungarie, Tullibigeal and Quandialla. The medium heavy loams predominate in the districts of better rainfall, while the medium deep loams are more frequent in the drier areas. However, these two types of soil occur quite frequently in the districts mentioned. In the drier areas about Merriwagga, Rankin's Springs, and Lake Cargelligo, the soils are usually light in character and deep. In parts a limestone formation is found at 18 inches to 2 feet below the surface. Pine, wilga, and bull oak comprise the main timbers on the lighter types of soil, and to a lesser degree whipstick and bull mallee. On the heavier soils box, yarran, and belar are more in evidence.

These soils are easily worked, very suited for wheat-growing, and also provide good grazing. Lucerne will do well on this type of soil, and provide good grazing.

Heavy gravelly loams—these though not so widespread as the main group—are good wheat lands.

Heavy Loams.

These occur throughout the same districts as the medium loams, but are more frequent in the Temora, Quandialla, Wyalong, Ungarie, Tallimba, Barellan, and Ariah Park districts. They are not so easily worked as the lighter types, but under fair seasonal conditions they possess the ability to produce heavy yielding crops. Box, yarran, belar, bull oak, and pine predominate. The surface soil is often shallow overlying a stiff retentive subsoil.

The heavy loams require a special system of cultivation and are easily thrown out of condition with incorrect methods of working. Generally speaking, this type of country produces good grass and herbage, and is excellent for grazing.

Heavy Clay Loams.

Areas of heavy clay loam are in evidence throughout the main wheat belt but they are less frequent than the types already dealt with. Some of the heavy clay loams carrying boree, belar, bull oak, spar or bull mallee are of a self-mulching type. Correctly cultivated, they are first-class soils for wheat-growing, and, in addition, have excellent grazing value, producing a vigorous growth of trefoil and herbage.

Another type of heavy clay, principally timbered with white box, is found. It is very difficult to cultivate, and to ensure success must be worked at the correct time, and this period is usually limited. If ploughed when too wet these soils are of a gluey nature, and when they are dry it is almost an impossibility to scratch the surface.

Areas of plain country are met with in the western section, the soils of which are generally of a heavy clay character. In favourable seasons these heavy clay soils (self-mulching types excluded) will grow heavy yielding wheat crops. Owing to the high costs of cultivation, and the uncertainty of sowing the crop under favourable conditions, it is open to question if on this type of soil wheat-growing is a payable proposition. A rotation which would give prominence to grazing is favoured, in preference to a rotation of fallow and wheat. Considerable improvement in the grazing value of this country can be made by a system of pasture improvement.

Heavy Pug Clay.

In the Ariah Park, Barellan, and kindred districts areas of heavy pug clay occur, and in the Quandialla, Bland, and Bimbi districts constitute the predominating type. Types of plain country are often of a heavy clay, and of a refractory nature, and very difficult to work. Many of the soils are shallow, and have a stiff pug subsoil. Gilgais, self-mulching, friable, clay puff banks and crabholes composed of stiff clay, are included in the make-up of this type of soil. Bimbi, box, yarran, belar, bull oak timbers predominate. The gilgai country is very difficult to cultivate, as it frequently happens that when the banks are in a suitable condition to work the hollows are often boggy or partially filled with water.

Wheat is grown to some extent on the heavy pug clays, with excellent results, provided the crop is seeded under favourable soil conditions and the season is neither too wet nor too dry. It often happens that a wet season is almost as disastrous as a dry one. Seeding may be held up, but eventually the crop has to be bogged in, and then partially drowned. A system of rotation which gives preference to grazing may be profitably adopted on this type of country.

The heavy pug clays are renowned for their excellent grazing and fattening qualities. The grazing value of the land can be profitably increased by a proper system of pasture improvement and top-dressing.

Alluvial Types.

Alluvial and semi-alluvial types occur along the river and creek frontages and valleys at Tumut, Gundagai, Burrowa, Cootamundra, Murrumburrah, Young, &c. They vary in depth, texture, and fertility according to location. In the Tumut valley sandy alluvial loams to heavy clay alluvial loams are met with. The Murrumbidgee flats, as a whole, are of a lighter character, though the heavier types do occur. The heaviest types of alluvial are often difficult to work, and unsuited to lucerne, owing to the high water-table and poor drainage. However, when laid down to suitable grasses and clovers they provide a large bulk of succulent and nutritious feed.

The medium heavy to light alluvial loams are admirably adapted for lucerne, maize, and broom millet. Semi-alluvial types, such as are found in the valleys about Young, Burrowa, Cootamundra, Junee, &c., are excellent for lucerne.

Miscellaneous Types.

In addition to the principal types already mentioned, volcanic, basaltic, and diorite soils, usually of a hilly and broken nature occur in the Gundagai and Tumut districts. By reason of their situation, they are best suited to grazing. Much of this country is overrun with red grass, and provides a minimum of grazing. Excellent results can be obtained by the introduction of grasses and clovers, in combination with top-dressing and careful management.

Ridges timbered principally with ironbark are met with in the Cootamundra, Temora, Ariah Park, Ardlethan, and Wyalong districts. In most instances the soil is inferior, of poor physical character, and unsuited for cropping. Ironbark ridges are of greatest economic value when reserved as a shelter for stock, and for the farm timber supply.

Shaley and gravelly soils are also to be found, some carrying broom bush mallee, and various species of wattle.

THE RIVERINA.

Riverina soils are mostly good textured red loam of volcanic origin, of an average depth of 6 to 9 inches, with a clay subsoil, which readily responds to cultivation.

West of Finley, to Deniliquin, the soils become heavier in texture and shallower, being 4 to 6 inches deep, with a clay subsoil. West of Deniliquin, to a considerable distance past Moulamein, the type verges into black soil plains, and towards Balranald changes to red sandy mallee, interspersed with heavy red and black plains. The mallee is big bull mallee, and though the soil is sandy, it has fair body, and is of a loamy character underneath.

In the Rock, Holbrook, Albury, and Corowa districts there are patches of grey clay loam of a poorer nature, but these do not occur to any considerable extent, and they grow fair crops, although more difficult to work. Cultivation improves them for grazing.

In the Narrandera, Berrigan, Oakland, and Finley districts there are a few patches of fairly deep, sandy loam rising pine country which are not so good for grazing, but grow fair crops. These also improve with cropping for grazing.

There are considerable quantities of heavy black mixed plain of a self-mulching character in the Lockhart, Urana, and Coreen districts, and to an even greater extent round Jerilderie, and from there in parts almost to Narrandera. In the latter districts they are interspersed with heavy shallow red plains.

There are thousands of acres of typical black self-mulching soil round about Moulamein, but the rainfall is only about 14 inches, and the carrying capacity only one sheep to 2, 3, or more acres.

Until recently all these heavy, self-mulching soils were looked upon as only suitable for grazing, and in central Riverina they are excellent grazing soils, but with modern cultural methods they are excellent wheat soils, provided the winter rainfall is sufficient.

In the southern tablelands (Tumbarumba) portion of Riverina the bulk of the soils are a deep, friable, basaltic, chocolate loam. These are excellent for oats, potatoes, wheat, and grazing.

MURRUMBIDGEE IRRIGATION AREA.

Yanco–Leeton Section.

The area consists of sedentary soils, which for all practical purposes may be divided into four types, with variants (these occur mainly in the grey clay loams).

The subsoils throughout the area vary considerably, from a light clay of a self-mulching type to a very stiff clay.

The following table gives details of the soils that occur on both the irrigable and non-irrigable areas, the extent of the various types, and their suitability for agriculture and grazing:—

Extent. Percentage.	Type.	Subsoil.	Variants.	Suitability for agriculture and grazing.
		Irrigable Area.		
45	Grey clay loam, 2–9 inches deep.	Grey clay ...	Blue grey clay loam ... Crab holey ,, ... Self mulching ,, ... Gray puff ,, ... Red puff ,, ...	Suitable for wheat and oats, summer fodder crops, and rice. Fair grazing country.
35	Red clay loam, 3–12 inches deep.	Red clay ...	.....	Suitable for wheat and oats, summer fodder crops and rice. Fair grazing country.
15	Red loam to sandy loam, 4–18 inche deep.	Red clay to gravel.	.....	Suitable for wheat, oats, and barley, summer fodders, peas, vegetables, &c. Good grazing country.
5	Chocolate loam to sandy loam, 4–18 inches deep.	Chocolate and red clay to gravel.	.....	Suitable for wheat, oats, and barley, summer fodders, peas, vegetables, &c. Good grazing country.
		Non-irrigable Area.		
60	Red loam to sandy loam, 4–18 inches deep.	Red clay to gravel	.....	Suitable for wheat and oats. Good grazing country.
20	Red clay loam. 3–12 inches deep.	Red clay ...	.....	Suitable for wheat and oats. Fair grazing country.
15	Chocolate loam to sandy loam, 4–18 inches deep.	Chocolate and red clay to gravel.	.....	Suitable for wheat and oats. Good grazing country.
5	Grey clay loam, 2–9 inches deep.	Grey clay ...	Blue grey clay loam ... Crab holey ,, ... Self-mulching ,, ... Grey puff ,, ... Red puff ,, ...	Suitable for wheat and oats. Fair grazing country.

The Mirool Section.

The soils of this section of the irrigation area are more variations of one soil type than different classes of soils.

The origin of these soils is regarded as alluvial, and they are usually classed as "alluvial plain soils," precisely the same as those forming the bulk of the Riverina. The term "alluvial," however, should not be misinterpreted to mean a type of soil such as is found in close proximity to rivers.

A general description of the profile of this red loam type of soil would be as follows:—A surface soil of approximately 8 inches overlying an incipient hard pan of about 2 inches. This hard pan is not altogether visible, and is more interesting from a scientific point of view than from any practical disability it may present. Below this there is a more or less impervious clay band of approximately 6 inches; then to a depth of 6 feet or more a yellowish limestone rubble is found, which is commonly but incorrectly referred to as "marl." Beyond this depth there is an alluvium, possibly 200 feet deep or more. The formation of the typical clay band in these soils is due to the incidence of the rainfall and evaporation, there being just sufficient rainfall to carry the colloidal clays to the depth stated and deposit them there. Without exception these soils are deficient in humus.

The depth of the surface soil and the thickness of the clay band determine whether a soil is suitable for horticulture or for mixed farming. Any soil less than 8 inches deep and having a stiff clay band would not be considered suitable for fruit-growing, but would make good mixed farming soil.

The class of soil described above covers perhaps the greatest portion of the settlement. It is not considered ideal for fruit culture, though vines grow fairly satisfactorily in it. It requires very careful attention in regard to watering and cultivation, and the use of gypsum has to be resorted to to maintain soil condition and to alleviate irrigation troubles. As mixed farming soil it would grow excellent cereals and summer crops, and would produce lucerne for hay and grazing purposes. It is usually indicated in the virgin state by mixed pine and box timbers with scattered clumps of yarran.

A heavier type of red loam, with a shallower surface soil and a slightly deeper clay band, would represent that portion of the district devoted almost entirely to mixed farming and rice-growing, for which purposes it is eminently suited. This type grows excellent cereals crops, and when fallowing and crop rotation are practised has a fairly high productive capacity. It is usually defined by growths of pine, box, yarran, and boree timbers.

A lighter soil than those described, with surface soil up to 18 inches deep, varying in texture from sandy to light loam and with a clay band not so impervious or so deep, and sometimes absent, is found close to the hills. It is ideal orchard soil, having better surface and sub-surface drainage. This type is rather limited to a few well-defined situations, and is intensively planted with fruit, particularly oranges and other citrus fruits, and vines. Large pine and box with scattered wilgas would indicate the situation of this class of soil.

In isolated parts of the area deep sandy soils are found, varying in depth to 6 feet or more, and free from clay bands. They are wind-blown sand types, and do not form a very large portion of the settlement. They are devoted almost exclusively to fruit and vegetable growing, for which purpose they are particularly suited, though they require heavier applications of

artificial fertiliser to maintain fertility than do the heavier loams. Often they are above the gravitation water supply and water has to be pumped to them. Where these wind-blown sands are comparatively shallow and overlie heavy clay subsoils they are particularly dangerous as orchard soils, and great care has to be exercised with regard to irrigation.

True mallee soils do not as yet form a very large part of the settled country. Further extensions of the irrigation area would embrace a large area of mallee land. Although these soils are very light and sandy and easily worked, besides having considerable depth, they present many problems to the horticulturist. Mallee soil situations for orchards appear to be very frost susceptible, and for that reason should be avoided where possible. Practically no mallee soil will be found on the larger mixed-farming areas.

In addition to the above soils, there are several types of gil-gai or boree soils which should be classed as red and grey gil-gai, with a further type of grey gil-gai having pronounced depressions and puff banks. All of these soils are indicated by growths of boree and yarran timber, and are at a slightly lower level than the loam soils. They are generally found in the lower country bordering creeks, watercourses, and swamps. As mixed farming soils they form a fair proportion of the Irrigation Area, the red and grey types being devoted to cereal and rice growing. Lucerne does not grow too satisfactorily on these soils. Grading and smoothing is an essential operation on these soils to ensure efficient irrigation. The grey gil-gai soil with the pronounced puff banks and deep depressions is not suitable for irrigation, and very little of it is incorporated in the irrigation scheme. It presents great difficulties in regard to irrigation; it is almost impossible to grade, or to drain the water away from the depressions. Wheat-growing has not been a success on this kind of soil—oats is perhaps the only crop that can be irrigated on it with any degree of success.

SECTION II.

The Chemistry of the Soil.

The essential difference between the new methods of farming and the old is that the rule-of-thumb methods of the past are now being superseded by those which are based on a study of the conditions under which crops grow, and of the relationship of the growing plant to soil, air, and water. These new methods have become necessary because of the changed conditions under which farming is being carried on. Land values have become higher, machinery and labour costs have increased, the amount of available land of good quality has diminished and poorer land or land in a less favourable climate now has to be utilised, yields from suitable land decreased under the old methods, and diseases have taken a heavy toll; all these and many other factors have combined to produce a set of conditions under which profitable farming is only possible by the application of principles which *science has discovered. This does not mean that the farmer must neces*sarily be a scientific man, but it is now an essential to success that he should understand something of the fundamentals of soil science.

The following notes are written with the object of affording some information (avoiding technicalities as far as possible) of the nature and functions of the soil, which, though it is no more than a thin film on the surface of the globe, and is infinitely small compared with the mass of the earth, is nevertheless the substance on which all the teeming life of the earth depends for sustenance. If we imagine the earth reduced to the size of an ordinary dray wheel, the thickness of the solid crust of rocks would be represented by the iron tire and the thickness of the layer of soil by a strip of fine tissue paper placed on the outside of the tire.

The upper layer of the soil, the depth of which varies considerably, is referred to as "surface soil." Beneath this layer is another, equally variable in depth, nature and composition, which is termed "subsoil," and below this again is rock more or less decomposed.

The point of view from which our study of the soil will proceed will be that of the conditions which make for soil fertility. By a fertile soil is meant one that is most favourable for producing crops, and if we know the factors on which this depends, we shall be able to maintain the fertility of a good soil, to restore impoverished soils, and to increase fertility in barren ones.

Classification of Soils.

The classification which will be adopted in the following pages is that based upon the mechanical condition of the soils and depending upon the proportion of particles of different size. For all practical purposes one

based on the proportion of sand and clay is sufficiently close, and the following table gives the standard which is adopted:—

NATURE OF SOIL.

	Clay. Per cent.	Sand, Gravel, &c. Per cent.
Clay	75–90	10–25
Heavy loam	60–75	25–40
Loam	30–60	40–70
Light loam	20–30	70–80
Light sandy loam	10–20	80–90
Sand	0–10	90–100

Gravelly soils contain over 20 per cent. gravel.

Calcareous soils contain over 5 per cent. lime.

Peaty soils contain over 20 per cent. humus.

There are, however, other methods of classification which can be usefully adopted under different circumstances. For instance, the farmer will distinguish between light and heavy soils, plain, timber, and swamp soils, or according to the nature of the vegetation, as pine country, box country, &c., or according to the different crops for which they are particularly suitable, as wheat land, lucerne land, grass land, &c. Another method of classification frequently adopted is one depending upon their manner of formation into sedentary and transported soils. Sedentary soils are those which overlie the rocks from which they are formed, and transported soils are those which have been carried away by the action of wind or rain, or streams, or by glacial action, from their original positions. Transported soils are divided into colluvial soils, such as are found on hillsides or in undulating country, which have been moved from their original position by the agency of wind or rain, and alluvial soils which have been carried away by streams and rivers and deposited, often far from their original position, by the action of running water.

Sedentary soils are usually met with on upland plateaux and are generally shallow, their depth depending upon the length of time during which denudation has taken place and the amount which has been transported by wind, rain, &c. They merge gradually and imperceptibly into the rock from which they are derived, and a knowledge of the nature of the underlying rock is of value in determining the character of the soil.

Colluvial (drift) soils.—In the formation of these soils the surface has been removed from its original position, and has become mixed with soils derived from other rocks, often of quite different character.

Their transportation may have been brought about by a variety of causes, such as the action of glaciers in remote times, or by the action or rain or of wind or running water.

Examples of drift soils blown about by the action of the wind are to be found in the western plains, where the movements of the soil during continued wind-storms have resulted in the transportation of the surface soils to new positions, where they are often piled up to the depth of several feet.

Alluvial soils are found in the beds of old watercourses or on either side of the banks of flowing streams, where they are deposited by the rise and fall of the river, and especially during floods. The Hunter Valley, in New South Wales, where the river is not only subject to periodic floods, but is continually changing its course, affords an excellent example of a large area of country covered by such alluvial soils.

Alluvial soils are also met with in the plain country, where no rivers are to be seen, and occupy the beds of dried-up watercourses, along which they were originally deposited.

Such alluvial soils are generally of great fertility, largely due to the fact that the soil particles are exceedingly fine. Those formed by the deposition of silt in successive floods upon the river banks are often of great depth. Much of the best lucerne land of the State is found in such localities.

The Formation of Soils.

Soils are produced in the first instance by the weathering of rocks. By weathering is meant the continued action of wind, water, and changes of temperature upon the rock, and the term includes the mechanical and chemical changes brought about by these agencies, as well as by the action of vegetable and animal life.

The disintegration of rocks to soil is an exceedingly slow process. It has been calculated that the disintegration of limestone rock (one of the most readily-weathered rocks) to the depth of one metre would take over 70,000 years. Syenite would take ten times as long to disintegrate to the same depth.

As a general rule, it is not easy to trace any close relationship between the soil and the rock from which it has been derived. This is especially the case when the soil has been exposed to atmospheric influences for a long period, when vegetation has taken a good hold, and when the land has been under cultivation. The changes brought about by all these processes render the mineral matter in the original rocks more soluble, and the further action of plant-growth, rain, drainage, &c., remove the more soluble salts from the soil to such an extent as materially to alter the original proportion of the ingredients.

The same thing happens when the soil is transported from its original position, either by rain or wind, or when the original soil is overlaid by transported soil from other rock formation or by flood deposits.

If the weathering or other agents of destruction have been sufficiently active, and have acted for a sufficient length of time, the resulting soil from a pure limestone rock becomes indistinguishable from that derived from sandstone.

Where, however, the rock has weathered *in situ* fairly rapidly, where vegetation has not taken hold and the rainfall is not excessive, it is possible to trace the effects of weathering in the different layers of soil.

Samples taken at Bathurst Experiment Farm from places where the weathering processes could be traced right through the different soil layers

right down to the unchanged granite rock were examined, and the effects of the weathering at various depths are shown in the following table:—

TABLE showing alterations in composition at different depths of a granite soil formed *in situ* (Bathurst Experiment Farm).

Locality and Depth.	Colour.	Reaction.	Water Capacity.	Capillary Power.	Clay.	*Lime (CaO).	*Potash (K_2O).	*Phosphoric Acid (P₂O₅).	Nitrogen (N).	Volatile.	Remarks.
			Per cent.								
1. Near silo—	from decomposition of granite *in situ*.										
0" to 6" ..	light yellow	strongly acid.	25	good	28·8	·169	·111	·072	·140	3·66	
6" to 12" ..	reddish	acid.	27	excellent	51·0	·218	·452	·069	·112	5·53	Red colour due to ferric oxide.
12" to 18" ..	,,	faintly acid.	44½	,,	61·8	·349	·559	·063	·112	8·55	
18" to 24" ..	yellowish	,,	45	,,	44·8	·333	·435	·104	·098	7·72	Contains lumps of decomposed granite.
24" to 30" ..	light yellowish	,,	42	,,	46·8	·446	·582	·122	·070	6·84	
30" to 36" ..	yellow	,,	39	,,	34·7	·369	·558	·063	·042	6·07	Very lumpy with decomposed granite.
2. Near orchard gate—	granite detritus redistributed by water.										
0" to 6" ..	light brown	strongly acid.	42	good	59·2	·249	·184	·094	·154	5·34	
6" to 12" ..	grey	very faintly acid.	26	,,	54·2	·184	·103	·012	·070	1·92	
12" to 18" ..	dark grey	neutral	42	fair	79·1	·307	·371	·052	·070	5·95	
18" to 24" ..	brownish	very	53	poor	85·6	·420	·425	·064	·084	6·09	
24" to 30" ..		weakly									
30" to 36" ..		alkaline.									

* Soluble in 1·1 HCl.

This table is instructive as showing that the subsoil in granite areas is invariably richer in mineral plant-food, especially potash, than the surface soil. The phosphoric acid gets slightly and the nitrogen considerably less at a depth, but the lime and potash are much higher. It follows from this that when a granite surface soil gets depleted in potash a good supply can be introduced by deeper ploughing. In sandstone country this is not true to nearly the same extent—a fact which makes a poor granite soil an infinitely better asset than a poor sandstone soil.

The Action of Air.

(*a*) *Mechanical.*—Air acts mechanically by the actual pressure exerted by the wind upon exposed surfaces, and by the bombardment of rock surfaces by wind-borne material such as fragments of rock and pebbles. Its action is also of importance in the removal by wind of the disintegrated rock, leaving fresh surfaces exposed to the other disintegrating agencies. It is also one of the principal factors in the formation of the drift-soils mentioned above.

(*b*) *Chemical.*—The chemical disintegration of rock, due to the action of the constituents of the atmosphere, is for the most part brought about by the carbonic acid and oxygen. The action of *carbonic acid*, since it is practically confined to the solution of the gas in water, either in rain or in spring or river water, will be better discussed later under the heading of water.

The action of *oxygen* is practically confined to the further oxidation of lower oxides of such metals as iron and manganese. A large number of minerals contain ferrous oxide, to which they owe their dark colour. This oxide readily absorbs oxygen, being converted into ferric oxide (rust); the change being accompanied by an increase in bulk assists in shattering the rock in which these minerals occur.

Changes of Temperature.

The mechanical effects of alternate heat and cold are potent factors in the disintegration of rocks, which, with few exceptions (such as limestone, quartzite, &c.), are made up of a mixture of different minerals. These minerals expand and contract unequally when subject to variations in temperature, and their alternate contraction and expansion is an important factor in the slow breaking down of rocks.

The daily alteration of temperature between night and day is capable of effecting the disintegration of the hardest rocks. This disintegration is accelerated by the fact that into the minute crevices so formed, water, dust, plant-roots, &c., are carried, themselves acting as further disintegrating agents.

On mountain ranges and over extensive plains, where frosts occur, and the air is clear and dry, the action is yet more marked. The surface soil in *the deserts of Central Asia and other parts of the world, including* the interior of our own continent, has been formed in this way, aided, of course, *by the other weathering agencies.*

Water.

The effect of water, and especially of water containing carbonic acid in solution, as is the case with rain-water and most spring and river water, has a most far-reaching influence in the disintegration of rocks and their conversion into soil.

(*a*) *Mechanical Action of Water.*—Water acts mechanically in several ways. The actual bombardment of exposed surfaces of rock by rain results in its slow attrition. Running water traversing rock surfaces exerts a very considerable erosive action apart from its solvent action. The action is further hastened by the removal to lower levels of the particles thus torn away and the exposure of fresh surfaces of rock to the weather.

Running water also plays an important part in the transport of soils from one part to another, from higher to lower levels, and in the formation *of alluvial soils by the deposition of mud and fine silt during flood. Such* alluvial soils occur along the banks of all our rivers for some distance from the river banks, and in the case of rivers which wind tortuously through level country and are subject to frequent floodings the extent of the alluvial *deposit* is very considerable. When such a river, as is the case with the Hunter, frequently changes its course, the extent of the alluvial deposit becomes still greater.

The alternate freezing and melting of water plays an important part in mechanical rock disintegration. Even the most compact rocks are not entirely impervious to water, and contain a small amount of moisture, known to quarrymen as "quarry water." Water in freezing expands about one-tenth of its bulk, so that in situations exposed to alternate frosts and thaws, the amount of disintegration brought about by this means is very considerable, particularly when the alterations are rapid, say, warm days followed by frosty nights. During periods of prolonged frost this action does not proceed.

Connected with the action of moving water, we must also take into account the action of glaciers, which, though it takes no part at present in the formation of soils on the Australian continent, has undoubtedly been an active agent in the past in the disintegration of mountain ranges and the transport of the debris to form soils in the valleys.

(*b*) *Chemical Action of Water.*—The chemical action of water, and especially of the dissolved substances, is undoubtedly the most extensive agent in the denudation of rocks.

Water acts on the soil constituents in two ways—

(*a*) By combining chemically with the ingredients to form hydrates; and (*b*) by its solvent action.

(*a*) A large proportion of the minerals which form rocks are hydrated silicates, containing a certain proportion of combined water. The hydration of these minerals is accompanied by considerable increase in bulk, which assists in the disintegration of the rock-mass, and also produces a substance which is more readily attacked than the original silicate. A good example of the expansion of rock on hydration is met with in the well-known operation of taking a cast in plaster of Paris, which is burnt gypsum, a substance which frequently occurs in rock-masses. When plaster of Paris is moistened with water it absorbs the water and becomes a hydrate, and in so doing expands; thus, *if a mould of a coin or medal is filled with moistened plaster*, the plaster will expand in drying out and setting, and force itself into the irregularities of the surface, forming a reproduction of the original medal.

(*b*) It is, however, *the solvent action of water which plays the most* important part in the breaking up of rocks. Even pure water exercises a slight solvent action on the minerals of which rocks are composed. If a little finely-powdered felspar be shaken up with water, the water will show an alkaline reaction, and turn red litmus paper blue—showing that something has been dissolved from the water. The same thing happens with powdered glass. Absolutely pure water is, however, not met with in nature. Natural water contains appreciable quantities of dissolved materials, some of which, such as carbonic acid, ammonia, nitric acid, exert a very considerable solvent action upon rock particles.

Carbonic acid is present in all natural waters to a greater or less extent. Even in rain-water the quantity, though small and very variable, is appreciable, and amounts to as much as 1 per cent. The solvent action of waters holding carbonic acid in solution is very considerable. Some rocks, such as *limestone, are completely soluble in such a solvent. On this account waters* flowing over limestone rocks are invariably hard owing to their containing carbonate of lime in solution.

Ordinary spring and river waters do not, indeed, contain very much carbonic acid, but some springs contain a very considerable quantity of the gas dissolved under pressure, and the effervescence of many mineral waters is due to the escape of this gas when the pressure is released on reaching the surface.

Other rocks and minerals are not so readily dissolved as is carbonate of lime, but all are very much more soluble in water containing this gas than in pure water. Felspar, for example, is very readily attacked, the carbonic

acid removing the potash (or other base) and leaving a residue consisting of pure clay. Even silica is attacked by it, and the minerals composed of hydrated silica—such as flint, jasper, and even quartz—are sensibly attacked by it. Quartzite is the only rock that may be regarded as practically unattacked by carbonic acid.

Ammonia, which is present in minute quantities in rain water increases the solvent action of carbonic-acid water upon silicates.

Glass is attacked slightly more by a weak solution of ammonium carbonate than by a weak solution of potash or soda.

Nitric acid is also present in small quantities in the atmosphere, and might be considered to increase the solvent action of rain water: but as a direct promoter of rock decomposition, the action, if any, is scarcely appreciable.

The *dissolved saline matter* in rain-water also helps in the disintegration of rocks, both by its chemical and its mechanical action. In the neighbourhood of the sea especially, the air contains particles of salt which are dissolved by the rain and carried into the minute abrasions and crevices formed in the rock by the mechanical action of wind and rain. As the water evaporates the salt crystallises out, expanding in the process, and thus aiding the work of disintegration.

The Action of Vegetation.

As soon as a very small quantity of disintegrated soil is produced, it becomes at once the medium for the germination of small seeds, wind-blown or dropped by birds. As these seeds germinate and grow they assist in the disintegration of the rock below, mechanically by forcing their roots into its mass, and chemically by the solvent action possessed by their roots. Even on the solid rock vegetation can gain a foothold. The first forms of vegetation are the lichens which cover the surface of the rock in moist and sheltered places. These plants secrete oxalic acid—a much stronger acid than carbonic acid—which attacks the lime in the rock. Crystals of oxalate of lime are frequently found in lichens. By their growth they exclude light and air, and help to keep the rock moist, thus favouring its further denudation.

When a certain amount of soil has been produced by the growth and decay of these lichens other forms of vegetation can obtain a foothold: mosses, ferns, stone-crops, and saxifrages, followed by other shallow-rooted plants. By the decay of these and the continued disintegration of the rock, the soil gradually increases in depth until higher plants and trees are able to find support and nourishment.

Bacteria.

Bacteria and micro-organisms generally play a highly important part, not only in the transformation of organic material within the soil (which will be discussed more fully under the heading "The Plant's Supply of Nitrogen" page 82 *et seq.*), but also in the formation of soil from the disintegration of rocks. The bare surfaces of rocks contain large quantities of organisms which, with the aid of the oxygen, ammonia, watery vapour, and carbonic acid of the air, are capable of decomposing the rock and of forming nitrates and accumulating carbon.

Factors which Determine Fertility.

There are many factors which influence soil fertility, the principal ones being the available supply of plant-food, and the physical and biological condition of the soil.

The conditions necessary for optimum plant growth are:—

(1) There must be a sufficiency of water.

(2) *There must be a sufficiency of air.*

(3) *There must be a sufficiency of plant-food.*

(4) The conditions regarding temperature must be correct.

(5) The plant must have adequate root room.

(6) Toxic or poisonous substances must be absent.

Any one of these may be a "limiting factor" as regards fertility of soil.

The soil is not an inert mass of material, out of which the plant picks whatever material is present for its nourishment, and having exhausted that, dies, but must be regarded as the medium in which the plant grows, and in which complex changes—chemical and biological—are taking place among the constituents. When we talk of changes that take place in the soil, we must realise that the changes are constantly going on, that the material of which the soil is composed is continually altering, that the growth and decay of plants, the movements of earthworms and of minute organisms, the fall of rain, the evaporation of moisture, alternations of temperature, of night and day, of summer and winter, even alterations of atmospheric pressure, the passing of clouds, and countless other phenomena of which we take no heed, or whose action we do not yet fully understand, all these agencies produce an incessant series of changes within the soil. When we add to these the changes produced by human agencies—by cultivation, by ploughing, liming, manuring, &c., &c.—it will be seen at once that a mere statement of the amount of fertilising material—potash, lime, phosphoric acid, and nitrogen—in the soil, even if we could say how much was actually available for any particular crop, is not all that is required to permit an evaluation of the soil's fertility.

The fertility of a soil depends, then, *in the first place*, upon the *presence* of a sufficiency of plant-food in a readily available form, and, secondly, upon certain physical characteristics, possessed more or less by all soils, which effect the splitting up of the mineral ingredients and nitrogenous matter in such a way as to render them available to plants, as well as regulating the supply of water, warmth, &c.

Of these physical characteristics the most important are:—

The texture and porosity of the soil.—On this characteristic depends a large number of the properties conducive to fertility.

By the porosity of the soil is meant the fineness and the number of its pores. We must distinguish between this and permeability to water; a coarse sand, for example, is permeable to water, but possesses properties exactly opposed to those of a porous soil. Humus soils are especially porous.

On the fineness of texture depend the following characteristics:—

Capillarity of the soil, or capillary power, is a physical property that aids in the circulation of water, and more particularly helps to supply the surface soil with water from the subsoil. Capillary attraction is the power which causes water to rise above its level in fine tubes and minute fissures.

It is largely through the agency of this circulating water, which contains carbonic acid and various compounds in solution, that the mineral and, in a less degree, the organic matter of the soil is rendered available for plant-food, and presented in solution to the plant.

The capillary power of a soil depends very largely upon the fineness of its texture, so far as the size of its grain particles is concerned. The nearer *the texture approaches that of a sponge the greater will be its capillarity.*

Humus has a very high capillary power, which is not possessed to any extent by either coarse sand or clay. The importance of maintaining and, if possible, increasing the humus content is therefore obvious.

The water capacity of a soil is a very important physical property, as it is only with the assistance of water that the mineral constituents are made *available to plants. A good soil must be able to store up water for the* future use of the plant. The capacity for water depends on the fineness of the soil—the finer the particles the more numerous will be the pore spaces between the particles and the greater will be the amount of water that can be absorbed.

The hygroscopic power—that is, the power of attracting water vapour—is *of practical importance, in that it prevents undue evaporation, and prevents* the soil from becoming parched up. It also serves as a guide to the absorptive power of other gases. This property, like capillarity, is due entirely to the fineness of particles, and the order is the same—humus, clay, loam, marl, sand, and coarse sand.

The absorptive or adsorptive power of the soil for salts is another factor of very great importance in determining the fertility of a soil. This power which soils possess of removing saline matter from solution, and retaining *it within their pores, is attributed partly to physical and partly to chemical* causes, resulting in a chemical interchange of basic constituents, substances such as humus and clay possessing the power in a remarkable degree.

Nitrification.

We now come to the most important property possessed by soils as affecting their fertility, and, at the same time, the most obscure, namely, their power of nitrification. This property depends upon a number of points on some of which our information is not very clear.

From what we know of the process of nitrification, we can lay down with tolerable certainty the following conditions as being favourable to the process:—

We must have free access of air and moisture, a certain degree of warmth, *and the presence of nitrogenous organic matter prone to oxidation* (represented by humus). The presence of reducible mineral matter, such as sesquioxide of iron or metallic sulphates, is also favourable. A sufficiency of basic substances to combine with the nitric acid appears to be advantageous to nitrification.

Putting on one side the bacteriological aspect of the phenomena involved, we shall find that the formation of nitrates within the soil is due primarily to oxidation, and that within certain limits the power of oxidation which the soil possesses is also the measure of its nitrifying power.

We are, therefore, justified in assuming that a soil will be most favourable to the development of the nitric ferment which combines the following characteristics:—

1. The presence of nitrifying organisms in sufficient quantity.
2. The necessary temperature (5 to 55 deg. C.—optimum 37 deg.).
3. Darkness to stimulate and develop bacteria.
4. Sufficient moisture for development of bacteria.
5. Free æration of soil.
6. A base to neutralise acids as produced.

These conditions are more fully discussed on page 83, but it will be seen that, beyond the presence of certain mineral and organic matter, the conditions favourable to nitrification are those whose presence otherwise indicates fertility, namely, fineness of texture and absence of excessive water. If the capillary power of the soil is low, it indicates an unfavourable condition for nitrification.

It has been stated that the presence of nitrates in the soil assists in rendering soluble the potash in such insoluble combinations as felspar, this being an additional mode by which the nitric organism promotes fertility.

Provided, then, that the condition of the soil with regard to the physical properties above enumerated is satisfactory, that the mineral and nitrogenous compounds requisite for plant growth are present in adequate quantity and sufficiently available, that the soil possesses good absorptive capacity and high capillary power, and that conditions requisite for nitrification obtain—such soil may be expected to prove fertile. In cases where one or more of the conditions requisite for fertility is lacking we must look to improved methods of cultivation and treatment to render the soil fertile and productive.

The above considerations lead us to attach special importance to two other factors than the chemical or mineral constituents of the soil. One factor is the texture of the soil, its porosity, and the second is the amount of humus or decaying organic matter it contains.

It may be worth while to study these two points a little more in detail.

Texture of Soil.

We have seen that the texture is of great importance in relation to the fertility of the soil. Some of the conditions which affect the texture and some of the means to be adopted to promote the desired porosity of texture are discussed in the following pages.

Relation of Texture to Moisture.

The ideal condition of the soil as regards moisture is obtained when the soil contains about half the amount of water which it is capable of holding.

For example, a fairly heavy clay soil will have on the average a capacity for water of about 40 per cent.—that is to say, 100 lb. of such soil will contain, when fully saturated with moisture, about 40 lb. of water. It is generally agreed that the amount of moisture most favourable to plant growth is something under half this amount, namely, about 18 per cent. If a much larger proportion of water exists than this, the interstices of the soil are filled with water instead of air, consequently there is a deficiency of oxygen, which we have seen is one of the prime agents in promoting chemical

action within the soil. The soil becomes what is called waterlogged, and the chemical action which we have recognised as essential to fertility is at a standstill. The roots of the plants, moreover, are immersed in water.

The condition of things in a soil containing the proper amount of water, and in good tilth, is pretty much as follows:—The minute grains, of which *the soil is composed, do not form a compact mass, but the intervening spaces* are so small that they act as capillary tubes, of the same nature as the pores of a sponge or the little tubes of an ordinary lamp wick, and their effect upon the water present is exactly the same as the bundles of hollow tubes in the wick—that is to say, they draw the water up by the attraction of the sides of the tubes. Each grain of the soil will be then surrounded by a thin film of water, which in its turn encloses and surrounds small bubbles of air. (In the case of a waterlogged soil, these bubbles are driven out, and there is little or no air in the soil.) In and out amongst the grains of soil the *plant pushes its roots and its root-hairs in search of food and moisture.* If the above rough description is at all clear it is obvious that the water in the soil is continuous—that is to say, a sufficiently minute organism could pass through the entire soil in the water, without ever having to touch a particle of soil, or pass through a bubble of air. The result of this is that, supposing a particle of water to be removed at any point, either by evaporation at the surface or by absorption by means of the root-hairs, its place is at once taken by adjacent water, and the whole of the water in the soil is at once set in motion until equilibrium is again restored. It follows from this that a crop with well-developed roots is itself an important factor in maintaining the circulation of moisture within the soil, for, as the water is absorbed by the root-hairs at any point and circulates through the plant, its place is taken by adjacent particles of water, so that a steady flow of water is set up towards that point.

The evil effects of too much moisture which cannot get away have been already mentioned. In addition, it is to be noted that this is one of the most common causes of sourness in the soil. *Sourness—that* is, the formation of certain acids within the soil—is largely due to the absence of air and oxygen, and can be remedied by the free admission of air, as by turning over and exposing to the atmosphere. To prevent this accumulation of water, the remedy is to drain. In many cases where it is due to the presence of a stiff clay subsoil through which the water cannot penetrate, subsoiling is resorted to.

It is also possible to have too little water in the soil, with the result that the crops wither and die. This also takes place when the transpiration equals or exceeds the absorption by the roots. Plants absorb water only through their roots and root-hairs, and mainly through the ends of these hairs.

Evaporation.

The soil-water evaporates in two ways. The water absorbed by the root *diffuses throughout the cell-system of stems and leaves, and evaporates or* transpires through the breathing-pores of the leaf. Water is also lost by evaporation from the surface of the soil.

Both kinds of evaporation are increased by high temperature, dryness of the atmosphere, or a high wind—that is to say, evaporation is most rapid in hot, dry weather and on a windy day, and is slowest in cool, moist weather and calm air. Shelter belts of trees are the only useful means of cooling and moistening the air and breaking its force, and thus preventing too rapid evaporation.

Evaporation from the surface can be checked by mulching. A covering of leaves or farmyard manure, or any other form of mulch, protects the surface-soil from the heat and the dry winds which cause rapid evaporation, and thus prevents the too great loss of moisture; or the same result can be obtained by hoeing or stirring the surface-soil, which has the effect of breaking or widening the capillary tubes at the surface, and by this means preventing the upward motion of the water. Cultivation practised for the removal of weeds has, therefore, another equally beneficial action.

An ideal soil from the point of view of texture is, therefore, one of a fine tilth, from which excessive moisture drains away readily, in which there is free movement of air and water, and in which too rapid evaporation is checked.

Humus.

Humus is a very important constituent of a fertile soil; it influences both the chemical and physical properties, and notably increases the water-holding capacity of a soil. Humus is a term applied to the black or dark-brown material of vegetable origin, essentially a product of bacterial action, which gives to surface soils a characteristic darker colour as compared with the subsoil. It is not a chemical compound of definite composition, but is a mixture of a number of different compounds of a complex character, the nature of which varies both with the material from which they were derived, with the kind of humus-forming fermentation, and with the age of the product. Humus is a mixture that has not yet been satisfactorily resolved into its component parts.

Over that considerable portion of the State's arable land on which the rainfall is limited or uneven, the need of retaining within the soil whatever moisture is received as rain is of paramount importance. The maintenance of the soil's fertility in these areas becomes largely a question of conserving this sometimes scanty supply, and soil-treatment having for its object suitable means of maintaining the most favourable conditions as to moisture claim the most serious consideration of the farmer.

Moisture conservation in these areas is of quite as much importance as, and is intimately connected with, the question of manuring, and it is safe to say that unless the conditions as to moisture are satisfactory, optimum results are not likely to be obtained from the application of fertilisers, nor a maximum return obtained from the money expended on them.

Apart from the question of cultivation and drainage, the maintenance of the best conditions as to water within the soil depends to a very large extent upon the presence of humus, and variation in the amount present will affect the value of the soil for agricultural purposes.

Functions of Humus.

The presence of humus in the soil increases the fertility in the following ways:—

In the first place it aids in absorbing and retaining moisture in the soil, and its presence tends to prevent surface evaporation. A surface soil, fairly rich in humus, exercises the same type of influence on the underlying soil, though in a lesser degree, as does a mulch of dead leaves, leaf mould, or other decomposed vegetable matter. During dry spells, and under the

influence of hot winds usually prevalent under such conditions, the loss of *moisture from the soil by surface evaporation* is enormous, and in soils destitute of humus this loss is so rapid as to result in the drying up of the soil and the wilting of the crops. The final result of such conditions is the *formation of scalded spots* and the complete removal of the fine surface soil by the wind in the form of dust.

The humus in the soil is an ingredient which is subject to alteration and destruction, and under dry conditions and in the presence of air it is more or less rapidly destroyed. The necessity of maintaining, if not increasing, the humus content cannot be too strongly emphasised.

The presence of humus in the soil tends to improve its texture, lightening and loosening it, and preventing compaction of the surface, so that it is of special value in the amelioration of stiff soils.

The *effects of humus may be summarised* thus:—

1. The organic matter (humus) imparts or tends to impart a black colour to the soil. Since it is a well-known physical law that a black substance absorbs more heat than a white one placed under similar conditions, it follows that a dark colour facilitates the warming of a soil in spring.
2. The organic matter greatly increases the water-holding capacity of a soil.
3. Organic matter facilitates the production of a fine tilth and a good seed-bed, and it renders cultivation more easy.
4. Organic matter is the soil material in which all the important actions of micro-organisms take place because its substance furnishes the food essential to their growth. Most of the soil's nitrogen comes from the organic material, and thus the nitrogen in the organic matter constitutes the main natural source of the soil's nitrogen supply. The nitrogen decomposed in the organic matter is held in slowly available form, gradually undergoing conversion into nitrate under normal soil conditions, in which form it is assimilated by the plant.

It is of interest to remember that the humus of arid or semi-arid regions is richer in nitrogen than that of the moister districts. This is a point of great importance with reference to the potential fertility of these soils. In point of fact, from a variety of causes acting together, the soils of the dry climates are richer in plant-food of all kinds than are the soils in regions of greater rainfall, consequently nothing but the absence of water prevents these from being extremely productive. There is, therefore, no problem which exceeds in importance that of retaining in such soils the little moisture that they receive, and any operation that succeeds in arresting even partially the unavoidable loss of that moisture deserves the highest consideration.

Loss of Organic Matter in Soils.

It is a well-known fact that soils lose their organic matter. The effect of this loss is shown in various ways, as by (*a*) increased compactness, (*b*) decreased capacity to receive and hold water, (*c*) increased difficulty of working, and (*d*) diminished productiveness.

Generally speaking, conditions that favour the increased action of the destructive micro-organisms that work in the presence of abundance of air hasten the disappearance of soil organic matter—especially when such conditions are accompanied by a lack of fresh supplies of organic matter. The conditions which favour rapid destruction and disappearance of organic matter from soils may be given as:—

1. *Abundance of Air.*—In very porous soils, where air penetrates freely, destructive fermentation of organic matter is marked, especially so with a high temperature and moderate moisture. When green manures are ploughed under there is often danger that they may not be sufficiently covered with soil or properly compacted, especially when the amount of the growth of green substance is very large; under such conditions destructive fermentation may destroy large amounts of it.
2. *Moderate Amount of Moisture.*—Destructive fermentation is prevented in a wet soil on account of exclusion of air. The presence of only a moderate amount of moisture favours action of micro-organisms.
3. *High Temperature.*—Temperatures over 75 deg. Fah. favour rapid action. Organic matter is used up more rapidly in warm climates than in cool. In temperate climates summer is the time when fresh organic matter is most rapidly changed into humus.
4. *Too much Cultivation.*—This has the effect of making the conditions of air supply and moisture favourable for the rapid decomposition of organic matter.
5. *Supply of Micro-organisms.*—When a soil contains large supplies of organisms that decompose organic matter, fermentation or destruction goes on more rapidly than when the supply is small. Green manures undergo decomposition more rapidly if 2 or 3 tons of partially fermented farm manure are spread on the surface before ploughing under.
6. *Lack of Supply of Organic Matter.*—It is obvious that in a cultivated soil the organic matter must become exhausted in time if entire crops are removed and crop rotations adopted which make no provision for supplying organic matter.
7. *Summer Fallowing.*—When a field is allowed to lie bare for an entire crop season conditions of temperature and moisture favour rapid destruction of organic matter with conversion of organic nitrogen into nitrate, of which form there is danger or loss by leaching before the soil is occupied by a crop.

Methods of Restoring and Maintaining Organic Matter.

To restore humus to a soil there must first be added a sufficient supply of fresh organic matter or material, and to maintain it the conditions of decomposition, especially as to the supply of air and moisture, must be so regulated that the process of decomposition will not on the one hand go on too rapidly, or on the other hand proceed so slowly as to waste time before the benefits are available for the soil and crops; and, in addition, care must be taken by the use of calcium carbonate (or hydrate) to prevent an accumulation of acid products of decomposition to a degree that will unfavourably affect the crops.

In agricultural practice the means adopted to restore organic matter to the soil are:—

(*a*) Application of large dressings of stable manure.

(*b*) Application of large dressings of compost.

(*c*) Green manuring (leguminous crops for choice).

The first and second are rather costly methods except under particular circumstances, and green manuring is certainly the cheapest method, and is applicable alike on sandy or on heavy soils.

(*a*) *Farmyard Manure.*

The composition of farmyard manure is far from constant, varying with the nature of the animal making the dung, the kind and amount of the food it receives, the proportion between solid and liquid excreta and litter, and the extent and nature of the decomposition which has taken place in the manure itself. Good farmyard manure would contain 0.5 per cent. nitrogen, 0.3 per cent. phosphoric acid, and 0.5 per cent. potash.

When stable or farmyard manure is used on any large scale it is found to give the best results if applied direct to the land: and this practice is generally followed. When it is desired to rot the manure well before use, the best plan is to put it in a shed and stack it, mixing with it any waste straw or other vegetable material. If possible the urine from the animals should also be added. When manure is stacked in any quantity, heat is quickly generated, and the temperature reached will destroy most of the larvae of insects and weed seeds.

Farmyard manure is not readily available in large quantities, and is relatively expensive, except perhaps in dairying districts or on farms where animals are stall-fed.

(*b*) *The Compost Heap.*

The compost heap is a valuable adjunct to the farm, and it is a very great pity that it is not more frequently to be found.

A heap or pit can be made very economically, and is of special value in that it utilises all sorts of vegetable and animal refuse, which would otherwise be wasted, and converts it into a valuable manure, rich in organic matter, and eminently suited for soils low in humus or subject to droughty conditions.

The principle of the compost heap is the fermentation of easily decomposed vegetable matter. It is not only substances like peat and straw, which form the usual basis of compost heaps, that are thus decomposable, but almost every kind of organic substance, both of vegetable and animal origin. Dead leaves, bush scrapings, sawdust, grass, weeds, tops and stalks of vegetables, as well as bone and animal refuse, can be treated in this manner. In the case of animal refuse, the operation is much slower, and it is important to be sure that such refuse is not derived from a diseased source.

The best way of making and maintaining the compost heap will depend largely upon local surroundings. As a general method of procedure the following will be found satisfactory:—When a sufficient quantity of refuse

is collected, make into a heap and cover with a thin layer of ground limestone, or preferably ground rock phosphate, and then with a layer of earth. Continue with layers in this order until the heap is 3 or 4 feet high, covering the whole with the last layer of earth. The heap should be kept moist, and for this purpose all refuse water from the house, slops, urine, &c., should be added. The heap may be conveniently watered by making a hole into the interior and pouring the liquid in. The object of the outer covering of earth is to absorb any ammonia which is evolved in the process of fermentation and by the action of the limestone.

When the heap has been prepared it must be left to itself to ferment for some time. Probably a few months will be sufficient unless very refractory substances, such as bone, &c., are present. Then it should be well forked over and another layer of ground limestone, and finally one of earth, should be added. In the course of another month or two the compost should be ready for use, providing, at a very slight cost, an excellent manure, rich in humus.

When refuse material is burnt, the ashes, though still possessing manurial value on account of the lime, potash, and phosphates they contain, are of incomparably less value than the original substance out of which they were derived, owing to the loss of humus material and nitrogen in the process of burning.

Instead of a heap the compost may be conveniently prepared in a pit. In either case the bottom should be cemented, or so drained that the liquid escaping from the mass can be collected and returned to the compost.

It will be found advantageous to prepare a second heap while the first one is ripening and being used.

(c) *Green Manuring.*

Among the most effective methods of supplying humus to the soil and increasing its fertility is the practice of green-manuring—that is, the growing and ploughing under of a green crop. The beneficial action of this operation is a twofold one: it enriches the soil, in the first place, by supplying it with a considerable proportion of readily-available plant-food; and in the second place, by adding humus, and thus improving the soil's texture and its power of absorbing and retaining moisture. Green-manuring is effective both in sandy and in heavy clay soils, and, indeed, on all soils deficient in humus. On sandy soils the effect of green-manuring is to consolidate the soil, the humus formed binding the particles together. On clay soils, the effect of the addition of humus (and the production of carbonic acid) is to loosen and aerate them.

Green-manuring depends for its success upon conditions favourable to the decomposition of the buried green crop, namely, sufficient warmth and moisture. A crop ploughed under in the late autumn or winter will nitrify only slightly, and the same applies to ploughing under a crop in a dry season. If the land is quite dry the crop will remain buried without decomposition for a considerable period, and its benefit will be lost. The practice of green-manuring is discussed in greater detail in connection with manures containing nitrogen on page 102.

Causes of Infertility.

It frequently happens that large or small areas of land are found to be unproductive or of poor quality, although from their origin, and the nature of the surrounding country, one would expect them to possess a high degree of fertility. Of such nature are the bare patches often met with in otherwise fertile areas.

Such bare patches may occur in areas of a few feet in diameter, or may be of very considerable extent. The causes of this infertility are various, and it is by no means easy in all cases to determine to what their unproductiveness is due.

The following are some of the instances most commonly met with:—

Shallowness of Surface Soil.

It may happen that the rock from which the soil is derived has weathered unequally in different parts, and that undecomposed rock is found quite close to the surface, thus forming a very shallow surface soil on which nothing but the most shallow-rooted crops will grow, resting on a hard stratum through which water will not penetrate. Crops or trees growing on such soil may do fairly well until the roots reach the impervious layer, when they begin to wilt.

The same result is produced when a hardpan or layer of impervious material is formed below the surface. This hardpan may be formed mechanically by the plough, either by ploughing stiff clay when it is wet, or by ploughing repeatedly at the same depth. It may also be formed naturally by the cementing together of the particles of sand and gravel of the subsoil by humates and silicates, particularly humates and silicates of iron and lime, and is especially likely to occur in ironstone country. The remedy is to break up the hard layer by deeper ploughing, and to apply slaked lime.

Scalded Plains.

Where conditions are such that a shallow and dry surface soil, or a soil deficient in vegetable matter, is exposed to the action of wind, large areas are frequently denuded. In such cases the top soil is carried away and a hard surface exposed, which is destitute of vegetable matter, and useless for the production of crops, or even of grass, until it has been thoroughly worked and brought under cultivation for some time. These patches form the well-known scalded or scoured plains of greater or less extent occurring in the arid and semi-arid districts, and particularly in thinly-timbered country.

The same thing happens in such parts as have been heavily trampled by stock on stock routes and camping-places. Such lands require only to be well ploughed and exposed to the influence of rain and sun to render them again productive.

Sourness.

This is one of the most common causes of infertility in soils. It is brought about either by the absolute exclusion of air, as in water-logged soils or soils in which the surface has been impacted; or it may also be the result of an excessive amount of organic matter, as in peaty soils. In both

cases the result is the formation of organic acids (humic acids, &c.), which, in the absence or deficiency of basic substances, such as lime, to neutralise them, act as plant poisons. They not only affect the growth of the plant, but have a solvent action upon the soil constituents, which are liable to be dissolved out and pass into the subsoil. Soils which are red or chocolate in colour from the presence of oxide of iron, if allowed to become sour, are very frequently bleached in colour. They also exercise a reducing action upon the higher oxides, such as ferric oxide, reducing it to the state of ferrous oxide. It is commonly stated that this latter substance is itself a plant poison, but since this compound would not be present in soils in good tilth, but would be converted into the higher (ferric) oxide, it is probable that the ill effects noted when ferrous oxide is present are in reality due to sourness, and that the presence of ferrous oxide is only one of the results of this condition.

The remedies for sourness are thorough cultivation and turning of the soil and exposing it to the air. In cases where it is the result of accumulation of water (in swampy soils) it will be necessary to have recourse to drainage. The addition of lime to neutralise the acids formed is in all cases beneficial; and by a proper system of drainage, together with thorough cultivation and the addition of lime, it should be possible to reclaim the most sour land. A sour condition of land is usually quite readily recognisable by the experienced farmer from its appearance, the peculiar odour when moist, &c.

Protoxide of Iron and Pyrites.

The presence of these compounds in the soil is generally an accompaniment of a sour condition of the soil, and is due to the same cause—want of aeration. It is doubtful whether they are themselves active plant poisons, but their presence is always associated with an infertile condition.

The presence of ferrous oxide is indicated by a bluish or greenish colouration in the clay. This colour changes to red or reddish brown when the soil is aerated.

Pyrites and marcasite (sulphide of iron) are commonly occurring minerals, and their presence unchanged is also a sign of deficient aeration.

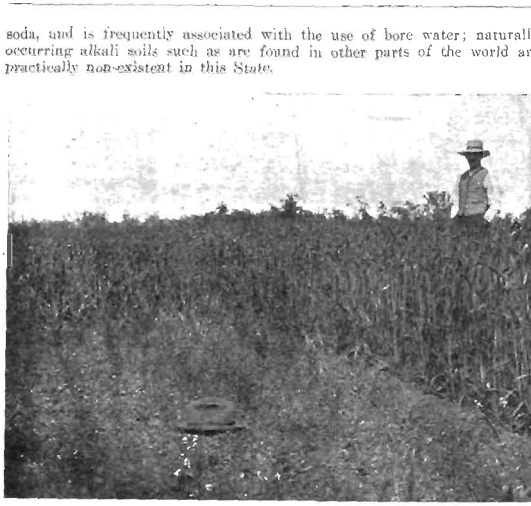
It is also stated that ferrous sulphate, the substance into which the sulphide is at first converted on oxidation, is itself a plant poison if present in excessive quantities, so that such soils require very thorough aeration in order to convert the ferrous sulphate into the fully oxidised ferric compound. It is probable that the injurious effects noticed when the compounds under discussion are present, are due less to the substances themselves than to the conditions under which they are produced.

The treatment of soil in which these substances are present is the same as in the case of sour soils—cultivation, liming, and draining.

Alkalinity.

The reverse condition to that of sourness, and one equally injurious to plant life, is the presence of "alkali" in the soil. The term "alkali" is now, however, broadly used to include "water soluble salts." As far as New South Wales is concerned this alkalinity is due to the presence of carbonate of

soda, and is frequently associated with the use of bore water; naturally occurring alkali soils such as are found in other parts of the world are practically non-existent in this State.



A "bare patch" in a Mature Wheat Crop in the North-west.

The continued use of bore water, especially when used to flood the land, and on dry land which is level and has no adequate natural or artificial system of drainage, results in the accumulation on the surface soil, as the water evaporates, of a white incrustation of carbonate of soda. This substance (alkali) acts injuriously in several ways. It corrodes the stem or crown of the plant or tree with which it comes in contact at the surface; it dissolves out the humus or vegetable matter of the soil, and it combines with the clay, forming a substance which is extremely slimy and sticky when wet, and which dries to a hard mass which it is almost impossible to break up with any agricultural implement. On drying, the surface contracts and opens out in cracks, thus damaging the roots of the crops.

If it is necessary to use this class of water for irrigation, the following precautions must be taken:—

The land must be efficiently drained if there is no natural run-off for the water; the water must be run on in channels and cross-furrows, so that it penetrates the soil laterally; it must be used in moderation, and not allowed to lie on the surface; the surface soil should be continually cultivated with the harrow, and, if possible, kept well mulched with vegetable matter.

Of the substances recommended to neutralise the effect of alkali, gypsum (calcium sulphate), in the form of powder, was first suggested by Professor Hilgard for the alkali lands in the United States, and has been found successful. It is applied directly to the land itself, dressings of 1 ton per acre and upwards being used.

The use of nitric acid has also been suggested; but, unfortunately, the results of the experiments so far carried out locally have not been very definite. The application of an acid naturally suggests itself as the most obvious means of neutralising an alkaline substance, and nitric acid has the additional advantage that it converts the injurious carbonate of soda into a

The "bare patch" terminates abruptly at the boundary of the plot to which superphosphate has been applie

valuable fertiliser—nitrate of soda. The cost of nitric acid is, however, very great, and under ordinary conditions would render the method uneconomic.

Common Salt (Sodium Chloride).

Except in the case of bore water, where its presence no doubt increases the injury done by the akali, but where its power for evil is insignificant in comparison with that of carbonate of soda, common salt is hardly ever met with in our soils, other than those close to the sea or salt-water creeks, and liable to flooding. Crops vary considerably in regard to their power of tolerating the presence of common salt. Some plants, such as beetroot and asparagus, benefit from its presence, and such plants as saltbushes, &c., contain considerable quantities in their tissues. Most farm crops will stand as much from 0.1 to 0.2 per cent. salt in the soil, but if the amount exceeds this quantity, crops are likely to be affected.

Salt is injurious in several ways. It affects the production of nitrates and the process of nitrification, and also affects the texture of the soil. The addition of salt, in the first instance, flocculates the clay particles, and makes the soil temporarily more friable; but it has a very damaging after-effect, due probably to its combining chemically, with exchange of base, with the silicates, particularly silicate of lime, and forming colloidal silicates, thus rendering the clay slimy.

Manganese.

Although salts of manganese, in small quantities, are found to be beneficial (indeed, some chemists go so far as to say necessary) to the growth of crops, they are undoubtedly injurious in larger quantities. Several instances have

come under notice in which small, bare patches occur in fields otherwise fertile; and examinations of these patches and of the surrounding good soil have shown them to be similar in all respects, except that the bare patches contain manganese, whereas the good soil either contains none, or proportionately much smaller quantities.

The action of manganese is peculiar, and extremely interesting. It would appear that certain compounds of manganese are more toxic than others, and that the higher oxides of the metal are more toxic than the lower, so that the process of aeration, usually of benefit in increasing the soil's fertility, has in this case a distinctly prejudicial action. The result is that it may happen that a soil may yield good results for a year or two, and suddenly develop toxic properties, due to the conversion of the more innocuous forms of manganese into higher oxides of greater toxity. Another point of some interest is that, when the quantity of manganese present is small in amount, it frequently happens that crops suffer during the winter months, and provided the quantity of manganese present is not excessive, recover themselves with the advent of the warm weather, and when their growth is more vigorous. Soils containing excessive quantities of manganese are generally dark in colour, and frequently it is possible to distinguish small particles of manganiferous compounds, black in colour, and very soft.

Generally speaking, manganese poisoning may be suspected when the affected patches are darker in colour than the normal soil, when the bad effects do not appear until the land has been under crop for a year or two, and when the crop suffers in the winter and recovers itself during the summer. It not infrequently happens that these bare patches change their position from year to year; that is to say, an area which was bare one season will resume its normal condition in the next, while other patches in the same paddock will become infertile. Such a condition of affairs will lead one to suspect the presence of manganese

With regard to remedies, it has been found that the addition of superphosphate has a decidedly beneficial influence on such soils, probably due to the formation of manganese phosphate—a compound of lower toxic action than the oxide. The data so far obtainable are insufficient to justify this being put forward as an infallible remedy, but it has been found to be successful where it has been tried, and is worth further trial.

Magnesia.

Although lime is one of the most important elements of soil fertility, magnesia, which is a very similar compound, and which is frequently found associated with lime, is by no means desirable in any considerable quantity. Although limestone rocks almost invariably produce the most fertile soils, those formed from dolomite (magnesian limestone), which is carbonate of magnesia, are of poor quality, and even the presence of any quantity of magnesia in the limestone renders the soil a poor one.

The general result of experimental work in the field and in pots tends to show that when the magnesia in a soil exceeds the lime the soil is an unproductive one. Loew, who has particularly studied this matter, contends that a certain ratio must be preserved between the lime and the magnesia in the soil. This ratio appears to vary with different crops; some crops do best when the amounts of these compounds are equal, whilst others require about two or three parts of lime to one of magnesia.

The remedy most likely to be effective in the case of soils whose infertility is due to excess of magnesia is the addition of lime, in order to restore the balance, and such soils come under the heading of those which are deficient in lime, although actually the amount of lime salts present might be sufficient, provided magnesia was absent.

Calcium Chloride.

This substance is stated by some authorities to be harmful to the growth of crops, though no exact experiments are recorded which prove its toxicity in the field. Chlorides of other metals are frequently injurious. The case of sodium chloride (common salt) has already been dealt with. It is quite likely that calcium chloride is an undesirable form in which to apply salts of lime.

In certain bare patches at Coolabah were found considerable concentration of plant-food in the soil moisture, a small proportion of lime and an absence of carbonic acid; and from the fact that the soil from the bad patches was deliquescent, and contained a larger proportion both of lime and chlorine than the good soil, the presence of calcium chloride was suggested.

The addition of lime is the remedy which suggests itself, so that the crop can be supplied with lime in another form than that of calcium chloride.

Alum.

A substance which is frequently accused of causing infertility in soils is alum. Alum is a double sulphate of alumina and potash, and it is not quite obvious why it should have such a bad name. In water cultures of spirogyra it has been recently found by M. Fluri (Bied. Centr. 1909, 38, p. 670) that proportions of aluminium salts as low as .003 per cent. deprive the cells of starch. Of all the soils examined by the Department in which the alum is stated to have been the cause of the trouble, none has contained alum; and the infertility has been due either to sourness (in the majority of cases) or to the presence of common salt or alkali.

Other Toxic Substances.

It is well known that when plants are grown continuously on the same ground without fallowing or rotation, the land becomes unsuited to that particular plant. The cause of this phenomenon was formerly explained as resulting from the continued removal by the plant from the soil of the necessary plant-foods, but in the light of more recent investigation this view requires considerable modification.

In 1845-47 Dr. Gyde (Highland Agricultural Society) concluded that plants (like animals) do throw off organic and inorganic excretions somewhat similar to their sap, but that the quantity is exceedingly small, and is not injurious to plants which furnish them. These poisonous or injurious substances are generally referred to as toxins or toxic substances.

Milton Whitney and others advanced the theory that soil becomes infertile by the accumulation of toxic substances excreted by the roots of crops, and that fertiliser acts not only as a source of plant-food, but also by inhibiting

or nullifying the toxins and putting them out of action, and it has certainly been supported by results of recent investigations. When first advanced the theory was captivating and attractive, as it readily accounted for facts otherwise difficult to explain; the great weakness, however, was the lack of actual proof of the existence of these toxic bodies.

Schreiner was the first to show the toxic effects of *di-hydroxy-stearic acid*, and to isolate this substance from soils on which wheat failed to grow. Fletcher has shown the extraordinary influence of the neighbourhood of sorghum and maize upon the growth of *Sesamum indicum*. This is not due to the removal of moisture or of plant-food by the maize crop, as both these essentials were abundantly supplied to the *Sesamum indicum*, but must, he concludes, be attributed to the excretion of a toxin by the roots of the maize plant. Fletcher believes this to be a salt of di-hydroxy-stearic acid.

Schreiner and Skinner have shown that in water cultures with wheat, di-hydroxy-stearic acid is least harmful when the plant is provided with fertilising substances relatively rich in nitrogen (such as nitrates), and that in the presence of this soil toxin the plant removes less phosphoric acid and potash than under normal conditions, but that its absorption of nitrogen was more nearly normal. These workers also studied the effect of other soil toxins.

Vanilin behaves very much the same way as di-hydroxy-stearic acid in its general effect upon roots and leaves, and its effects are least when the plant is supplied with nitrates.

Quinone is another organic substance harmful to the growth of plants. Its ill-effects are less marked when the plant is supplied with relatively large proportions of sulphate of potash.

Coumarin, a substance of fairly wide distribution in the vegetable kingdom, is found to be toxic to many plants, particularly to the wheat plant, the leaves being short and broad and the roots discoloured and their surface very shiny. The harmful effect of this substance was greatest when phosphoric acid was absent from the nutrient solution and practically disappeared when the fertiliser was rich in phosphates. These results were also obtained with wheat plants grown in soil in culture pots.

It would therefore appear that the injurious effects due to the presence of di-hydroxy-stearic acid and of vanilin can be to a large extent neutralised by application of nitrate of soda; those due to coumarin by phosphoric acid and those due to quinone by sulphate of potash.

These studies have, with the exception of that of coumarin, been carried out in water cultures, and when extended to field practice may or may not be modified by the chemical or physical nature of the soil. In any case they are sufficiently striking to emphasise the fact that the function of fertilisers is not restricted solely to supplying plant-food, and are the nuclei of practical proofs which, when extended, will place this interesting theory of Milton Whitney's on a firmer footing.

Whatever may be the real cause of the trouble, whether it is due to soil exhaustion or to the production of toxins, either by the growing plant or by bacterial action on crop residues, or to a combination of these causes, the remedy indicated will in every case be the same, namely, crop rotation and fallowing.

Excessive Concentration of the Soil-water.

Damage may also be done to the growing plant by otherwise harmless or even beneficial ingredients, when the solution in which they are presented to the plant is too concentrated. During dry spells, for example, the soil moisture will contain a relatively larger amount of soluble saline matter than under normal conditions; and it may quite easily happen that a soil on drying out during a dry spell may lose moisture to such an extent that the remaining water may contain an excessive quantity of soluble salts. If the quantity of matter dissolved in the moisture in the soil is in excess of that present in the cell of the plant-roots, the result is that the water will pass out of the cell into the stronger solution outside, with the result that the contents of the cell will shrink and the plant itself wilt.

The ill effects of want of water during a protracted dry spell are thus accentuated by the danger of an over-concentration of mineral matter in the remaining soil moisture. A rich soil (one well supplied with soluble plant-food) would therefore be expected to show the ill effects of drought *even more than a poor one.*

Absence of Essential Elements.

In addition to the presence of the actively injurious substances enumerated above, soil infertility may be caused by the absence or deficiency of certain essential soil ingredients.

Want of lime, for instance, as we have seen, may induce sourness and a disturbance in the ratio between lime and magnesia. Its absence also affects the growth of many crops for which it is an essential plant-food, particularly leguminous crops—lucerne, clovers, &c.

Deficiency in humus is a common cause of infertility. A soil deficient or wanting in humus is less able to withstand droughty conditions, lacks cohesion, is easily blown or washed away, and is unfavourable to the growth of micro-organisms. The subject is more fully dealt with on page 69.

Absence of bacteria, particularly of the nitrifying organisms, is prejudicial to the satisfactory production of crops. The cause is generally one or other of those discussed above, either want of aeration, lack of lime or vegetable matter, sourness, bad tillage or drainage, &c., and when such soils are restored to good condition the development of the nitrifying organisms will proceed normally.

Want of plant-food is, of course, a common cause of infertility, especially in the case of land which has been exhausted by repeated croppings without manuring or rotation. *Proper manuring*, giving due consideration to the requirements both of the soil and of the crop, is the remedy, provided that the land is in good condition; but the important fact must not be lost sight of that the mere addition of plant-food is not sufficient unless the soil is in such mechanical condition that it can make good use of the manure applied.

Manuring alone is not likely to be of any benefit on land that is badly drained, sour, or in bad tilth.

Presence of Organisms which Destroy the Nitrogen-forming Bacteria.

In connection with one of the causes of sterility noted above, namely, the absence or deficiency of bacteria, the results of an investigation of the greatest interest and importance has been published by Messrs. Russell and Hutchinson from the Rothamsted Laboratory. These investigators found

that probably in all soils the development of these bacteria is kept in check by the presence in soil of certain larger unicellular organisms (protozoa) which feed on the bacteria concerned in the formation of soluble nitrogen compounds.

If the soil is partially sterilised by heating for a short time to the temperature of boiling-water, or by subjecting it to the action of vapours such as chloroform, bisulphide of carbon, toluene, &c., such vapours being subsequently removed by spreading the soil out in a thin layer and allowing the vapour to evaporate, the effect is to destroy the protozoa and probably most of the bacteria as well, but not the spores of the ammonia-producing bacteria. These spores subsequently develop, and, in the absence of the hostile protozoa, their development proceeds with increased activity, the result being a considerable increase in the soluble nitrogenous plant-food and a more vigorous crop growth.

These experiments have so far been carried out in the laboratory. If economic means are discovered of partially sterilising the soil in the field a most valuable method of increasing the fertility of the soil will be placed at the disposal of the farmer.

The Plant's Supply of Nitrogen.

The question of the plant's supply of nitrogen is one of the most interesting of the problems presented to the agriculturist; it is also one of the most obscure and the least understood. A proportion of the dry matter of all plants, which varies with the nature and kind of plant, consists of nitrogenous material, and this portion of its structure is of fundamental importance to the plant. Further, it is upon the nitrogenous matter of plants that animals depend for their proteid material—blood, flesh, &c.—since animals can only utilise for this purpose nitrogenous materials already elaborated in the tissues of plants or other animals.

The ultimate source of all this nitrogenous matter is the free nitrogen in the atmosphere. It is the study of the different methods by which this element is brought (naturally or artifically) into combinations in which it can be utilised by the plant that will form the subject of the present discussion.

The plant may absorb its nitrogen in two ways, either by means of its leaves from the free nitrogen or from the ammonia or the nitric acid in the air, or by means of its roots.

With regard to the first of these, the absorption of nitrogen by means of the leaf, the question cannot be said to be definitely settled at the present time; the concensus of opinion, however, is that if such absorption takes place, it does so to a very limited extent, and is insufficient to constitute part of the economic functions of the plant.

By means of its roots, however, the plant absorbs nitrogen, in the form of either nitrates, nitrites, or ammonium salts dissolved in the water of the soil.

It appears probable that in the main the nitrogenous material taken up by the plant from the soil by means of its roots enters the plant in the form of nitrates. In the case of leguminous plants, as we shall see later on, the free nitrogen contained in the air imprisoned in the soil can be made use of under certain conditions by the roots of these plants.

Formation of Nitrates in the Soil.

It has long been known that the addition to an impoverished soil of a quantity of a more fertile one renders the impoverished one more fertile: and the operation of top-dressing poor soils in this manner was a common one amongst the nations of antiquity.

When the subject was approached in the light of more recent advance in scientific knowledge, it was shown that this increase in fertility was accompanied by an increase in the quantity of nitrates in the soil. How it was that the addition of a relatively small proportion of a soil containing nitrates could bring about the large increase of nitrates observed, was a problem which remained unsolved until the discovery by Pasteur of organisms capable of inducing fermentation and of producing certain chemical substances as by-products, paved the way for a rational explanation of the process. Pasteur himself surmised that this gain in nitrates was due to bacterial activity.

(*a*).—*From Nitrogenous Organic Matter.*

In 1877, it was shown by Schloessing and Muntz that the formation of nitrates (nitrification) only took place within certain temperatures, and that it could be entirely stopped by antiseptics—such as chloroform vapour—showing that nitrification was brought about by the action of organisms.

We know now that quite a number of different organisms take part in the conversion of organic nitrogenous material into nitrates. In the first stage of the process, the nitrogenous matter in vegetable or animal refuse is converted by putrefaction into humus, carbonic acid being evolved and the nitrogen converted into simpler forms such as amides (*asparagin, urea*) and ammonium carbonate; the familiar odour of stables and dung-heaps is due to the ammonia evolved. Quite a number of bacteria and moulds possess this power of converting albuminoid matter into ammonium salts. In ordinary manure heaps moulds produce this decomposition; in arable soils it is brought about by the action of bacteria (particularly by *Bacillus mycoides*, which is widely distributed in surface soils, air, and water). The further nitrification of ammonium salts is the work of yet other bacteria.

Warington first showed that there were two distinct stages in the conversion of ammonium salts into nitrates, and that nitrites were formed as an intermediate oxidation. Consequently, there must be two distinct organisms involved.

In 1890 these were isolated by Winogradsky, who found two distinct organisms capable of converting ammonium salts into nitrites—namely, *Nitrosomonas europea*, occurring in soils of the Old World, and a nitrococcus, which he found in American and Australian soils.

The further conversion of nitrites into nitrates is the work of another organism, of the genus nitro-bacter. Frapps has identified a fourth organism, which it is stated converts nitrogenous organic matter directly into nitrites and nitrates.

The process takes place, more or less vigorously, in all soils not absolutely destitute of organic matter, but there are certain conditions which are more particularly favourable to the process. They are—

1. The presence of organic matter prone to oxidation, represented by humus.
2. The presence of suitable food, such as lime, potash, sulphates, phosphates, and free carbonic acid, for the growth and development of the organisms.

3. Suitable temperature. The optimum temperature is about 35 deg. to 36 deg. C. Nitrification is stopped at temperatures over 50 to 55 deg. C., or at 0 deg. C.
4. The presence of a base to combine with the free nitrous and nitric acid formed: carbonate of lime is the most suitable. The presence of free acid prevents nitrification, as does an excessive amount of alkali (carbonate of soda).
5. Presence of adequate moisture.
6. Absence of too strong light.
7. Presence of sufficiency of oxygen (the process is essentially one of oxidation).
8. Good drainage.

(b).—From the Nitrogen of the Air.

We have seen that nitrates are derived from the decomposition of animal and vegetable nitrogenous matter within the soil. How is this material, in its turn, derived from the free nitrogen of the air, for that must be its ultimate source? Atmospheric nitrogen is converted into organic material in nature in several ways.

Quite a number of free-living organisms have been isolated during recent years which have the power of fixing the free nitrogen of the air, and thereby enriching the soil in nitrogenous material and nitrates.

The *Azotobacter chromococcum* (for example) of Baeyerink is capable of fixing atmospheric nitrogen in a medium in which nitrogenous matter is absent, the fixation being due to the presence of lime, and is much more active in soils rich in lime.

These free-living organisms do best in soils containing organic matter, but poor in nitrogen. Hall thinks that, as in the case of the nitrifying organisms, the fixation depends upon the oxidation of carbohydrates, which supplies the energy.

Henry has found that decaying leaves of forest trees, such as oak or beech, possess the power of fixing free atmospheric nitrogen in considerable quantities. The fallen foliage on the surface of the ground in an oak-forest accumulates 13 kilogrammes of nitrogen per hectare annually (11½ lb. per acre). In the case of beech leaves, 22 kilogrammes is annually accumulated per hectare (19¾ lb. per acre).

(c).—By the Root-nodules of Leguminous Plants.

An extremely interesting instance of the absorption of free nitrogen by a certain class of plants was first observed by Hellriegel and Willfarth.

The roots of leguminous plants when vigorously growing develop small nodules or excrescences, which contain bacteria capable of fixing the free nitrogen in the interstitial atmosphere of the soil, and of handing it over to the plant in a form in which it can be readily assimilated. The process is either symbiotic or parasitic, and is quite distinct from the fixation of nitrogen by the free-growing organisms, and explains the enormous gain in nitrogen found to result by the growing of a crop of, say, clover or peas. The growth of such a crop, even if not turned under, enriches the soil with nitrogen produced by these nitrogen-fixing bacteria.

Pure Cultures of Nodule Organisms.—Many attempts have been made to prepare cultures of these organisms, for use in directly inoculating either the seed or the soil. The best-known of these was a preparation originally prepared by Professor Nobbe, known as "Nitragin," which was in use for many years, and which consisted of gelatine cultures of these organisms. Its use was not attended by universal success, and many attempts have been made to prepare by other methods cultures of these organisms which shall possess greater vitality and be of more universal practical application. The best known of these in recent years have been prepared by Professor Hiltner, in Germany, by Dr. Moore, of the United States Department of Agriculture, and by Professor Bottomley, of London.

Reports of exact experiments conducted with these cultures in England, Canada, and South Africa, show that it is premature to claim for them anything like certainty in ordinary farm practice. Our own experiments with Dr. Moore's cultures, both in pots and in the field, have likewise yielded disappointing results. It is possible that some method of preparing these cultures will yet be devised by which not only will the vitality of the organisms be retained, but their use will be made practical.

Artificial Fixation of Atmospheric Nitrogen.

Nitrogen is one of the most difficult elements to force into combination; it combines directly with only a few elements. It has only recently been possible to devise means whereby atmospheric nitrogen can be made to combine in such a form as to be available for plant-food when applied to the soil. The problem of the artificial fixation of atmospheric nitrogen has, however, now been successfully accomplished, and industrial plants are in successful operation in several countries, *e.g.*, Britain, United States of America, France, Germany, Italy, Norway, Sweden, &c. Future developments in the industrial production of synthetic nitrogen and nitrogen compounds are being watched with extreme interest.

MANURES AND MANURING.

In order to understand properly the action of the different substances used as manures, it is necessary to study in some detail the food requirements of the plant and the manner in which they are satisfied.

The Chemical Composition of the Plant.

Generally speaking, all plants are built up of the same elements combined together in different proportions. These elements are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, silicon, chlorine, potassium, sodium, calcium, magnesium, iron, and manganese. It is to the relative proportion of these elements and the compounds formed, that the great differences in the chemical composition of the various plants are due.

Different combinations of carbon, hydrogen, and oxygen give us the large class of bodies known as carbohydrates, including such dissimilar substances as starch, sugar, the woody structure, cellulose, gum, &c. Hydrogen and oxygen combined give us water; nitrogen, united with the above elements and sulphur, forms the nitrogenous constituents of the plant, such as the gluten in wheat. Little is known regarding the manner of formation of

these substances in the living plant. Still less is known of the metals—their disposition in the plant, and the changes they undergo. We are able to detect their presence in the ash, in combination with oxygen, phosphorus, sulphur, and chlorine.

Not only do the quantities of the different elements vary in different plants, but in the same plant some elements are present in quantities out of all proportion to the others. Over one-half of the bulk of most growing plants consists of water. In watery fruit, such as the melon or cucumber, the percentage of water is as high as 90 to 96. Of the remaining portion of the plant the compounds of the metals rarely exceed 2 per cent., and are more often about 1 per cent. This may readily be proved by burning a weighed quantity of any green crop until a white or nearly white ash, is left. The ash from every pound of such crop will not weigh more than 100 to 200 grains.

The point of importance to keep in mind is that each of these plant constituents is as necessary for the well-being, even for the existence, of the plant as any other, whether that constituent be present in large or small quantities. The substances found in the ash, though present in minute proportions, are as indispensable to the well-being of the plant as the elements found in large quantities. Not only that but if any single one of the ash-constituents is insufficiently supplied—if the potash is deficient or the iron—the plant suffers, although the amount of such element does not in many cases amount to more than a fraction of 1 per cent. of the weight of the ash.

The volatile portion of the plant—that is, the water and the carbo-hydrates—*is for the most part abundantly supplied to it by air and rain* (with the exception of nitrogen in some plants). That is to say, about 98 per cent. of the food of the entire plant is derived from air and water. From the soil it extracts the remaining 2 per cent., consisting for the most part of iron, lime, magnesia, potash, and soda, combined with sulphuric, hydrochloric, and phosphoric acids, together with the nitrogen as already stated. These substances it is the function of the soil to supply, and where the soil, by reason of its nature, or from having been exhausted, is unable to meet the demand, we have to assist it by means of manure.

The object, then, of manuring is to assist the soil in presenting to the plant a portion of the food necessary for its growth; and though the food-stuff thus supplied is extremely minute in comparison with what the plant derives from other sources, it is nevertheless of the greatest importance, and its absence or insufficiency will affect the health of the plant quite as much as will the absence of air or of sunlight or of water.

Ingredients to be Supplemented by Manure.

Of these ash ingredients, the greater portion is found in all soils in quantities more than sufficient for the requirements of any number of crops; thus, iron, magnesium, sodium, manganese, chlorine, sulphuric acid, silica, are present in nearly all soils in greater quantities than the plant requires, so that there is little danger of the soil becoming exhausted as far as they are concerned. The ingredients, therefore, that we have to supplement by means of manure are reduced to three or four, viz., lime, potash, phosphoric acid, and nitrogen, and artificial manures are classified according as they supply these foods.

Lime is probably present in most soils in quantities sufficient for the purposes of plant-food, and it is seldom necessary to supply it with that object. Its principal functions when applied to land are, firstly, a mechanical one, in modifying the physical character of the soil; and, secondly, a chemical one in rendering available certain insoluble plant-foods. (See pages 90 to 94.) Lime acts, however, also directly as a plant-food. The food supplied by the soil is taken up in solution by a peculiar process by means of the roots. It is necessary, therefore, that such food should be in a soluble form to be of any use to the plant, which is unable to utilise insoluble material. By soluble is meant soluble in water or in the weak acids present in the soil or secreted by the plant-roots.

Insoluble and Soluble Plant-food.

This is what is meant by the constituents being "available for plant-food," and when the terms "latent" or "dormant" and "active" are employed, they simply mean insoluble or soluble respectively in the water imbibed by the root. Those manures which are known as quick-acting manures are such as contain their potash, phosphoric acid, and nitrogen in a soluble form at once available for the plant; those which are slow-acting contain these substances in a more or less insoluble condition.

In these latter cases a gradual decomposition takes place in the soil, due to the action of chemical agencies within the soil and assisted by the action of the roots of the plant, by which the insoluble compounds are converted into soluble ones, and so become gradually available, the beneficial action extending over a long period of time.

A good example of these two conditions is found in the state of the phosphoric acid in bone-dust and in superphosphate respectively. Bone-dust consists of bones ground to a powder, and the compound of phosphoric acid and lime which it contains is insoluble in water to any appreciable extent. In course of time the agencies at work in the soil render it soluble. Superphosphate is a compound manufactured by treating bones, rock, or mineral phosphates with sulphuric acid, by which treatment a different compound of phosphoric acid and lime is produced. This, being readily soluble in water, is at once made use of by the plant.

Plant-food Requirements of Crops.

All plants do not take up the constituents presented by the soil in the same proportions, and are consequently benefited differently by different manures. While all crops will benefit from the application of a manure containing all the elements of plant-food, there is in each case a special ingredient, or group of ingredients, which the crop more particularly requires. Some require nitrogen, while others do not thrive unless there is an abundance of phosphoric acid. Some crops occupy the ground for a longer period than others; those that come rapidly to maturity require a larger store of immediately available food. Again the requirements of a crop may vary at different stages of growth.

In the selection of the proper manure for use with any particular crop, it is necessary to consider, not the amount of plant-food required by the crop, but how much of it the soil can supply, and this can only be determined by actual cropping tests. As will be noted in the case of several crops given below, the actual amount of plant-food removed by the crop is of no use as a guide as to what ingredients should be added in the form of manure profitably to increase the yield.

Wheat and Other Cereals.—A 30-bushel wheat crop weighs about 5,000 lb. o the acre, or something over 2 tons of grain and straw, and removes from he soil during the period of its growth 48 lb. nitrogen, 21 lb. phosphoric cid, and 29 lb. potash.

Wheat depends practically entirely upon the soil for its nitrogen, so that for he whole of the above quantities of food it is dependent upon the supplies xisting in the soil. Now, 48 lb. nitrogen is equivalent roughly to about 003 per cent., as indicated by analysis in a soil of average weight, 6 inches leep. This quantity is very much less than the average percentage of nitrogen in our soils, which is quite .1 per cent. In the same way 21 lb. phosphoric acid represents about .001 per cent. phosphoric acid in a soil of verage weight and depth. This quantity is present ten times over, even in oor soils, as is also .002 per cent. potash, the quantity represented by 29 lb. otash, required by the 30-bushel crop. If, then, it were possible to convert he plant-food in the soil into an available form at the times that the plant ould make use of them, the necessity for manuring of any sort would be lone away with and the poorest soil would contain abundance of plant-food or a succession of several crops. But wheat does not appear to be capable of utilising the soil ingredients to their full extent; consequently the appli-ation of soluble manures is particularly beneficial to it and the other ereals.

Contrary to what might be expected from the amounts of plant-foods emoved by the wheat crop, the application of a small quantity of super-hosphate with the seed when sown proves most profitable throughout the heat belt of this State. In this respect the practice is opposed to that hich prevails in the older wheat-growing countries of Europe and in England and America, where the application of nitrate of soda is almost niversal. With us the application of nitrate of soda (or of ammonium alts) is found to be of little or no benefit. The reason of this want of esponse to nitrogen in the wheat crop is, possibly, to be found in the lifferent conditions as to rainfall under which the crop is grown, and the ffect thereby produced in the natural formation of nitrates within the soil.

In Europe the grain sown in autumn remains dormant after germination or four to five months during the late autumn and winter, its period of ctive growth being practically confined to the months of April, May, and June—particularly May and June. It is during the dormant period that the reatest fall of rain takes place. The ground is covered with snow during he winter months, so that during the thaws, when the frost breaks up in February and March, the soil is subjected to a very heavy leaching. This pplies more particularly to Northern Europe and America, where there is ittle thawing during the actual winter, and the whole of the accumulated now melts in a comparatively short time, flooding the land, and leaching ut the nitrates which have been produced during the previous summer and utumn. The leaching process is continued by the spring rains—which are sually fairly heavy—of March and April, so that when the plant enters pon the period of its most active growth in May, the soil's store of nitrates as been removed beyond the reach of the roots, and the addition of readily vailable nitrogenous manures such as nitrate of soda or sulphate of mmonia is essential for a satisfactory harvest.

Rothamsted (England) experiments show that nitrification is most active uring summer and autumn, the formation of nitrates increasing from July o October. When wheat was grown at Rothamsted after fallow the increased yield was found to be almost wholly due to the retention in the soil

of the nitrates thus formed in the summer, and to depend upon whether the fallow was succeeded by a wet or comparatively dry autumn. Should a wet autumn and early winter succeed, the nitrates are washed so far down into the subsoil as to be out of the reach of the crop, which then shows a very small return for the previous summer fallow.

The Rothamsted experiments also showed that little or no nitrification goes on during the three months preceding harvest—that is, during the period of the plant's most active growth. The period of active nitrification begins about midsummer, and continues with increased activity during late summer and after the grain is harvested. The nitrates thus formed are to a greater or less degree washed down into the subsoil during the rains of autumn and the thaws and rains of late winter and early spring. Hence the great importance of the use of nitrogenous manures in these countries. The Rothamsted experiments show, further, that practically the whole of the nitrogen supplied as ammonium salts is nitrified during the season of growth of the wheat, and whatever is not removed by the plant gets washed down as nitrate into the subsoil.

In New South Wales things are very different. During our mild winter the wheat plant, once well started, is making steady and continuous growth the whole time, from April or May, when the seed is sown, till December. The months succeeding harvest are usually comparatively dry and warm, and favourable to nitrification. The seed is thus sown, and the plant germinates in land in which nitrates are abundantly present; and as there is practically no dormant period the plant gets the full benefit of this, at least during the early stages of its growth, until it is well established. The greater portion of the rain falls (at least in the principal wheat-growing districts) during the winter months—June, July, and August—when it is of the greatest benefit. If these months are dry, a reduction in the harvest is almost certain, unless rain falls in September or October.

Nitrogenous manuring is, therefore, of little benefit under our conditions. What the wheat crop appears to need is an application of fertiliser, which will cause a vigorous growth at the outset, and develop the root system. These properties are possessed in a high degree by superphosphate, which supplies readily available phosphoric acid.

Grasses.—A crop of 1½ tons of meadow hay per acre contains on the average 49 lb. nitrogen, 51 lb. potash, and 12½ lb. phosphoric acid, yet superphosphate has proved to be the most profitable manure to apply. Particularly does it increase the legumes in the pasture.

Root Crops.—A crop of 6 tons of potatoes weighs about 18,000 lb. of tubers and haulm, and removes from the soil 67 lb. nitrogen, 80 lb. potash, and 24 lb. phosphoric acid. As in the case of cereals, these quantities are abundantly present in the poorest land, but not in a form in which the plants can assimilate them. However, it is the application of readily available phosphoric acid (superphosphates) to potatoes which results in a profitable increase in yields in most districts, while the addition of nitrogenous fertiliser to the superphosphate is recommended for the cooler and wetter districts.

Leguminous Crops.—Crops such as peas, beans, lupins, lucernes, clovers, vetches, &c., stand midway between the cereals and root-crops in regard to the amount of fertilising materials they contain. A crop of 30 bushels (grain) of beans consists of 800lb. grain and 2,200 lb straw, and contains 99 lb. nitrogen, 67 lb. potash, and 29 lb. phosphoric acid. A Red clover crop of 2 tons contains 102 lb. nitrogen, 83½ lb. potash, and 25 lb. phosphoric acid

Composition and Action of Manures.

The objective in manuring is to add to the soil plant-food constituents that are naturally deficient or that are not available to crops, but it must be clearly understood that these substances will not be of use to the plants unless the other factors that make for fertility are taken into account. In the absence of sufficient water, for example, or in the presence of unfavourable soil conditions, the action of fertilisers is almost negligable. It is a lack of understanding of these conditions that has been the frequent cause of the unsuccessful use of manures. The idea that failure in plant production is due solely, or even chiefly, to deficiency of plant-food in the soil, is no longer tenable.

To consider the composition and the specific action of the several substances used as manures it will be convenient to classify them according as lime, phosphoric acid, nitrogen, or potash is their dominant constituent.

MANURES CONTAINING LIME.

The manures which depend for their action upon the presence of lime are (*a*) quick or burnt lime (calcium oxide), (*b*) limestone (calcium carbonate), and (*c*) gypsum (calcium sulphate).

Burnt Lime or Quick-lime.

When liming is recommended for a soil, it is always either burnt-lime (*powdered or freshly slaked*), *that is intended or else carbonate of lime.* The following remarks apply to burnt-lime or quicklime. Many substances used as manures contain calcium, but in these cases the calcium is in combination with other substances, and has not the same action on the soil as burnt-lime. For example, bone-dust and superphosphate both contain considerable proportions of calcium in combination with phosphoric acid as calcium phosphate. Neither of these substances, however, has any effect in lightening clay soils, or in sweetening sour ones. In the same way gypsum (calcium sulphate or sulphate of lime) is a substance rich in lime, and a valuable addition to the land in certain cases, but its action is not that of burnt-lime, and it is not to be used when liming is recommended. Wood-ashes also contain carbonate of lime and have a value as fertilisers. Thomas' phosphate contains free lime, and there is no doubt that it has an effect in altering the texture of heavy clay-soils, but none of these substances are to be substituted for burnt-lime.

There are few soils which will not derive benefit from the application of lime, even when this substance is present in fair proportion. A. D. Hall, the late Director of the Rothamsted Station, states that English experience shows that soils containing less than 1 per cent. carbonate of lime require liming. This represents about $\frac{1}{2}$ per cent. lime, and there are not a great number of soils in New South Wales which contain as much as this, whereas the bulk of our soils contain considerably less. Liming is beneficial on a great variety of soils, and is to be regarded rather as a means of improving the land than as supplying plant-food. The soils on which it is particularly beneficial are the following:—

1. Soils deficient in lime.
2. Sour soils, on which it acts as a sweetening agent, neutralising the soil-acidity. On land which is newly opened up, or land which is being reclaimed from swamps, the addition of lime is an essential.

3. On stiff clay soils. The action of lime on this class of soils is to lighten them and render them more friable and amenable to tillage operations.

4. On sandy soils, lime acts in an opposite manner, as will be shortly explained, consolidating them and increasing the cohesive and capillary power of the soil.

5. On land which is destined for leguminous crops, or such crops as are specially benefited by the presence of lime, such as sugar-cane, maize, &c. Where a green crop is sown to be ploughed under (green-manuring) the previous application of lime to the soil is of the greatest benefit in promoting the growth of the green crop.

Nature of Lime.—Burnt-lime, stone-lime, or quicklime is obtained by burning limestone (carbonate of lime) in kilns of special construction. In the process of burning or calcining, carbonic acid and water are driven off, and the burnt product is lime (calcium oxide) of greater or less purity according to the purity of the original stone. Other substances, having the same composition as limestone, such as chalk, marble, shells, &c., also yield lime on being burnt. If the lime has been properly burnt it forms a very hard, stony substance, nearly white, which slakes, or combines with water, with great avidity, crumbling to a fine white powder, and evolving sufficient heat to convert a part of the water into steam. In slaking, it combines with the water, slaked lime being a hydrate of calcium oxide, or calcium hydroxide. As its function in the soil is principally mechanical, a test of its goodness lies in the readiness and completeness with which it slakes. Both under-burnt and over-burnt lime slake badly, though from different causes.

Burning Limestone on a Small Scale.—If only small quantities are to be burnt at a time, the use of a kiln may be dispensed with and the lime burnt in the open or in an excavation on the side of a hill. This is best done by placing the wood and limestone in alternate layers. About 1 ton of wood is required to 2 tons limestone.

A method reported as successful is as follows:—Excavate about 10 feet into a bank, thus making the sides of the excavation act as the three sides of a kiln, and then lay about 18 inches of timber on the bottom; then 18 inches limestone on the top of this, filling up the excavation with alternate layers of wood and limestone; then light the timber at the bottom, and the fire will burn through the lot. The lime produced is quite good enough for agricultural purposes.

A method adopted in South Australia is as follows:—

A 12 to 14 feet cube is excavated, with a trench 2 feet wide slanting into the bottom on one side for lighting purposes. Pieces of thick wood are laid at intervals of about 3 feet on the floor, and in between are put dry boughs, &c., for lighting. The fire can then spread all over almost immediately, and the lime will be evenly burnt. The first layer of wood is put crosswise on the bottom piece, and then alternate layers of stone and wood not more than 18 inches thick. Finish with a layer of wood to ensure the top stone being burnt.

In places where limestone occurs and wood or other fuel is abundant, one or other of the above methods, or a similar method, will give satisfactory

results, while avoiding the expense of the construction of a kiln. In modern industrial practice, however, limestone is converted into lime in properly constructed kilns.

Mechanical Action of Lime.—The action of lime in the first place is a mechanical one, in altering the texture of the soil, and with it those properties which depend upon its texture, such as its absorptive power for water, its amenability to tillage operations, &c. The action of lime upon a clay soil may be illustrated by the following experiment:—If a small quantity of a heavy clay be mixed with water in any suitable vessel, it will form a muddy liquid. If a little lime be added to this, and the mixture well shaken, it will be noticed that the solid matters sink to the bottom in a loose powder, and in a short space of time, if the water is poured off and the soil dried, it can be readily broken up by the fingers. If no lime had been previously added, the clay, on drying, would form a hard mass, difficult to break up. This action, which is due to the power that the lime has of coagulating the fine particles of the clay, is identical with what takes place on the larger scale when lime is added to the field.

The presence of lime also prevents the shrinkage which wet clay soils undergo on drying, and which causes the cracks and fissures seen on the parched clay soil. The admixture of lime to a clay, therefore, prevents the formation of a sticky mass when wet, and a cracked, parched appearance when dry.

Limed land is drier and warmer, more friable, and consequently more readily cultivated than unlimed land. Land which has been limed is ready for the plough sooner than unlimed land.

On light, sandy soils, the action of lime is also strikingly beneficial in binding the particles of sand together, and increasing the cohesive and capillary power of the soil. Its action is, in fact, exactly that of lime on sand in the mixing of mortars, only on a much modified scale, since for making mortar the proportions are one part of lime to three or four parts of sand, whereas the addition of a ton of lime per acre represents one part of lime to nearly 20,000 parts of sand. The action of the lime is the same in both cases—on drying it absorbs carbonic acid from the air, forming carbonate of lime, which cements the particles of sand together; forming, in the proportions used in making mortar, a hard compact mass, and, in the case of the soil, increasing its cohesiveness and its power of retaining water.

Lime, therefore, lessens the cohesiveness of clay soils, and increases that of sandy soils—two properties which are apparently opposed to one another. In fact, there are few soils the mechanical texture of which is not improved by liming.

Chemical Action of Lime.—Apart from the above mechanical property of lime in improving the texture of the soil, it has also a chemical action, and though this is not thoroughly understood, it may be classed under the following headings:—

Firstly, it neutralises the acids sometimes present in soils. Sour soils in particular, contain free acids present in such quantities as to be injurious to plant life, and such soils are "sweetened" by the application of lime—that is to say, the free humic and similar acids are neutralised.

Secondly, it attacks the inert organic matters in the soil and promotes fermentation—one of the most active agents in the production of available plant-food. It is, of course, possible to have too much of a good thing, and an excessive dressing of lime would tend to burn up the vegetable matter of the soil, and do as much harm as good; but in the moderate dressings recommended, it will be found beneficial even on land which has recently been green-manured. It must not be forgotten, however, that the action due to caustic lime soon ceases, for it is very rapidly converted into carbonate of lime within the soil, which has no such action on organic matter.

Thirdly, it attacks certain of the insoluble mineral constituents of the soil to some extent. Phosphoric acid enters into combination with lime, and is in this form more readily utilised by the plant than in its insoluble combinations with iron and alumina, with which it may be associated in the soil. Owing to the tendency of lime to burn up a portion of the organic matter, its benefit is more marked on soils rich in organic matter.

Fourthly, carbonate of lime (into which we have seen the lime is soon converted in the soil) is beneficial, if not necessary, to the process of nitrification, the peculiar ferment action by which the inert soil-nitrogen is converted into nitrates.

Fifthly, whilst it promotes certain ferment action, such as the above, it hinders the active growth of many fungi.

Methods of Application.—Lime is usually applied in the form of freshly slaked quick-lime. Up to ½ ton per acre is used, or even more in the case of very stiff clays. In modern practice heavy dressings of lime at long intervals have given place to smaller dressings at more frequent intervals.

Liming with freshly-slaked lime is best carried out as follows:—The quick-lime (stone-lime) is broken up into small lumps and placed in heaps about the field and covered with moist loam. It is left exposed to the air and moisture until it begins to crumble to powder. As soon as this happens the heaps are scattered with a shovel as evenly as possible over the surface of the field, and harrowed or ploughed in very lightly. Liming is most effectively done in the autumn or winter, but whenever it is done the land should be left alone for two or three weeks after the application, and no seed sown nor any manures (especially superphosphate or such as contain nitrogen) used during that period.

Other Lime Compounds.

Carbonate of Calcium is used in several forms—such as chalk, ground limestone or shells, and "mild" or "agricultural" lime, which latter is old burnt lime which has been exposed to the air and become converted into carbonate by absorption of carbonic acid. The term "agricultural lime" is also applied to the screenings from builder's lime, or to lime rejected by the mortar makers. Its addition to the soil promotes nitrification, sweetens sour soils, and prevents clay soils from puddling, though it is less powerful in the latter respect than burnt-lime. It is milder in its action and, as a rule, burnt-lime is to be preferred for lightening stiff soils, though for sweetening sour soils or for supplying lime to soils deficient in that ingredient, it is equally effective. It should be applied in quantities of not less than 1 ton per acre.

The following are a few examples of the calcium carbonate content of the ash of some individual timbers, and of wood-ashes from mixed sources examined in the Department's laboratory:—

Ash.	Calcium Carbonate, per cent.	Ash.	Calcium Carbonate per cent.
Gidgea acacia ...	95	Mixed wood-ashes ...	43·0
She oak ,, ...	75·6	,, ,, ...	26·0
Red-apple ...	60	,, ,, (hardwoods) ...	24·0
Grass-tree ...	44·5	Mixed wood-ashes (principally box)	12·3
Red-gum ...	23·4	Tobacco leaves ...	76·0
Bloodwood ...	15	,, stalks ...	40·0
Blackbutt ...	13	From sawmill ...	28·0
Mixed wood-ashes ...	85·4	Seaweed ash ...	17·0
,, ,, ...	73·8	Vine cuttings ...	20·0

The composition of these mixed ashes will be seen to vary very considerably. This will always be the case, both on account of the nature of the timber from which they are derived and also the length of time to which they have been subjected to the weather and the amount of leaching they have undergone.

Gypsum or land plaster (calcium sulphate) may also be sometimes used to advantage. Its action is principally that of a direct plant-food on soils *poor in lime; hence it is most useful for such crops as clover, and other* leguminous crops on soils poor in lime, and is applied at the rate of 2 to 3 cwt. per acre. Gypsum, when added to dung or urine or decaying animal and vegetable matter, decomposes the carbonate of ammonia which is being continually evolved from such substances, and converts it into sulphate of ammonia, in which form ammonia does not escape into the air.

Gypsum is also of great value in lands which are charged with alkali, or irrigated by alkaline water. For this purpose it is sown on the land in *proportions depending on the amount of alkali in the soil. Dressings up to* 2 tons per acre are given, the application being repeated the following year if necessary.

MANURES CONTAINING PHOSPHORIC ACID.

Phosphoric acid is applied to the soil almost exclusively in the form of calcium phosphate, the sources of which are *mineral* phosphate, rock phosphate, bones and phosphatic guanos, from which superphosphates may be produced.

Superphosphates.

When these phosphatic substances are acted upon by oil of vitriol (sulphuric acid), the calcium phosphate which they contain, and which exists in the form of *tri-calcium* phosphate, is *converted into a different* compound, known as mono-calcium phosphate, or superphosphate. This substance differs from the original phosphate in being readily soluble in water. We have already seen that the availability of a manure as plant-food depends largely upon its ready solubility; consequently a phosphate soluble in water is the most *available form of this substance.* Plants, however, are not dependent for their food-supply only upon such compounds as are soluble in water, but are able, by means of the acid juices secreted in the *roots and root-hairs, to avail* themselves of a class of compounds soluble in vegetable acids. It is, indeed, very improbable that superphosphate remains in the soil for any length of time in a water-soluble condition, for it is

readily decomposed, both by calcium carbonate and by the iron and alumina salts present in the soil. Carbonate of calcium converts it into a third compound, known as *bi-calcium phosphate*. This substance is insoluble in water, but being in a very finely-divided state is readily dissolved by the plant-acids. Iron and alumina may also combine with superphosphate, *forming phosphates of iron and alumina, which are less readily soluble than* the calcium phosphates.

Superphosphate forms the basis of the "general" manures, special manures, mixed fertilisers, &c., on the market, such manures being usually prepared by mixing it with sulphate of ammonia or nitrate of soda and potash salts.

Superphosphate obtained from mineral phosphate contains no nitrogen; *that obtained from bones usually contains 2 or 3 per cent., a portion of the* nitrogen having been lost in the process of manufacture.

The following table will serve to convey an idea of the result of the action of sulphuric acid upon mineral phosphates and upon crushed bone respectively:—

	Superphosphate from Mineral Phosphate.	Superphosphate from Crushed Bone.
Water	16·00	10·00
*Volatile and combustible matter	9·50	33·00
Phosphate of lime (soluble in water) .. .	28·00	31·50
Insoluble phosphate of lime	6·00	2·00
Sand and insoluble matter	5·00	3·00
*Containing nitrogen...	.....	3·00
Equal to ammonia	.....	3·60

The tendency to revert is greater in those superphosphates which contain iron and alumina, and in such manures a portion of the soluble phosphoric acid may revert to bi-calcium phosphate on keeping for a length of time.

Dissolved bones is the name applied to superphosphate prepared from bones as described on page 98.

Dissolved guano is superphosphate obtained from guano.

Mineral Phosphates.

Mineral phosphates are little used in New South Wales, but they form the basis of the bulk of the superphosphates and mixed manures on the market in some countries. The mineral known as apatite is a crystalline form of calcium phosphate and phosphorite a non-crystalline form. These occur as rock-masses or in nodules embedded in rocks of sedimentary origin in many parts of the world, notably Canada, South Carolina, Florida, England, Spain, and Norway. The Canadian phosphate is a crystalline rock; the English *coprolites are for the most part spherical nodules found in the* green-sand and chalk.

Rock Phosphates.

Rock phosphates are found in considerable quantities in the islands in the Pacific (particularly Nauru and Ocean Islands), whence they are imported to the mainland of Australia and used in the manufacture of superphosphates.

There has been considerable conjecture as to how these extensive and wonderfully rich deposits came into existence. What is known as the bird theory is the most popular and generally accepted, and it is in all probability correct, for phosphatised fish bones, shark teeth, &c., are continually being discovered; but the original guano, in the form of bird excreta, must have been deposited many thousands of years ago. There is evidence that the islands have been submerged on several occasions. The result is that all impurities have long since been washed away, and practically only the pure phosphate remains. There is no odour or unpleasantness of any kind, and, to the unpractised eye the Nauru and Ocean Island phosphate is no different in appearance from ordinary friable, light-brown soil. Occasionally it takes the form of rock, some of which is as hard as granite, with a surface which will take a polish equal to any marble.

Ground Phosphate.

Ground phosphate is the name usually given to the above compounds when finely ground. They are not much used in this condition, but if so employed it is essential that they should be as finely ground as possible. They are non-nitrogenous.

Guano.

Guano, in its original signification, is the name applied to the dried dung of fish-eating sea-birds, and is obtained principally from the rocky islands in the Pacific and Atlantic Ocean. Guanos are either nitrogenous or contain little or no nitrogen, the amount of this ingredient decreasing with the age of the deposit. Guano was at one time very extensively used as a manure, but it is being largely superseded by cheaper and more concentrated forms of phosphoric acid and nitrogen. Nevertheless, it should not be overlooked, in view of the quantity of it existing in the islands of the Pacific Ocean off our own coasts.

The term is used locally to include a much more extensive class of substance. The dung of bats, flying-foxes, and marsupials goes under this name. A large number of artificial fertilisers are also sold as "guanos."

The nitrogen exists often in the three forms of organic nitrogen, ammonium salts, and nitrates, the last form being the most soluble form in which nitrogen can be applied to the soil. Guanos likewise contain an appreciable percentage, 2 to 3 per cent., of potash.

Basic Slag.

Basic slag, or Thomas' phosphate, must also be mentioned amongst phosphatic fertilisers. It is a waste product of the manufacture of steel, and contains, in the form of a calcium phosphate, the phosphorus existing in the original impure pig-iron. In England enormous quantities have been consumed, it having proved a very valuable and cheap form of phosphoric acid. Its great weight and the consequent cost of transport has, no doubt, prevented its economical use in this country. Recent changes in the steel-making processes, however, are affecting the supply, and European farmers are likely to be dependent on slags of rather less uniform and somewhat inferior qualities.

Bones and Bone Products.

Bones vary very slightly in composition from whatever source they are drawn, or from whatever part of the animal they are taken, though as a rule the thigh-bones and the bones that have to bear the greatest mechanical strain are the richest in phosphate of calcium. Bones are composed chemically of water, ossein or collagen, fat, and mineral salts. The last-named, which are left behind as ash when the bones are burnt, consist principally of calcium phosphate. Bone-ash contains about 83 per cent. of this substance, together with about 10 per cent. carbonate of calcium, and in much smaller quantities magnesium compounds, and fluoride and chloride of calcium.

The ossein of the bones is the substance which is converted into gelatine by boiling with water, and is an albuminoid containing about 16 per cent. nitrogen. Bones, are, therefore, a nitrogenous, as well as a phosphatic, manure. An average sample, reduced to powder as bone-dust, contains about 20 per cent. phosphoric acid, and a trifle under 4 per cent. nitrogen.

Bones are used in a variety of ways. They may be used whole or broken, or reduced to powder (in the form of bone-dust, or ground bones); or they may be boiled or steamed, fermented, calcined (bone-ash), charred (bone-black), or converted into superphosphate.

Bone-dust.—When simply broken or crushed the chemical composition of bones is unaltered, and the principal advantage derived from their finer mechanical condition is the greater rapidity of their action. Whole bones resist decomposition within the soil for a considerable length of time, and it is very doubtful if their use is in any sense economical.

Bones are, therefore, most efficacious when crushed, and, within certain limits, the finer the powder the better the product as a manure. An additional advantage of fineness of division lies in the ease and evenness with which it can be distributed on the land or mixed with other manures.

Bone-dust is decomposed in the earth, the nitrogen in the ossein being converted by putrefaction into ammonia and subsequently into nitrate, and the phosphate of calcium rendered soluble by the action of carbonic acid and the vegetable acids. It is more particularly adapted to light soils, and is sometimes disappointing on heavy clays, the probable reason for which is that in stiff clay soils it is more or less protected from putrefaction (which we have seen is the cause of its efficacy) by the absence of air and moisture.

Boiled or Steamed Bones.—When bones or bone-dust are boiled, and more effectually when they are subjected to steam, the ossein of the bone is gelatinised, and more or less removed, whilst the fat is also removed, the resulting compound being, therefore, poorer in nitrogen, but richer in phosphoric acid. The treatment renders them more friable, and they are easily reduced to fine powder. The removal of the fatty matter also renders them more easily decomposed in the soil, as fresh bones are more or less protected from external action by the presence of the fat. Not only is the proportion of phosphoric acid increased, but the rapidity of action of the product, and its consequent effectiveness as a manure, is increased, at the expense, of course, of the nitrogen, which may be reduced 1 or 2 per cent., as is shown in the table on page 98.

Bone-ash.—The residue left after the calcination of bones consists, mainly, of calcium phosphate, and contains no nitrogen. It is not largely used as a manure. It is dissolved in the soil by carbonic acid, and conveyed thus directly to the plant.

Bone-black is the product of charring bones. The broken bones are subjected to strong heat in closed iron cylinders, whereby they are converted into bone-charcoal, on exactly the same principle that wood is converted into wood-charcoal. The volatile matter of the bones is driven off in the form of gas, water, oil, and tar, and the carbon present is for the most part left mixed as charcoal with the mineral matter of the bones. This product is largely used by sugar refiners for removing the colouring matter from sugar solutions. After it has been used for this purpose a certain number of times it becomes unserviceable, and can be obtained at a cheap rate for manurial purposes. It may be applied directly to the soil as a phosphatic manure or converted into superphosphates by treatment with acid.

Fermented Bones.—Bones may be decomposed and rendered more active by mixing them with about one-fourth of their weight of loam, and keeping the heap moist with stable-liquor or urine. The heap should be protected from rain. By this process also there is a loss of nitrogen, but the phosphate is rendered more readily available and proportionately increased. This is a method that deserves to be made use of where bones are plentiful, and there is no means of reducing them to powder.

Bones may also be softened by mixing in heaps with quicklime and loam. A layer 6 inches deep of bones, then a layer 3 inches deep of lime, and then a layer about 4 inches deep of loam, and so on, repeating until the heap is made of convenient height, when it is covered up with a thick layer of earth. Holes are then bored into the heap from the top, and water poured in to slake the lime. The mass will become hot, and remain so for two or three months, after which the bones will be found very friable. The whole heap may then be mixed together, and is ready for applying to the ground.

Composition of Bone Products.—The following table shows the alteration in composition which bones undergo when subjected to the above methods of treatment. The analyses are not analyses of the same sample, but represent fairly the average composition of the several products. The analyses of bone-black were kindly supplied by the Colonial Sugar Company, and represent their "char" before and after it had been used for the purpose of refining:—

	Bone-dust.	Boiled bones.	Steamed bone-dust.	Fermented bones.	Bone-ash.	Fresh bone charcoal.	Spent charcoal.
Water	10·43	10·61	11·57	12·02	1·86	.....	2·0
*Organic matter, including 10% carbon in the case of charcoal ...	32·30	21·55	19·01	28·71	.....	13·5	18·0
Calcium phosphate ...	48·40	60·19	60·02	49·28	86·34	76·0	74·0
Calcium carbonate, alkalies, &c.	7·20	5·81	8·54	8·92	11·20	7·0	5·5
Insoluble	1·67	1·84	0·86	1·07	0·51	1·0	1·5
	100·	100·	100·	100·	100·	.....	.....
*Containing nitrogen ..	3·71	1·76	1·60	3·47	.....	0·7	0·7

Manufacture of Superphosphate from Bones.—The following directions for making this invaluable fertiliser on a small scale may prove useful on farms where bones accumulate, and the question arises how to deal with them most economically.

It will be found most satisfactory in the first instance to burn the bones, and convert them into what is known as bone-ash, since fresh bones or bone-dust produce, on treatment with acid, a slimy mass, which is exceedingly difficult to dry.

To prepare the superphosphate from bone-ash, it is necessary to provide a receptacle for mixing the ingredients which is not attacked by sulphuric acid. A wooden trough lined with lead (a sheet of lead hammered to fit the trough) is about the best; but a wooden trough, pitched inside, will answer the purpose, or a hole in the ground lined with cement. In this receptacle the ingredients are mixed in the following proportions:—For every 40 lb. of bone-ash add 1 gallon of water and 15 lb. strong sulphuric acid (commercial oil of vitriol). Pour the whole of the water into the empty tank, then add *gradually*, stirring constantly with a wooden pole, the sulphuric acid. The acid combines very violently with the water, and unless it be added as directed above, an explosion may result. Now add gradually, a little at a time, the bone-ash, stirring constantly with a stout pole or hoe.

The above proportions should yield a mass possessing the consistency of a stiff dough. If it is not stiff enough, some more bone-ash may be added. Leave it to itself for a few hours, when it will dry to a friable mass, easily broken, and in a fine state of division. Protect from rain whilst drying. The manure is now ready for use. The acid does not actually *dissolve* the bone-ash, but converts the tri-calcium phosphate into mono-calcium phosphate (water soluble). Although burning the bones destroys the organic matter, this loss is more than compensated for by the ease with which the product can be dried and handled. If fresh bones or bone-dust be used, the fat which they contain prevents the complete action of the acid, and the resulting product is so slimy as to be unmanageable in many cases, and much difficulty will be experienced in getting it to run through the drill.

If it is preferred to use fresh bones or dust, the following proportions are said to be the best:—

Dilute every ½ gallon of acid with 1 gallon of water as directed above—that is, add the acid to the water, stirring all the time Never, on any account, add water to the strong acid. Pour this diluted acid upon 20 lb. of the bone-dust in the trough, taking care to pour slowly, stirring all the while. The sticky mass must now be mixed with loam, wood-ashes, peat, or gypsum, in order to dry it.

Instead of burning the bones, the fat may be removed by steaming them, but this is rather a troublesome process, though a smaller proportion of nitrogen is lost by this means. Simple boiling with water is better than nothing, but in no case is the product so satisfactory as that prepared from burnt bones.

In order to avoid disappointment, it must be remembered that superphosphate is not entirely soluble in water. It is known as soluble phosphate, but the solubility only refers to the calcium phosphate. A large proportion consists of calcium sulphate (gypsum) produced by the action of the sulphuric acid on the bone-dust, and this is insoluble in water.

Instead of using acid, bones may be rendered soluble by allowing them to ferment (see page 98). The following is also a good plan:—

Dig a trench, and fill it with alternate layers of wood-ashes and bones, beginning and ending with wood-ashes. Moisten each layer of ashes when laid, and keep the whole moist by watering from time to time. In a few months the heap may be turned over.

Bones can also be dissolved by placing them in a pit, and drenching with a hot solution of lye—1 lb. of potash lye to every 4 lb. of bones. Cover with earth, and stir occasionally for two or three weeks, when the mixture may be turned out to dry.

It will be seen that treatment with acid is the most rapid, and the product is more satisfactory, but a little caution is required in mixing the ingredients.

MANURES CONTAINING NITROGEN.

Nitrogenous manures fall under three heads, according as the nitrogen they contain is (1) combined with organic matter, (2) exists in the form of ammonium compounds, or (3) exists as nitrates. In the last two forms it is soluble in water, and immediately available as plant-food. Most of the quick-acting concentrated fertilisers contain one or other of these compounds, usually sulphate of ammonia or nitrate of soda. What is known as organic nitrogen is contained in animal products, refuse, and excreta, such as blood, bones, hair, meat, guano, farmyard manure, &c.

The nitrogen in these animal products is not in a state in which it can be immediately utilised by the plant, but requires first to undergo fermentation within the soil, resulting in the first instance in the formation of ammonium compounds before it is available as plant-food. Although the nitrogen in these different substances is usually classified for the sake of convenience under the one heading of "organic" nitrogen, it occurs therein in a variety of combinations, some of which are more susceptible to fermentation than others, and consequently more rapid in their action. The smell of ammonia is soon noticeable from such products as urine and farmyard manure, which contain a large proportion of their nitrogen in the form of urea, whereas hair, wool, &c., resist decomposition for a considerable length of time.

The following list shows the order of solubility of the most commonly occurring of these products, the most soluble standing at the head:—

Fresh urine.	Fine bone-dust.	Coarse bone-dust.
Dried blood.	Oil-cake.	Horn-meal.
Dried and pounded flesh.	Fish scrap.	Dung.
Guano.	Dried offal.	Hair and wool.

This list is of course only intended to show the relative solubility of the nitrogen in the different substances named. It is not meant to apply rigidly in all cases, nor is it possible to draw any such rigid comparison, for the solubility will vary according to the fineness of division of the material, to some extent also with the nature of the soil, and with the substances with which the manures in question are mixed. The list will serve its purpose if it makes clear the fact that some of these nitrogenous products are more soluble than others, just as we have seen that some forms of phosphoric acid are more soluble than others, and that the percentage of nitrogen alone is not always a sufficient indication of the value of such manure, unless the source of the nitrogen is also known.

Those products containing their nitrogen in the most inert form, such as hides, horn, hair, &c., are not generally utilised by the manure-makers, but may be usefully added to the compost heap.

The most important and most commonly used nitrogenous manures are:—

Dried blood and dried flesh.—These substances are produced in considerable quantity in slaughter-houses and boiling-down works, and are dried by means of steam. They are similar in chemical composition, and contain on the average 10 to 13 per cent. nitrogen. They are less soluble than such manures as sulphate of ammonia and nitrate of soda, and are more applicable as an autumn manuring than as a top-dressing.

Sulphate of ammonia is a manure of very great value, and being a waste product of the purification of coal-gas, it can be produced more cheaply than other soluble forms of nitrogen. It is obtained by treating the ammoniacal liquor with lime, which drives off the ammonia. The ammonia is absorbed by sulphuric acid and forms sulphate of ammonia. Sulphate of ammonia is also recovered from the waste gases in the manufacture of pig-iron, and also by absorption in sulphuric acid. Sulphate of ammonia is a white crystalline powder when pure. It is the most concentrated form of nitrogen we possess, containing about 20 per cent. of this element in combination. It is readily soluble and immediately available, and specially valuable as a top-dressing to certain crops.

For gardening purposes it may be dissolved in water (about ½ oz. to 1 oz. to the gallon), and will be found effective for most pot plants and flowers. It is more particularly adapted for clay soils. It is stated to be ineffective on strong calcareous soils—that is, soils which contain over 8 or 9 per cent. of carbonate of lime; but as the cultivated soils of the State average something under 1 per cent., there is not much to be feared on this score. Sulphate of ammonia, or manures containing sulphate of ammonia, should not be mixed with lime, nor applied to land which has been recently limed.

A still more effective form of available nitrogen exists in nitrate of soda, the principal source of which is the nitre-beds of Chili and Peru. Enormous quantities are exported to England and the European continent, and it is largely used both in the imported and locally-made fertilisers.

It contains about 15½ per cent. nitrogen, as against 20 per cent. in the case of sulphate of ammonia, and the unit value for the nitrogen is higher than in the case of sulphate of ammonia. Its local use is consequently limited.

Soot contains from 1 to 2 per cent. of nitrogen, principally in the form of ammonium compounds. It is fairly quick in its action.

Calcium cyanamide or *Nitrolim* is a product obtained by passing nitrogen over calcium carbide at a high temperature. It is lower in nitrogen than sulphate of ammonia, and does not appear to possess any higher manurial value.

Calcium nitrate is the manurial product obtained by the electric process for the manufacture of nitric acid from the atmosphere. It contains about 13 per cent. of nitrogen, and appears to have the same manurial value as nitrate of soda that contains the same amount of nitrogen.

Humus and Green Manuring.

Amongst the most effective means of adding nitrogen to the soil is the application of vegetable matter in the form of farmyard or compost manures, and the ploughing under of a green crop or green manuring.

When ploughed under, provided that sufficient moisture and warmth are present, the buried mass decomposes with more or less rapidity, and the succeeding crop gets the benefit of the fertilising ingredients contained in the decaying mass of vegetation in a readily-available form. The resulting humus is of the greatest value, not only as a source of plant-food, but in improving the soil's texture, in preventing too rapid evaporation, and in enabling the soil to absorb and retain water, thus rendering it less liable to suffer during dry spells.

During the growth of the plant, too, the soil is, in addition, stirred up and disintegrated by the development of the roots. A further important result is the formation of carbonic acid by the decomposition of the buried crop. Carbonic acid is given off abundantly in the fermentation of the mass and assists in the disintegration of the soil and in rendering available the plant-food contained in it.

When conditions as to warmth and moisture are favourable, and the crop decomposes fairly rapidly, the production of soluble plant-food proceeds with considerable rapidity. This is especially the case in respect of nitrogen, which is the principal manurial ingredient. Nitrification (that is, the conversion of the nitrogenous material of the plant into soluble nitrates) takes place quite rapidly. In sandy soils, green manure nitrifies more rapidly than manures like dried blood, bone-dust, &c., and only less slowly than ammonium sulphate; while in stiff clay soils the green crop nitrifies very much more rapidly than either sulphate of ammonia or animal manures.

With regard to the kind of crop to be used for the purpose of green-manuring, a good deal of latitude is permissible. Any crop that is rapid and luxuriant in growth, and that can be readily turned under, is suitable for the purpose, and the selection will be guided by considerations such as the time of year at which it is to be grown, its suitability to soil and district, &c.

We have seen in the case of many leguminous crops (page 84) that they are not only independent of the soil for their supply of nitrogen, but that their growth actually enriches the soil in this ingredient. The land on which such a crop has been grown contains a larger proportion of nitrogen than before. This property is turned into account in rotating crops, and also suggests a means of supplying nitrogen to the soil without the addition of nitrogenous manures. If a leguminous crop is grown, and is ploughed into the land just before it reaches maturity, a manure is thereby added to the land containing 100 lb. or more of nitrogen to the acre—that is to say, the land receives a manuring of nitrogen equivalent to that produced by the addition of over 4 cwt. sulphate of ammonia or of 8 cwt. of dried blood per acre.

There are, however, many other crops which are suitable for the purpose, and frequently used, such as oats, rye, &c. These are all rapid growers, and can be grown as catch-crops—that is to say, after the main crop has been harvested and before the succeeding one is sown.

AMOUNT of fertilising ingredients added to the soil by ploughing under certain green crops.

	Average yield per acre.	Percentage composition of whole plant.				Amount of fertilising ingredients added to the soil in pounds per acre.		
	Tons.	Water.	Nitrogen.	Phosphoric Acid.	Potash.	Nitrogen.	Phosphoric Acid.	Potash.
Cowpeas ...	7½	84·4	0·63	0·13	0·46	106	22	77⅓
Oats	8	77·0	0·72	0·19	0·56	129	34	100½
Rye	8	81·9	0·32	0·17	0·60	57½	30½	107½
Red clover ..	2	76·8	0·54	0·12	0·67	24	5½	30
White clover..	2	80·0	0·43	0·12	0·40	19¼	5½	18
Lucerne ...	3	77·5	0·58	0·12	0·50	39	8	33½
Vetches ..	4–6	85·0	0·36	0·10	0·45	40	11⅓	50½
Rape	2–4	85·7	0·35	0·12	0·62	23⅓	8	41½

MANURES CONTAINING POTASH.

With the exception of wood-ashes, we had in the past no other sources of supply than the German potash deposits for this invaluable plant-food; but during the war these were inaccessible. With the opening up of the Alsatian deposits the supply of fertiliser containing potash is now almost normal again, though the price is considerably higher than in pre-war times.

Sulphate of potash is a very concentrated form of potash, of which it contains over 50 per cent. It has been replaced since the war by the chloride or muriate.

Potassium chloride or muriate is the potash salt obtained from the Alsatian mines. It contains a higher proportion of potash than the sulphate, though there are several grades procurable, and may be used to replace the sulphate in certain cases.

Since 1914 extensive field trials have been made at Rothamstead, and the director (*Dr. Russell*) *states that there is little to choose between* sulphate and muriate.

Wood Ashes.

The value of wood-ashes as a fertilising material is not as widely known as it deserves to be. In newly-cleared country this valuable substance is produced in large quantities, and it will be found to more than repay the trouble of returning to the land. It is a matter of common observation that after a bush fire the vegetation is particularly strong and luxuriant, and the effect is due largely to the lime, potash, and phosphoric acid thus returned to the soil. The household wood-fires also furnish a small but continued supply of ashes which should be all kept and made use of. They may be utilised, either by themselves or mixed with other manures, or added to the compost heap—a valuable adjunct to the economy of the farm. (See page 105.)

The ash of the different woods contains the mineral portion of the wood from which it has been obtained, though in burning a considerable proportion of the potash is lost by volatilisation. Of these ingredients the substances possessing fertilising value are lime, potash, and phosphoric acid. Their potash and phosphoric acid are, moreover, in an exceedingly soluble condition, and are in such a state as to be readily assimilated by most plants. The value of the ash of the different varieties of European trees has been long well known and their constitution established by numerous exact analyses. The composition of the ash of our own trees has not as yet been studied systematically, but from the following analyses made in the Department it will be seen that they are likely to be quite as valuable:—

	Phosphoric Acid	Potash.
Spotted-gum	·10	·69
Red-gum	·38	3·17
Bloodwood	·27	5·25
Box	·67	1·65
Blackbutt	·94	2·02
Ironbark	·82	1·53
Red-apple	47	6·00
Grape-vine	1·85	3·76
She-oak	8·85	2·19
Grass-tree	3·07	5·30

The following figures indicate the content of potash (K_2O) of samples of wood-ashes from mixed timbers (varieties unknown) made at different times in the laboratory for individuals:—3.46, 1.57, 0.06, 5.04, 4.65, 0.27, 0.83, and 0.30 per cent.

The following analyses made of wood-ashes from various timbers specially burnt for the purpose by the Forestry Department will serve further to show the variations to be expected in the potash-content of the same timbers, and even of individual specimens of the same timber:—

Tree.	Unburnt Carbon.	Potash (K_2O).	Tree.	Unburnt Carbon.	Potash (K_2O).
	per cent.	per cent.		per cent.	per cent.
Myall	17·10	1·36	Mountain Ash	20·02	9·23
Yellow Box	16·74	0·28	Blue Gum	28·14	5·17
Mountain Gum	30·60	6·88	Grey Box	24·80	2·95
Mountain Ash	30·57	5·57	Grey Ironbark	22·89	0·13
Woollybutt	17·60	6·36	Red Ironbark	21·32	1·02
Yellow Stringybark	9·70	5.59	Forest Red Gum	47·03	1·58
Brush Box	24·14	1·78	Grey Gum	24·66	0·26
Spotted Gum	20·02	4·70	Blackbutt	40·31	2·04
Forest Oak	27·45	5·09	Turpentine	22·17	1 88
			Mixed North Coast Hardwoods.	11·63	1·34

None of the figures here quoted can be accepted as representative of th timbers specified, as the burning was not conducted uniformly; the varis tions in the unburnt carbon are considerable, the temperatures at which th wood was burnt vary, also the exposure of flame.

Exceptionally high figures for potash were obtained in a sample of the ash of *Pinus insignis* (from the Forestry Department), which gave 18.67 per cent. potash, and from the ash of bracken fern, which contained 16.71 per cent.

The process of burning converts the potash salts into carbonate of potash for the most part. The calcium is present in the form of oxide and carbonate, and the phosphoric acid partly as calcium phosphate, and partly as alkaline phosphates. Now, carbonate of potash and alkaline phosphates are particularly soluble forms of potash and phosphoric acid respectively; the beneficial action of calcium, both in the form of oxide (quicklime) and of carbonate (chalk), is well known. It will, therefore, readily be seen what a valuable manurial substance wood-ashes are. In addition to their direct action as plant-food, wood-ashes act beneficially in improving the quality of stiff clay-lands, and equally so in binding light sandy soils: in fact, they benefit the soil *mechanically exactly in the same way that lime does*, though to a lesser extent. With the exception of nitrogen, which, of course, has been burnt off, they contain all the ingredients of a complete manure, and in a particularly serviceable form.

It might, therefore, be expected that the addition of a nitrogenous substance would make a complete manure of them; but such addition must be *made with caution, as the presence of free lime and alkalies in the wood*-ashes is liable to decompose the nitrogen in such a mixture, driving it off in the form of ammonia, the smell of which will be apparent when sulphate of ammonia and wood-ashes are mixed together.

The ash of young wood is especially rich in potash, and, generally speaking, the ash of young and small wood, as young boughs, twigs, &c., is more valuable than that obtained from the trunk or heart of an old tree.

One of the best ways to utilise wood-ashes is in the compost heap, though they may be used alone as a top-dressing.

The best material with which to compost wood ashes is undoubtedly peat, but other decayed or decaying vegetable matter, such as straw, dead leaves, &c., is nearly as good. Such substances are fermented in contact with wood-ashes, and their nitrogen rendered available. On farms where the compost heap is an institution, it should not be forgotten that the addition of wood-ashes improves the value of the compost.

The following method of composting ashes will be found useful:—Make a heap of alternate layers of peat, peaty loam, or vegetable refuse, and wood-ashes, or make a hole and fill it with these substances in alternate layers; moisten the heap with urine or slop water, and allow to ferment for a few months, when it may be turned over. The addition of stable manure, dung, and in fact all refuse matter of the farm, will benefit such a heap, which may be thus made the means of utilising a great deal of valuable fertilising material which would otherwise be thrown away.

The above remarks apply to unleached ashes, such as are obtained from the burning of timber.

Leached ashes contain practically little but lime and calcium carbonate, as the potash and phosphoric acid are for the most part leached out. Their use and action are similar to those described under the heading of calcium carbonate. They may be sometimes economically used instead of this substance, but in no case will the farmer derive any benefit from leaching his own ashes. As the above analyses will show, it is chiefly for the sake of their

potash that wood-ashes are used, and they may be regarded as potash manures. They are not nearly so concentrated a form of this substance as potash salts, and if substituted for them it is well to remember that 1 cwt. sulphate or muriate of potash contains about the same quantity of potash as *12 or 13 cwt. wood-ashes.*

The fertilising value of wood-ashes is, for the reason referred to in the *preceding paragraphs, very variable, even ashes from the same timber* giving different figures according to the way they are burnt and the amount of weathering or leaching they have undergone. The potash content is especially liable to variation, as potash salts are volatile to some extent; *when the wood is burnt in contact with a hot bright flame, a considerable quantity* is lost by volatilisation, whereas when the timber smoulders away, little, if any, is so lost.

Sea-weed as a Manure.

Sea weed is not at a first glance a very promising fertilising material. It has, when fresh, a fertilising value somewhat lower than that of farmyard manure, and its large content of water prevents its carriage in a fresh state to any distance with economy. Even at the distance of a few miles from the coast the cost and labour of transport places it out of court as a fertiliser.

The ash of sea-weed contains a considerable quantity of fertilising *materials, potash, and phosphoric acid, and in some cases it may be found* economical to utilise sea-weed in this form. The nitrogenous matter is, of course, thereby lost. The ash is richer in fertilising substances than wood-ashes—the potash varies in the different varieties from 4 to as high as 20 per cent.

Comparative Value of Farmyard and Artificial Manures.

The following comparison of the relative manurial value of farmyard manure and a typical complete artificial fertiliser on the market may be found useful.

One ton of farmyard manure contains, roughly, the following quantities of fertilising ingredients:—

Nitrogen	8 lb.
Potash	6 lb.
Phosphoric acid	6 lb.

In 3 cwt. of the artificial fertiliser there are of—

Nitrogen	9 lb.
Potash	6 lb.
Phosphoric acid	42 lb.

That is to say, 3 cwt. of the fertiliser contains about the same quantities of nitrogen and of potash, and seven times the quantity of phosphoric acid, as *1 ton of farmyard manure.*

The manurial ingredients in the artificial products are in a very soluble form, and their effect is more rapid. On the other hand, they contain no organic matter like the litter in farmyard manure.

Mixing Manures.

In the case of complete fertilisers, the purchaser is charged for the cost of mixing, and the question often arises whether it would not be cheaper to buy the simple manures and mix them on the farm. On the other hand, the mixing (especially in the case of large quantities) can be much more thoroughly done by the manufacturer.

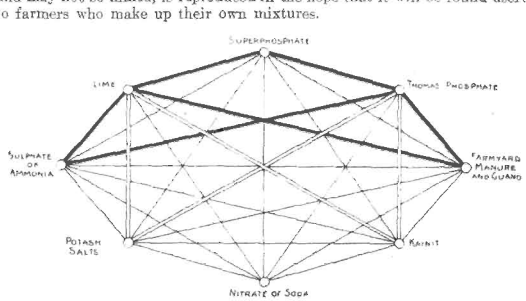
The simple manures are bone-dust and superphosphates, containing nitrogen and phosphoric acid (superphosphates from mineral phosphates contain no nitrogen); dried blood, sulphate of ammonia, and nitrate of soda, containing principally nitrogen; sulphate and muriate of potash, and wood-ashes, containing potash; and lime, gypsum, &c., containing lime. As these fertilisers are seldom used in greater quantities than can be mixed by hand, the trouble involved is very small.

A further advantage is that the proportions may be varied to suit the particular requirements of different cases, while with a purchased complete fertiliser it may be necessary to pay for a quantity of some ingredient which is not required.

Only certain fertilisers may be combined in mechanical mixtures; the admixture of others results in chemical reactions which may result in either a complete loss of the fertilising ingredients or their change into forms in which they are not readily available to plants. Lime should not be added to ammonium sulphate, or dried blood, or bone-dust, as it drives off ammonia. It is safer not to add lime to any nitrogenous manure; hence, when the land has been limed, it is better not to manure it for two or three weeks.

Lime is added to superphosphate in the preparation of basic superphosphate, but in this case the mixture is a chemical one, and in the new product the phosphoric acid is not so readily available as a plant-food.

The accompanying fertiliser diagram, which shows the manures that may and may not be mixed, is reproduced in the hope that it will be found useful to farmers who make up their own mixtures.



Substances connected by thick line must not be mixed together.

Substances connected by double line must only be mixed immediately before use.

Substances connected by single thin line may be mixed together at any time.

List of Manures in New South Wales.

The accompanying list of manures obtainable in New South Wales, *together with their composition, as guaranteed by the vendors*, is published in the interests of the farmers, and it is hoped that it may serve as a guide to those requiring any particular class of manure. It is complete to 1928.

It must be clearly understood that the figures given are not those obtained by analysis of the sample by the Department. They represent the *guarantees* given by the vendors in accordance with the provisions of the Fertilisers Act. Where possible, samples have been taken from bulk by one of the officers of the Department, and purchasers may be confident that the manures included in the list are up to the guarantee.

The unit values of fertilising ingredients in different manures for 1928 are as follows:—

	Per unit. s.	d.
Nitrogen in nitrate	22	6
,, in ammonium salts	17	8
,, in blood, bones, offal, &c.—fine	18	11
Phosphoric acid in bones, offal, &c.—fine	5	3
,, ,, (water soluble) in superphosphate-	5	8
Potash in sulphate of potash...	6	8

Price per lb. of fertilising ingredients in different manures for 1928.

	Pence per lb.
Nitrogen in nitrate	11·8
,, in ammonium salts	9·2
,, in blood, bones, offal, &c.—fine	10·1
Phosphoric acid in bones, offal, &c.—fine	2·8
,, ,, (water soluble) in superphosphates	3·0
Potash in sulphate of potash	3·6

To determine the value of any manure the percentage of each ingredient is multiplied by the unit-value assigned above to that ingredient, the result being the value per ton of that substance in the manure. For example, a bonedust contains 4 per cent. nitrogen and 20 per cent. phosphoric acid:—

4 × 18s. 11d.	= £3 15s. 8d.	=	value of the nitrogen per ton.
20 × 5s. 3d.	= £5 5s. 0d.	=	,, phosphoric acid per ton.
	£9 0s. 8d.	=	value of manure per ton.

It must be clearly understood that the value thus assigned, depending solely upon *the chemical composition of the manure, does not represent in all cases* the actual money value of the manure, which depends upon a variety of causes other than the composition, and is affected by local conditions; neither does it represent the costs incurred by the manufacturer in the preparation, such as cost of mixing, bagging, labelling, &c. It is simply intended as a standard by which different products may be compared. At the same time, it has been attempted to make the standard indicate as nearly as possible the fair retail value of the manurial ingredients, and it will be found in the majority of cases the price asked and the value assigned are fairly close.

These figures have been checked by analyses of samples collected by an officer of the Department. It by no means follows, however, that the particular product guaranteed and here published will be in stock for any length of time or that the prices may not vary.

The Fertiliser Adulteration Act is in force, and the purchaser has only himself to blame if he pays for an inferior article. Every vendor is obliged to furnish a guarantee with every delivery of fertiliser, setting forth its actual composition as determined by analysis.

If the purchaser has any reason to suspect the genuineness of the guarantee, all he has to do is to notify the vendor of his intention to take samples for analysis, in sufficient time to enable the vendor or some person appointed by him to be present. The samples must be taken before the consignment is finally in the purchaser's possession; for example, if the fertiliser is sent by rail, the sample should be taken at the railway station or siding. Three samples must be taken, one being given to the vendor or his representative, the second kept by the purchaser and submitted to an analyst, and the third forwarded to the Department of Agriculture for future reference, in case of divergence in the analyses of the other two. All three samples must be sealed up.

In the case of bonedust, blood and bone manures, &c., the valuation has been made on the assumption that the product is in a fine state of division, and is based on the amounts of fertilising ingredients only; but it must be borne in mind that finely-ground bonedust acts more rapidly than coarse, and that unground fragments of bone only become available as plant-food very slowly.

A number of waste products which may in many cases be economically utilised have been analysed in the laboratory at various times. The results of those analyses appear in Table III on pages 111 to 113.

TABLE I.—SIMPLE FERTILISERS.

Manure.	Where obtainable.	Guaranteed Composition.				
		Nitrogen.	Equal to Ammonia.	Lime.	Potash.	Phosphoric Acid.
		per cent.	per cent.	per cent.	per cent.	per cent.
Sulphate of ammonia	Australian Fertilisers Proprietary, Ltd.	20·4	24·8	..	..	..
Nitrate of soda	,, ,, ..	15·5	18·8	..	..	..
Superphosphate	,, ,, ..	..	..	..	..	22*
Sulphate of potash	,, ,, ..	..	..	..	52	..
,, ammonia	Australian Gaslight Co., Haymarket ..	20·4	24·8	..	..	..
,, ,,	Farmers' Fertilisers Corporation, ..	20·4	24·8	..	..	..
Superphosphate	,, ,, ,, ..	..	..	..	..	22*
Sulphate of potash	,, ,, ,, ..	..	..	..	48·6	..
Ground rock phosphate	,, ,, ,, ..	..	..	..	..	31·95
Sulphate of ammonia	Paton, Burns, & Co.	20·4	24·8	..	..	..
Nitrate of Soda	,, ,, ...	15·5	18·8	..	..	..
Superphosphate	,, ,, ...	..	..	..	..	22*

* Water-soluble.

II.—Bone and Blood Manures, 1928.

Manure.	Where obtainable.	Guaranteed Composition.			
		Nitrogen.	Ammonia.	Phosphoric Acid.	Equal to Tricalcium Phosphate.
		per cent.	per cent.	per cent.	per cent.
Bonedust	Australian Fertilisers Proprietary Ltd.	3·8	4·61	22·0	48·03
B. and B. manure	Kitchen and Sons, Ltd.	5·0	6·07	17·0	37·11
Blood and bone	R. S. Lamb & Co.	4·12	5·0	13·74	30·0
Bonedust, 1	,,	3·20	4·00	18·32	40·00
Pure fertiliser	N.S.W. State Abattoirs, Homebush Bay	6·68	8·11	10·87	23·73
Bone and Blood, 1	Farmers' Fertilisers Corpn., Ltd.	6·0	7·28	16·0	34·93
,, 2	,, ,, ,,	5·0	6·07	16·0	34·93
Bonedust	,, ,, ,,	3·7	4·49	22·12	48·29
Blood	,, ,, ,,	12·0	14·57	.....	.....
Bone and Blood	M. Gearin and Sons	5·0	6·07	14·0	30·56
Bonedust, B.D. 1	Paton, Burns, & Co.	3·7	4·49	22·12	48·29
,, B.D. 2	,, ,,	3·7	4·49	22·12	48·29
Bone and blood manure, B.B. 1	,, ,,	5·0	6·07	17·00	37·11
,, ,, ,, B.B. 2	,, ,,	5·0	6·07	13·00	28·38
Bone phosphate	,, ,,	.....	.....	20·77	64·99
Dried blood	,, ,,	13·00	15·79	.....	.....

III.—Waste-Products, Ashes, &c., not on the Market.

Manure.	Original Source.	Water.	Volatile and Combustible.	Nitrogen.	Insoluble.	Lime.	Phosphoric Acid.	Potash.
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Deposit from wool-scouring tanks { 1	Liverpool Wool-scouring Works	.....	.....	·64	.....	.....	·16	·72
2	" " "	.....	.....	1·02	.....	.....	·14	·39
3	" " "	.....	.....	1·37	.....	.....	·14	·2
Deposit from breakers	" " "	34·47		1·81	50·68	·35	·88	1·60
Sediment from wool-scouring works	Yass	10·57		·59	8·24	·07	.....	·29
Scutch	Australian Glue-Gelatin Works, Alexandria.	56·98	.....	2·95	.....	4·16	None.	None
" from limed pelts	*Hugh Wright, Auburn*	5·22	72·42	1·80	3·61	9·36	·89	·20
Decomposed hair and lime	Fellmongery	9·70	57·08	0·86	1·22	26·27	.....	.....
Tan-yard refuse	Tanneries, St. Mary's	6·43	33·83	2·24	21·43	26·96	·67	.....
Tan refuse	.....	7·10	50·90	2·62	16·03	18·58	·56	·18
Fleshings from tannery	.....	·91	75·37	44·43	5·98	.....	1·14	·04
Salt (sweepings from tannery)	.....	3·94	.....	·70	·38	.....	.....	.....
Wool-waste	.....	.....	.....	8·15	.....	.....	.....	.....
Peat	*B. Tager, Moss Vale*	34·33	28·20	1·97	26·05	2·76	·47	·32
"	.....	72·93	10·68	·35	10·39 (ash).	.....	.....	.....
"	S. Cook, Pyrmont	49·51	34·63	·75	.....	.....	·06	·01
Burnt peat	.....	.....	.....	.....	84·45	.....	·25	·33
Filter-press muck	Cane-mills, Broadwater	16·39	20·07	·22	34·95	13·20	5·08	·44
Megass	Clarence River cane	9·86	67·32	·63	8·61	·30	·01	·05
Megass ash	"	.....	.....	.....	87·69	3·07	·16	·51
"	Richmond River cane	.....	.....	.....	.....	1·11	·21	4·79
Bloodwood ash	.....	.....	.....	.....	.....	8·47	·37	5·25
Ironbark ash	.....	.....	.....	.....	.....	.....	·82	1·53
Blackbutt ash	.....	.....	.....	.....	.....	7·27	·04	2·02
Red-gum ash	.....	.....	.....	.....	.....	.....	·33	4·17
Spotted-gum ash	.....	.....	.....	.....	.....	.....	·10	·70
Box-wood ash	.....	.....	.....	.....	.....	.....	·07	1·85
Grass-tree ash	.....	·86	1·78	.....	3·48	24·94	3·07	5·30
Vine-cuttings ash	.....	·49	.....	.....	60·64	11·31	1·95	3·76
Red-apple ash	.....	.....	.....	.....	54·52	13·96	·47	0·09
She-oak ash	.....	.....	.....	.....	9·57	42·35	8·85	2·19
Hardwood ash	.....	·50	1·35	.....	62·38	13·50	1·76	3·09
Ash of *wild melon*	Stock Branch	.....	.....	.....	.....	5·12	4·86	·27
Wood ashes	.....	·30	.....	.....	21·43	41·37	·25	3·80
"	Wentworth Irrigation Area	.....	.....	.....	11·12	50·78	·58	3·21
Ash of *burrawerie* shale	*Hartley Vale*	1·49	27·93	·70	67·59	.....	·28	·14
Eucalyptus leaves ash	.....	.....	.....	.....	.....	.....	.....	10·64
"	.....	.....	.....	.....	.....	.....	.....	30·52
Camphor laurel ash	.....	.....	.....	.....	.....	.....	.....	2·65
Coachwood and sassafras wood ash	.....	.....	.....	.....	.....	16·16	3·60	13·63
Gidgea wood ash	.....	.....	.....	.....	.....	40·3	·36	·25
Bracken fern ash	.....	.....	.....	.....	56·17	9·64	5·09	4·98
Broom millet ash	.....	2·59	.....	.....	57·23	11	4·67	15·53

III.—Waste-Products, Ashes, &c., not on the Market—*continued.*

Manure.	Original Source.	Water.	Volatile and Combustible.	Nitrogen.	Insoluble.	Lime.	Phosphoric Acid.	Potash.
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Coals (ash)	....	.....	.....	.....	64	.....	·29	·16
Clinker from locomotive boiler	....	.....	.....	.....	.....	.....	.....	·25
Residue from furnace	R. E. Bragg, Marrickville	1·55	35·63	·54	52·40	·64	·43	·02
Sea-weed ash	....	.....	.....	.....	.....	9·27	·49	·59
,,	....	.....	.....	.....	.....	6·29	1·27	17·56
,,	....	·43	.....	.....	56·28	9·30	·47	2·26
,,	Manly	.....	.....	.....	43·06	6·52	·01	13·88
,,	,,	.....	.....	.....	·07	·53	·19	34·30
,,	,,	3·25	19·16	.....	61·03	4·22	·34	·22
,,	....	.....	.....	.....	.....	4·67	1·08	31·41
Sea-weed, fresh state	....	80·00	.....	·16	.....	·41	·09	·18
Sea-weed	....	41·03	42·49	·11	.....	.....	·21	·20
Sea-weed, dried	....	18·95	65·97	1·64	15·44 (ash).	3·44	·14	·11
Sea-weed, air-dried	....	3·60	.....	.....	10·89	.....	·42	1·07
Air-slacked lime	....	16·28	.....	.....	1·88	75·11	.....	.....
Residue from calcium carbide	....	41·26	.....	1·08	.....	36·19	.....	.....
Limestone rock	Queanbeyan	1·10	.....	.....	4·70	48·20	1·22	.....
Agricultural lime	Portland Cement Co.	16·33	.....	.....	2·80	Hydrate 13·89 Carbonate 33·97	.....	.....
Gypsum	Marulan	(Crystallised $CaSO_4$ = 92·64)			4·47	.....	.....	.....
Cave deposit, shells, &c.	Cowan, Hawkesbury River	2·11	.....	·82	.....	35·40	1·59	·88
,,	Macleay River	23·66	16·01	2·43	26·77	13·88	7·40	.....
Deposit (coral, shell, &c.)	Pacific Islands	2·13	13·65	·72	.....	44·00	3·53	·39
Shells	Pambula River	.....	.....	.....	.....	44·59	·10	.....
Flue deposit	Maitland	.....	.....	.....	83·75	2·56	·32	·31
,,	Liverpool	.....	.....	.....	91·17	·42	1·29	·17
,, from sanitary furnace	....	.....	.....	.....	63·53	9·64	1·82	1·01
,,	....	9·20	2·45	.....	84·89	·72	·26	·38
Night-soil *mixed* with lime		44·33		·74	18·60	7·02	·78	.....
Night-soil	Wagga Wagga	6·70		·05	82·19	·44	·28	·09
,,	,,	9·14		·28	78·92	1·18	·18	·54
,,	,,	.....		·50	.....	.....	·64	·42
Night-soil preparation, No. 1	....	8·22		3·73	50·22	13·32	9·65	·91
,, ,, No. 2	....	7·20		1·83	29·02	8·05	4·10	·35
,, ,, No. 3	....	25·96		1·64	80·17	1·39	1·61	·70
,, ,, "Pinhoe" manure	....	·22	9·54	·21	57·68	14·71	1·26	·56
,, ,,	F. Arlett, Parramatta	7·33	30·06	2·10	46·28	2·09	1·92	·01
,, ,,	....	10·11	42·59	4·97	·94	30·12	·39	.....
,, ,,	Mr. Halstead, O'Brien's patent	1·64	12·36	·54	77·95	.....	·63	.....
,, ,,	....	20·62	36·15	2·55	14·33 (ash)	.....	.....	.....

III.—WASTE PRODUCTS, ASHES, &c., NOT ON THE MARKET—*continued*.

Manure.	Original Source.	Water.	Volatile and Combustible.	Nitrogen.	Insoluble.	Lime.	Phosphoric Acid.	Potash.
* *		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Farmyard manure		67·90	22·03	·40	8·10	·16	·20	·30
Stable manure	Bathurst	39·26	.....	·41	.....	.....	·27	·67
Fowl manure		3·05	16·48	1·47	70·16	2·10	1·04	.....
,,		1·54	15·23	·86	79·06	·64	·59	·33
Fowlyard manure		4·80	14·26	·91	.....	3·12	·84	.....
Sheep manure	Bathurst	7·73	.....	1·06	.....	.....	·69	1·17
,,	Liverpool Wool-scouring Works	9·71	50·91	1·79	32·26	2·30	·91	·92
Sheep dag		.....	.....	3·04	.....	.....	.....	.....
Refuse manures	Abattoirs	12·90	74·51	4·14	6·56	.....	1·80	.....
Flying-fox manure		1·09	35·34	3·34	50·29	1·02	·36	1·15
Fish fertiliser		14·47	64·36	10·37	4·62	.....	.....	.....
Shark fertiliser		9·02	68·61	10·50	3·86	.....	7·27	.....
Fish manure		10·88	29·21	6·10	5·39	9·82	8·28	.....
Rabbit hair, long	Anderson, Oxford-street	8·73	88·64	14·03	3·63 (ash).	.....	.....	.....
,, short	,, ,,	9·72	87·76	14·00	2·82 (ash).	.....	.....	.....
Bat guano		14·11	17·69	1·55	28·77	13·72	11·42	.....
,,		10·86	19·05	2·24	51·05	1·75	3·55	·15
,,		13·70	34·35	4·76	3·90	22·28	13·04	trace
Bat deposit	Cave Flat, Cooradigbee	5·43	12·98	·50	57·64	5·60	12·12	.....
Guano deposit	Tamworth	8·75	38·40	6·17	12·85	.....	9·24	.....
,,	,,	8·42	20·97	3·10	31·89	.....	7·87	.....
,,	,,	14·55	29·91	3·66	15·81	.....	12·08	.....
,,	,,	9·95	44·32	6·73	7·38	.....	13·17	.....
Ground guano		4·57	11·44	·21	.....	34·90	28·20	·22
Deposit from cave	L. R. Mercy, Ashford	23·75	35·57	3·63	1·65	16·32	11·28	·60
Bone breccia	Queanbeyan	5·71	.....	·59	9·48	42·80	3·11	.....
Muck from waterworks reservoir	Maitland	4·84	17·55	·74	63·42	4·50	·31	·60
Muck raked from waterhole		63·66	29·86	·81	3·80	·96	·10	·06
Sawdust		33·52	62·35	·82	.....	.....	1·70	·05
Decayed wood, bark and leaves, bloodwood		57·80		·74	40·68	1·30	.....	.....
Decayed wood, bark and leaves, pepper-tree		79·92		·8	17·77	1·50	.....	.....
Coconut oil cake		8·24	.....	1·25	.....	.....	1·26	1·49
Castor cake		18·81	74·08	4·23	.....	.....	1·83	·86
Pea cake	Java	16·02	.....	7·24	.....	.....	1·46	1·17
Bean cake	North China	14·52	80·32	6·77	.....	.....	1·33	1·99
Rice husks		42·74	42·15	1·07	13·77	·02	·03	·04
Field pea, whole plant		88·58	9·97	·55	.....	·15	·12	·49
Tares, whole plant		88·97	14·96	·73	.....	.....	·11	·21
Marsh mallow, whole plant		79·06	17·96	·85	.....	.....	·14	·69
Horse bean, leaves and stalks		82·87	15·90	·90	.....	·05	·11	·54
Refuse from wheat cleaner	State Wheat Office, Tyrrell	9·78	81·52	3·29	8·70	·4	1·18	·66
Whale bones		8·53	28·04	3·64	.....	.....	28·13	.....

SECTION III.

The Farm Holding.

CLEARING.

THE methods by which land is cleared in New South Wales vary widely according to the nature of the timber and the purpose to which the land is to be applied.

Where cultivation is the object in view, the work must be done with some degree of thoroughness, the trees being either grubbed out to a depth of 9 to 12 inches, or burnt off to 1 or 2 inches below the surface. The former method permits of the use of the set-plough, but the latter limits the farmer to the stump-jump implement.

Where dairying is intended, the practice in heavily timbered coastal districts is to cut the brushwood and undergrowth, to ringbark all big trees, and, after waiting for some months, to apply a fire-stick to the dry material where it lies.

In western districts, where wool and mutton-growing are alone thought of, it is usual to sweeten the soil and improve the pastures by cutting down the small timber, ringbarking more or less the larger trees, "suckering" as required for a few years, and permitting nature to do the rest.

Clearing for Cultivation.

To deal fully with these various methods is unnecessary for the purposes of this Handbook. The primary clearing on many properties is done by contract, and the farmer, even if previously ignorant of this class of work, usually acquires sufficient knowledge while the contractor is on his land to enable him to proceed at his own convenience with the extension of his cleared area. A general indication of the principles underlying the different methods may, however, be of use.

A warning should be interpolated here that, if it is decided to clear by contract, land which is to be put under cultivation, it is necessary to see that the contractor is bound down pretty strictly as to the depth to which the roots are to be run to, whether or not the timber is to be burnt on the ground, and to an agreement that when the land is being broken up, the contractor shall follow the plough to run any roots exposed.

Before proceeding to the consideration of the various methods of clearing, it should be stated that there are many farmers in different parts of New South Wales who do not like the practice of clearing land of green timber

and applying it to cultivated crops at once. They state that the results are better if the timber is "rung" and allowed to die before it is removed. They have found it takes the soil two years to sweeten after green timber is cleared, whereas the sweetening period is much shorter if the other method is adopted.

Hand Grubbing.

Fortunately clearing need not now be the very heavy, tiresome work that it was a generation ago, science having come to the assistance of the farmer with winches, jacks, hauling gear of different kinds, and explosives, and by the use of two or more of these agents in conjunction it is possible now to clear in a few days areas that at one time would have taken almost as many weeks. For convenience, the principles of hand-grubbing may be stated first, and the application of the various mechanical devices and of explosives afterwards.

The grubbing of timber, especially green timber, in preparing land for the plough, is one of the most laborious tasks with which the new settler has to contend. If the weather has been dry for some time previous to the beginning of operations, the ground is exceedingly hard and the task doubly difficult, as more labour is necessary to remove the earth from around the tree (that the roots may be cut to allow the tree to fall), and also, the earth requires to be dug to a greater depth, as the lower roots, owing to the dryness of the soil, will not draw out so easily when the tree begins to overbalance, as they would if the ground were soft. The same applies also to the running of those roots which are near enough to the surface to interfere with the ploughing, and which if not taken out at first may cause breakages to the plough and harness, and injuries to the man and horses.

The advice that clearing should be done when the soil is moist has to be offered with some reservation, however. It almost invariably happens that that is the time when the farmer is least able to give attention to the extension of his cleared area, for the reason that he is then usually fully occupied ploughing or cultivating elsewhere on the farm. What clearing is done has often, therefore, to be carried out during dry spells, when the ground is too hard to cultivate, and so hard as to make clearing very hard work indeed.

One of the commonest errors of beginners is to think that if they are getting the trees down quickly they are getting along famously, but the experienced hand knows that if the tree falls, breaking off and leaving the tap root unmoved, the hardest part of the work is yet to be done; for when the tree has fallen, there is no leverage to assist in drawing the tap or main roots.

Another error is to try to save labour by removing as little earth as possible from around the tree or stump; it is invariably found that before the job is finished the barrow-loads of earth have run into cartloads ere the mattock and axe can be swung freely and the taproot reached. Until that is achieved, and the root is severed, the end is not in sight. The soil should be opened well back from the trunk, a mattock and long-handled shovel being the most suitable implements.

The root system having been opened up, the first thing to do is to cut through, or partially through (with as wide a cut as possible), the roots on the side towards which the tree leans (see Fig. 1). If there is a taproot, a cut should be made into it as far as possible on this side. Explosives are very useful at this stage, inasmuch as an auger hole can be bored in the taproot and gelignite employed to sever it.

Meanwhile the roots on the other side being intact will hold the tree, thus enabling the workman to operate in security. All the cutting possible having been completed on the side to which the tree leans, the roots on the other side are followed a bit further out, and severed one by one. Nothing

Fig. 1.—Showing how large-headed trees can be canted with lever.

is gained by cutting these latter roots close in to the tree. On the contrary, the further they can be followed the better, especially if tackle is used, or if the tree has a decided lean or there happens to be a favourable wind. As shown in the illustration, a long sapling, used as a lever, can sometimes be employed with advantage to cant the tree.

The manual labour involved in clearing land thoroughly by hand is very heavy, and for the man who is dependent on immediate returns most costly in the long run. Indeed, it would pay a man better to defer building a cottage, and to camp in a tent for six months or a year, so as to have the money for pushing forward with the clearing. Some of the clearing can be done by degrees as opportunity occurs, but it will always be most profitable to get at least half of it done so as to catch the autumn or spring season for sowing a crop which can be growing while the rest of the work is in progress.

Winch Grubbers and Jacks.

Such machines as the jack, "forest devil," and winch grubber, can now be had for a comparatively small outlay, and they are capable of doing all that is claimed of them, providing they are properly handled.

With the aid of a tree-pulling winch, and by severing with an axe or by means of explosives the larger main roots 4 or 5 feet from the trunk, both green and dead trees of 5 and 6 feet diameter can be pulled down in a very short time. Away from the coast, in districts where the timber is of normal size, several acres can be brought down in the course of a day. The

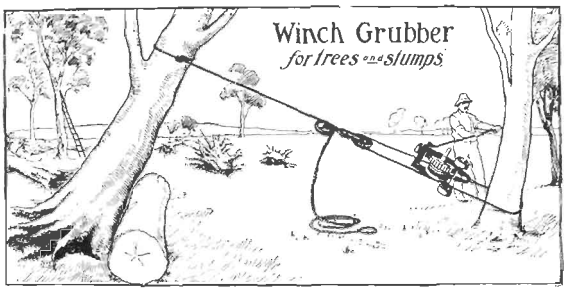


Fig. 2.—A winch grubber of modern type.

method of attaching the gear is shown in Fig. 2. One end of a steel rope is passed through a pulley-block as high up the trunk as convenient, while the other is hitched to the machine and an anchor-tree. If the main roots have been severed well back from the trunk, the tree can be made to "run" its own roots as it falls.

An implement that is almost indispensable where clearing is going on is the jack. For running roots, prising out trees or stumps, moving logs, boulders or floating rocks, or drawing old fence posts, &c., it is well suited, doing the work with little exertion on the part of the man, and in a surprisingly short time. The use of this implement is illustrated in Figs. 3 to 7.

Fig. 3.

Fig. 4.

Yet another machine, in which the lever is again the chief agency, is that known as the "forest devil." It consists of the ironshod end of a wooden lever pivoted between a pair of parallel iron plates, and an arrangement of bolts or steel clutches provided to grip two chains, one attached to the tree pulled and the other to the anchor-tree. If the distance is at all considerable, steel bars are often used for portion of the way instead of chains. A man grips the free end of the lever and walks backwards and

Fig. 5.

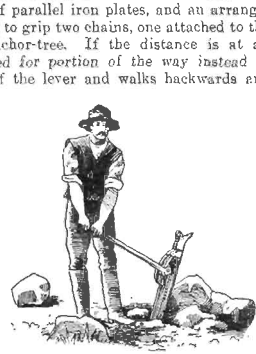


Fig. 6.

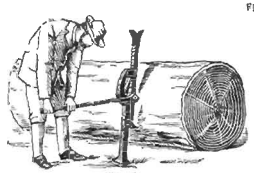


Fig. 7.

forwards in a semicircle, whilst a lad rearranges the clutches or bolts at the end of each trip so as to reverse the direction of pull. The slack portions of the chains fall to the ground as they are drawn in. As the lever may be of any desired length, the power which may be obtained is practically limited only by the strength of the tackle. In South Gippsland, Victoria, appliances of this nature have been largely used in clearing the heavy forests of that region, particularly for drawing stumps after a burn.

In connection with machines of all these kinds, it must be borne in mind that no machinery will continue to work well without oiling, and the cost of a tinful of oil is but a fraction of that of a broken part, quite apart from the vexatious delays that breakages entail.

Block and Tackle.

In certain districts it is economical to hire a team of bullocks or steady horses, and to use hauling gear on a more powerful scale. The method, though extensively used in the past, is being superseded in many parts of the State by the machines for manual power just described, but it still has its utility, and there are those who prefer it, though winch grubbers or explosives are generally employed in conjunction with it.

The team having been obtained, the selector himself, with what assistance he can arrange for, can perform the necessary shovel, mattock, and axe work in opening up the ground about the trees and stumps. Under fair weather conditions great headway can be made in getting the trees down, and the heavy logs hauled off the clearing, while the tops can be at once disposed of by burning on the spot. The advantage of this system is that the owner of the area can see for himself exactly how the stumps and roots are removed.

There are several methods of hauling down timber, but the description of two here will suffice to indicate the principles.

For one, used in clearing the site of Cowra Experiment Farm, the plant consisted of:—

200 feet of 2-in. circumference wire rope.

150 feet of 2½-in. circumference wire rope.

Two pieces, 20 feet long, of 3-in. circumference wire rope.

Three pulley-blocks, size of sheaves 8 inches x 2 inches, viz., one treble, one double, and one single sheave.

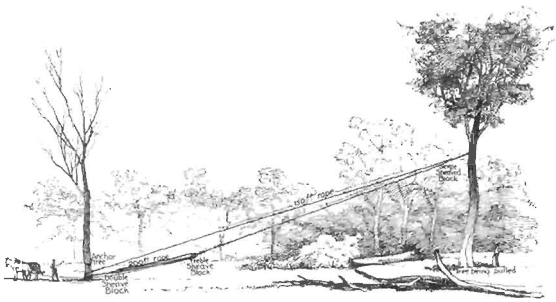


Fig. 8.—Tree-hauling gear, as used in clearing at Cowra Experiment Farm.

The method of using this tackle is as follows:—

One of the short pieces of 3-inch rope, with the single-sheave block hooked on, is placed round the barrel of the tree that is to be pulled down, a ladder being brought into requisition to fasten the rope as high as possible. The 200-feet rope is reeved in pulleys of double and treble sheave blocks. The double block is hooked on to the other short piece of rope, which is then fastened round the butt of a neighbouring stump or tree, on the side on which it is intended to pull the tree. The end of the 150-feet rope is hooked on to the treble block, passed through the single block attached to the tree, and after the slack is taken up, is anchored by winding it round the butt of the stump or tree, where the other block is anchored, or if the stump or tree is small and not likely to stand the strain, to another tree in the line of pull. A pair of strong steady horses is hooked on to the end of the 200-feet rope, and everything is then ready for the pull. The slack is taken out of the ropes, and, by means of a strong steady pull, the tree will come down.

The side from which the tree will be pulled will depend upon the shape and lean of the tree, the slope of the land, the direction of winds, if any, and the nearness or otherwise of anchor-trees.

When the ground is soft and in good order, as is the case after or during rains, green trees up to 2 feet in diameter may be pulled down, taking almost every root with them, without easing; and dry trees of any size with sound barrels may be pulled down. If the ground is dry and hard, or the trees are extra large, it will be found necessary to ease them by removing the soil around the butt of the tree to a depth of a couple of feet, and perhaps cut some of the larger roots. It will thus be seen how important it is to take advantage of any wet weather, thus effecting a great saving of labour. Five men and a pair of steady horses could pull down about 5 acres of ordinary box timber in a day.

Fig. 9.—Manual tree-hauling gear.

In the case of stumps, or trees with hollow or defective barrels, they should be grubbed round *well before* commencing to pull, as there is often not the same leverage obtainable, and should the tree break off level with the ground, the butts and roots would have to be taken out in the ordinary way, thus necessitating a great deal of extra labour.

All blind stumps and roots that may have been cut in easing the trees are then taken out to a depth of 18 inches from the surface—a depth that will not interfere with future ploughing, and, if necessary, subsoiling of the area. These should be taken out thoroughly.

The tackle illustrated in Fig. 9 has been found very useful where the trees are of a moderate size. It does not help so far as opening out about the main roots and cutting them through are concerned, but it saves worrying

around the taproot. A log is usually placed at the foot of a tree that is being felled, as shown in Fig. 2. The effect is to "draw" the roots on the near side of the tree. The logs shown in Fig. 9 are placed for the tree to fall on, so that in sawing the trunk time may not be lost by the saw cuts biting the saw as the ends of the unsupported parts of the trunk press in against each other. This can also be prevented by using wedges gently tapped into the cut as soon as it is deep enough to carry a wedge. The wire rope is about 25 yards long, and an ordinary double purchase tackle is used. In hauling, the operatives stand well away from the line of fall, and as the ropes slack off when the tree begins to fall the blocks are jerked aside. The rough ladder shown is made of a couple of bloodwood saplings, which are tough and soon become very light when stripped of the bark. The gear is fixed ready before the tree is opened up.

The mistake is often made when pulling down trees by machinery when the ground is hard, of not easing the trees sufficiently to allow of the drawing of the roots, and consequently when the strain of the machinery is brought to bear on the tree, it (being too firmly held in the ground—especially if the barrel or trunk be hollow) breaks off level with or close to the surface, and then more labour is necessary to get the stump out than was at first required if it had been gone about in the proper manner.

At times the burning of big trunks that have been brought down is almost as difficult a problem as was the standing tree itself. Explosives are proving valuable in shattering such trees and enabling the farmer to burn them.

Before filling in the holes that have been made by the removal of large stumps, a careful examination should be made, and all roots that will interfere with the ploughing removed.

LAND CLEARING BY EXPLOSIVES.

One has only to watch a man hand-grubbing a forest giant in the heat of a summer day, and to follow him home in the evening, to appreciate really the magnitude of his task, and it is an open question if any system or machine used singly or in combination, would have lightened his heavy task to the same extent as a few packets—perhaps a few plugs—of gelignite would have done. After removing dray-loads of material in trenching round a tree or stump, in order to be able to swing the axe or mattock, roots may be met that the axe cannot reach, whereas an auger hole and a few plugs of gelignite (varying in number according to the size of the roots) will sever and shatter the hindrances and loosen up the surrounding soil at the same time. The same question arises when the forest devil or 10-ton jack, or any other mechanical device for pulling down green timber is being used—that of getting rid of the trunk. Frequently the crosscut or lightning saw is used to cut the log into suitable lengths for handling, stacking and burning; but it is a much cheaper proposition to frill and poison the tree, and then, when dead, to shatter it with gelignite, and burn in an upright position. Besides, the hot ashes falling from the burning upright tree operate considerably in "stoving" out the tree-roots. When the tree falls, that section of the trunk and any larger limbs that are not consumed by the fire, can be better handled with a little gelignite than by all the axes in the country, and with infinitely less labour and hard work, though the axe must be used on the lighter and more easily handled portions.

There is nothing more troublesome after the trees have been felled, all their limbs, branches and leaves burnt, and grass is beginning to appear, than the wilderness of blackened and half-burnt logs that is to be seen in almost any section of this State. Frequently there is no light wood available, without endless carting, to burn off these blackened tree trunks, and such a proposition would be ruinous. But gelignite does just the very thing that is needful for dealing with such logs; it makes kindlings, and in making cords and cords of kindlings it converts large sections of those troublesome logs into the very condition that is essential, if rapid and effective burning off is to be accomplished.

Ordinary ringbarking is the method usually adopted for the killing of timber preparatory to clearing, and if thoroughly done at the right season it is effective; but it is very slow, often taking well over twelve months to bring about the desired result. A better method is frilling and poisoning, (see page 136) as this kills in a few weeks, and often in a few days. Even with this method some trees will be more resistant and will sucker, no matter how carefully they may be treated; but, generally speaking, the treatment is highly effective, enabling the dead timber to be handled well within twelve months, and affording the owner the additional advantages of an extra season and a sweetened soil, due to the timber having been allowed to die in the ground instead of having been cleared off green.

Necessary Tools.

The tools necessary are:—Earth auger, bulb bar, wood augers (two), chisel bar, tamping stick, crimping pliers, electric firing battery, galvanometer, firing cable, No. 6 detonators (ordinary), No. 6 detonators (electric or E.D. fuses), and the explosives.

Earth auger.—This is made from an ordinary 1¼-inch Mathieson wood auger, the centre screw lead being cut out and the auger end fishtailed to the depth of about ½ inch, and new cutting edges then filed on the proper sides of both wings; the handle or shank is lengthened to suit, but 4½ feet is a convenient length, as holes 4 feet deep are ample for practically all tap roots.

Bulb bar.—This tool was designed to expedite the placing of holes round and under trees and stumps, and as will be seen from the accompanying illustration it is unnecessary to remove the core of earth, as has to be done when using the earth auger. The bar is 5 feet long, of ⅞-inch octagonal steel, one end being thickened up to 1½ inches diameter, and drawn out to a fine point 3 inches long on the lead end; behind the thickened section the bar is gradually tapered back to the diameter of the bar (⅞ inch) for, perhaps, a couple of inches. The top end is headed for driving-in purposes. When this bar is in use, it is driven home preferably with a wooden maul, as a steel sledge knocks the steel bar head about too much. When it is about 8 inches in, water is poured into the hole made, and the driving is continued until the hole is of the desired depth. This makes a circular hole of 1½ inches, and when the bar has to be withdrawn there is only the friction of the bulb section to contend with, as the bar shank is so much smaller in diameter; besides, the water poured in during the driving operation follows the bulb down, lubricating the sides of the hole, and making the job of withdrawing the bar comparatively easy. It may happen that in driving this bar down, a root may be gone over or under,

and this may make the task of withdrawing the bar more difficult, but it was to avoid this that the taper was designed at the back or top side of the bulb. In any case a 6-foot length of ¼-inch chain, double half-hitched round the bar at the ground level, and then round a long rail or stout sapling, which can be used as a lever, will soon release it. Any blacksmith can make this implement; in fact, it might easily be made on the farm at a moderate cost. It will get through more than ten times as much work as the auger, and it will ease much hard work.

Wood augers (two).—The ordinary 1½-inch Mathieson wood auger similar to the one the earth auger is made from, is a highly efficient tool, though a good deal of trouble is often met with in getting it to start boring after it has been withdrawn for clearing purposes—which is necessary from time to time—on account of chips being left in when releasing the screw lead preparatory to withdrawing.

The L'Hommedieu or bull-nosed auger of 1½-inch diameter is a rapid and efficient wood-boring tool, but it needs a Mathieson auger to start the hole; usually an inch or two will suffice. It cuts quicker and with less exertion to the operator, and when withdrawn for clearing out the hole—as is necessary from time to time—it goes right down to the bottom at once, making re-starting easy and simple. A handle or shank 4 feet 6 inches long is a convenient length in each case.

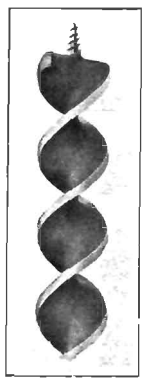
Chisel bar.—This is a most useful tool, and a practically indispensable implement when using explosives, as so many trees and stumps have large, solid, or even hollow hip roots, partially under or very near the surface, where a grubbed hole, somewhat similar to a rabbit hole, but smaller, allows the charge to be bunched right up against the timber, causing a maximum amount of shattering, a result that is very desirable for rapid burning off afterwards.

The best way to make this implement is to have the centre portion, between the two working ends, made of a piece of ordinary 1-inch black iron piping 3 feet 6 inches long, the external diameter of which would be 1¾ inches (galvanised piping will interfere with the welding of the steel terminals). A piece of ⅞-inch steel, 6 inches long, is then welded into each end of this pipe length, one piece being drawn out to a cutter bar, 3 inches wide, ground on the inside only and set back an inch or so as shown in the accompanying illustration. The piece of steel at the other end is made as an ordinary chisel bar, 1 inch wide and sharpened cold-chisel fashion; besides being useful for grubbing charge holes, small and medium roots may easily be cut, if met with during grubbing operations.

Tamping stick.—This must always be of timber, about an inch in diameter, and an old broom-handle about 5 feet long makes a most efficient one.

Crimping pliers.—These are used for fixing the detonators on to the safety fuse and cutting it into convenient lengths. Some people use their teeth, but it is most unwise and should not be encouraged under any circumstances. (See Figs. 2, 4, and 5.)

Electric firing battery.—This is used only where several charges have to be exploded simultaneously, as there is no other reliable method. It is mostly, if not entirely, used when it is desired to blow trees and stumps right out of the ground. This firing battery is in no sense a chemical battery, but is similar in operation to a magneto or dynamo. There are different types on the market, varying from a capacity of a single shot, for coal-mine work, up to fifty shots at one time; in style they also differ, ranging



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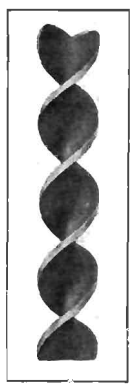

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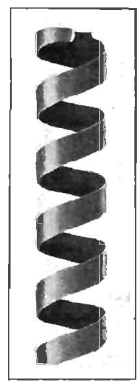

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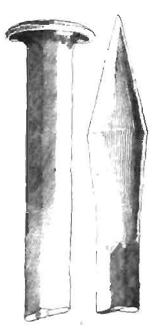

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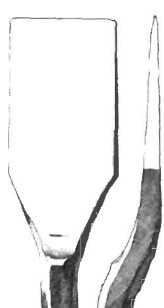

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Fig. 1.—Implements used in Clearing by Explosives.

1 and 2. Mathieson Wood Auger before and after cutting out the screw head. 3. L'Hommedieu or Bull-nosed Auger. 4. (a) Top and (b) bottom ends of Bulb Bar. 5. (a) Front and (b) side view of wide chisel end of Cutter Bar. 6. (a) Front and (b) side view of narrow chisel end of Cutter Bar.

from the ordinary Q type, where a handle is revolved at a high speed and at the same time a button pressed to break the current and flood the circuit with a full, fat spark, to the Rackbar type, where a long handle-bar with a fine-toothed rack attached, is pushed down briskly and a cut-out plate struck at the bottom to flood the circuit. This scheme of liberating the current generated at the very last moment is to ensure that the whole amount will speed round the circuit in one energetic mass and so provide sufficient to fire all the charges concerned; otherwise the firing would be irregular and some charges would be unexploded. The Rackbar type is by far the better machine, and a 10-shot capacity is the most convenient size.

The Galvanometer is a very weak, chemical dry-cell battery, and is only useful for testing the electric detonators before inserting them in the various charges, and then after connecting up these charges in series and coupling up to the firing cable, to make sure that all connections are secure and no "shorts" exist. With care these dry cells will last for months, and when they run down they can be renewed for a few shillings. It would be extremely risky for anyone who is not thoroughly conversant with galvanometer testing to attempt to renew these dry cells. Too strong a cell would explode and not test the electric detonator.

The Firing Cable is, or should be, 100 yards long and composed of two wires or strands of wires, separately insulated and waterproofed to prevent "shorting," and then further insulated and waterproofed to prevent damp or wet penetrating them. It is highly flexible, and should be quite moisture-proof under all circumstances; with care it will last for years.

No. 6 Detonators (ordinary).—These consist of small copper cylinders, about ¼ inch diameter, open at one end only, and charged with about 16 grains of fulminate of mercury, a very sensitive compound with a high detonating force. Their function is to explode the charges of gelignite by detonation, and they should be handled with all care and respect, since their explosive force is in the neighbourhood of 60 lb. per square inch, which is more than sufficient to blow one's hand off.

No. 6 Detonators (electric or E.D. fuses).—These are similar to the ordinary No. 6 detonators as to the copper cylinder and charge of fulminate of mercury, but they have an addition to enable them to be fired electrically instead of by ordinary safety fuse. Attached to each electric detonator are two wires, and on one end of each wire is a small metal pole, one slightly shorter than the other. Uniting the ends of these poles of varying length is an extremely fine platinum wire, over which fits a gun-cotton priming, very similar in appearance to a fusee match head. This priming rests right up against the fulminate of mercury in the copper cylinder, the whole attachment being kept firmly in place by a waterproofed insulation compound on its open end, performing the dual purpose of keeping the contrivance in its place and preventing any moisture reaching the fulminate. In operation, the current generated in the firing battery flies down one wire and across the fine platinum wire bridge, which instantly becomes incandescent, just as an ordinary electric lamp does, thus setting fire to the gun-cotton priming which explodes the fulminate of mercury and detonates the charge of gelignite. The current having completed its function in the first E.D. fuse, rushes up the other wire and along to the next fuse, repeating the same operation to the number of charges in the circuit or the capacity of the firing battery.

Explosives.

There are many kinds of explosives on the market, most of which are applicable to the varying work of land clearing. Gelignite, dynamite, rack-a rock, and black powder are the most generally known and distributed, and are therefore comparatively easy to obtain: in normal times most of the agents for explosives handle the above. They all have their advocates and will all do good work; but the conditions under which some will and some will not, make it essential to explain in detail.

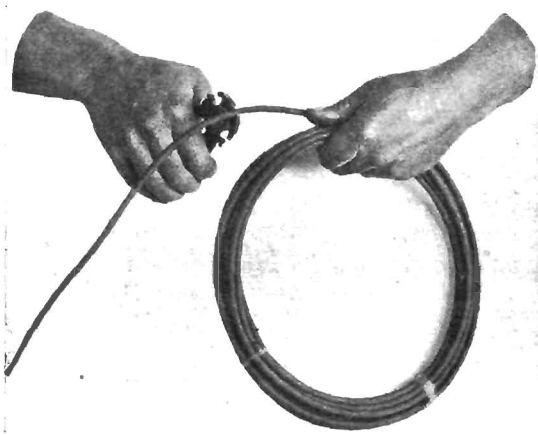


Fig. 2 Cutting the required *lungth* of fuse.

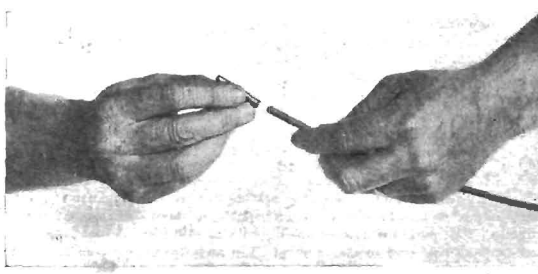


Fig. 3.—Inserting the Fuse in the Detonator.

Gelignite and dynamite are both nitro-glycerine compounds, and for land clearing purposes they practically do the same work, but there is a vast difference in their character and method of manufacture, which stands out in favour of one to the exclusion of the other, for the farmer who is not necessarily an expert with explosives.

Dynamite is a mechanical mixture and soluble in water, that is to say, the nitro-glycerine, being only absorbed or taken up in a containing earth, separates out from that containing earth on coming in contact with water, and this crude form of nitro-glycerine is highly sensitive to friction, even when a wooden tamping stick is in use. It is highly dangerous for the reason that the farmer may frequently be working in wet ground when clearing, and the above conditions would operate. Many serious fatalities have been attributed to this solubility of dynamite.

Gelignite is a definite chemical compound, being nitro-glycerine gelatinised chemically and mixed with certain other ingredients. It is quite insoluble in water, and if left in it for long periods would certainly deteriorate, but its chemically combined parts would never separate.

Both of these explosives—dynamite and gelignite—will burn freely if a match is applied, and in the open air in such a condition would be comparatively harmless; but if thrown into a hot confined fire, where air had very little access, such as a stove fire, or a fierce burning log, serious results are likely, for the reason that as the explosive burns, the gases produced by the chemical change are generated very rapidly, and not being able to get away they form a pressure about themselves, which explodes them—really spontaneous combustion.

Rack-a-rock is a combination of two chemicals, one a solid and the other a liquid, neither being classed as an explosive separately but becoming so when they are brought together as rack-a-rock. The solid section consists of a 98 per cent. chlorate of potash cartridge, packed in small calico bags of sausage shape and varying diameter. The liquid is an oil known generally as murbane or almond oil, and chemically as nitrate of benzole, and by soaking the chlorate of potash cartridge in the murbane oil for about three minutes, it becomes a powerful explosive. It is somewhat slower in its explosive action than nitro-glycerine compounds, as used in this State, and for that reason it is well adapted to the work of land clearing; but it is of very little use in wet holes or wet ground, not for the same reason as dynamite but because water apparently breaks up the chemical combination of the chlorate of potash and the murbane oil, rendering it inoperative. All the foregoing—gelignite, dynamite, and rack-a-rock—are exploded by detonation through a No. 6 detonator, and not through the ordinary fuse by itself, though it is good practice to use half a plug of gelignite in addition, as a primer, when firing rack-a-rock, as a No. 6 detonator often proves not to be strong enough for absolute certainty.

Black powder is a proportional mechanical mixture of three substances—nitre, sulphur and charcoal—not so strong in explosive force as any of the foregoing, and very much slower in its action. Its slow pushing action is ideal for work in the soils, but the lack of explosive force throws black powder out when handling trees and stumps: it is used extensively for log splitting in the sleeper-cutting and timber business, as its slow action does not shatter

and destroy the logs like the more rapid gelignite and dynamite do. Black powder is exploded by fire and not by detonation, and the ordinary safety fuse is used for this purpose.

Safety fuse is the ordinary powder fuse, used for firing blasting powder, and attached to a detonator for firing gelignite, dynamite, and rack-a-rock. It consists of a continuous core of powder through the centre of an inflammable and practically waterproofed wrapper, is made with great skill and very little variation, and is tested carefully by the Explosives Department, having to answer certain rigid requirements before it is permitted to be placed on sale. The rate of burning is about 2 feet per minute, and for land-clearing purposes, where charges are usually fired shortly after they are tamped, it is quite waterproof. There are several makes on the market, the double tape being pre-eminently the best, but of unnecessarily high quality and price for land-clearing purposes, where a cheaper article, such as "blue sump," is quite as effective.

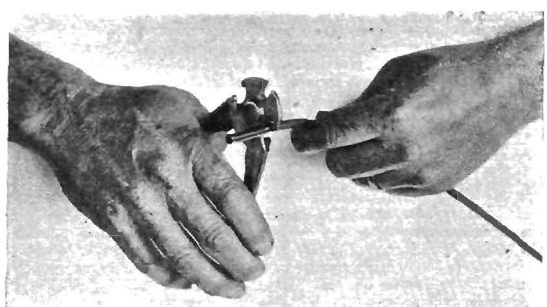


Fig. 4.—Crimping the Cap on the Fuse.

All the foregoing explosives have their adherents, and justly so, but gelignite is recommended as the safest in the hands of the farmer, who is not necessarily an explosive specialist. Gelignite is all ready prepared in convenient cartridge or plug form, will stand a considerable amount of rough handling, is not affected by water, and can probably be purchased more generally than any of the other explosives. It is somewhat too suddenly strong and rapid in its effect, however, and appears to give better service when slowed down mechanically. In very cold weather gelignite, in common with all nitro-glycerine compounds, becomes frozen, getting as hard as a board. In this condition it should not be used, on account of its liability to miss-fire and, curious though it may appear, of its greater sensitiveness to friction. Its susceptibility to explosion in this frozen condition is due, experts tell us, to the rubbing together of the frozen ice crystals of nitro-glycerine. Proper warming pans are on the market for the purpose of thawing out frozen gelignite, but a simple and effective

way is to place the plugs or cartridges in an ordinary tin billy, and to stand this billy in a bucket containing hot water—so hot that you can just about bear your hand in it—for about twenty minutes, when it becomes soft and pliable. On no account should the bucket containing the hot water and frozen explosive be put on or near a fire; such a proceeding would be highly dangerous.

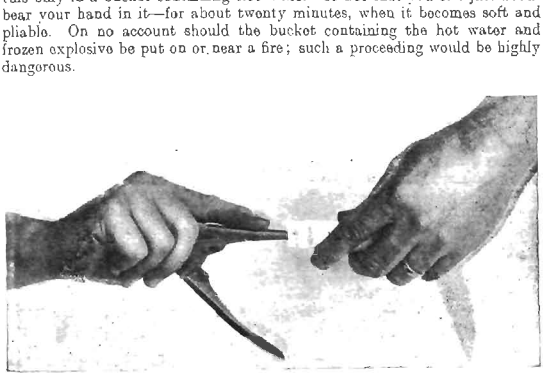


Fig. 5.—Punching a hole in the plug of gelignite, showing the correct position of the hands and gelignite when making the hole with crimpers.

When gelignite was originally recommended for land-clearing purposes in pre-war days, it contained about 62 per cent. nitro-glycerine, but as the war period extended and the demand for nitro-glycerine for military purposes became more acute, the percentage was reduced to 50 per cent. This 50 per cent. nitro-glycerine product is more satisfactory than the old 62 per cent. form for clearing purposes, owing to the reduced percentage of nitro-glycerine having a much slower effect. Both qualities are now available locally.

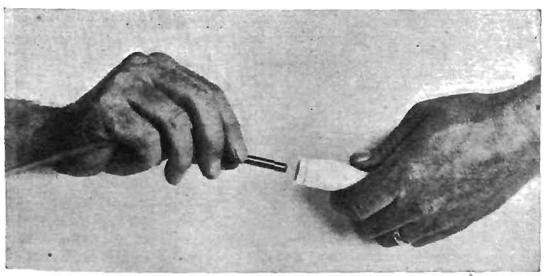


Fig. 6.—Inserting the Capped Fuse in the Gelignite.

Methods of Using Explosives.

The variation in the method of using explosives for clearing—from shattering for burning to the blowing right out of stumps and trees—is so great, with the different root systems, variety of timber, soil conditions, &c., met with, as to make it next to impossible to give a concise description in writing of just where to place the charges, and just how much explosive to use. A certain variety of tree may "tap" very badly in one district, and may make no tap-roots at all in another; or the soil may be strongly resistant, with a good stiff solid subsoil for shooting off, and everything in favour of good results in one place, or it may be sandy and friable, and offering but little resistance in another. Such cases need to be tackled rather differently, so that the beginner, after he has mastered the handling and preparing of the charges, &c., and has thereby gained confidence, has to study many points if he is to succeed in keeping down the cost of his clearing, never using the axe if gelignite will do the job quicker and better, or *vice versa*, and never using two plugs if one will be enough.

On most areas the stump question looms large, and in describing the method of handling the stump, the handling of the tree is also described in general principles, since one is the same as the other, except that the trunk and branches have been removed.

It may be taken almost as an axiom that charges should never be placed by means of auger or bulb bar holes in sandy ground or under hollow stumps, that is, stumps with, say, a hollow of a foot or more in diameter. In such cases the charges should be placed by means of the chisel bar close under the hip roots and where the stump is held the strongest, so that the gelignite is resting right up against the timber in a bunch. This ensures the maximum of shattering. The amount of the charge depends wholly on the mass of timber to be shattered; it is next to impossible to lay down hard-and-fast rules as to the amount of charge to be used where such wide variations are the rule rather than the exception.

If a battery is being used, all the charges will be fired at the one time and together, but very good results can be obtained by placing one charge and firing it with ordinary fuse; then preparing another charge hole, the position of which will be dictated to a large extent by the results of the shattering of the first charge, in conjunction, of course, with the next heavy hip root. The work can be continued thus right round the stump, until it is shattered satisfactorily for burning. This is where the grub-hole application of charges is ahead of the auger or bulb-bar application, since a charge put in with the latter would so loosen up the whole soil area of the stump as to make it quite impossible to place another auger or bulb-bar charge under it.

In handling strongly-rooted solid stumps of, say, up to 3 or 4 feet diameter, the auger or bulb-bar can be employed with advantage for a one-charge and ordinary fuse job, but it is advisable to put this hole down quite 4 feet and well under the centre of the stump. The reason for putting this hole down so deep is that the explosive force of the charge travels at a definite and regular angle towards the point of least resistance, which naturally is the surface soil; consequently the deeper the charge is placed, the wider will be the range of the explosive force, and the greater will be the total area of root-system affected.

"Bulling" a Hole.

A method of using gelignite which might perhaps be used to a much greater extent with advantage, and the effect of which is plainly noticeable when grub-hole charges are used, is that of bunching the charge. By this is meant putting the several plugs that comprise the charge in one lump, instead of, as in a bulb-bar hole, distributing them to a certain extent up the length of the hole. To accomplish this, the hole has to be what is termed "bulled"; this consists of opening out a chamber at the bottom or deepest point, by exploding a small charge of gelignite at that point before the main charge is put in position. The size of this "bulling" charge depends on the number of plugs it is intended to use in the attack upon the stump itself and the physical condition of the ground. Generally speaking, however, one-third of a plug of gelignite will open up a cavity about 6 inches in diameter

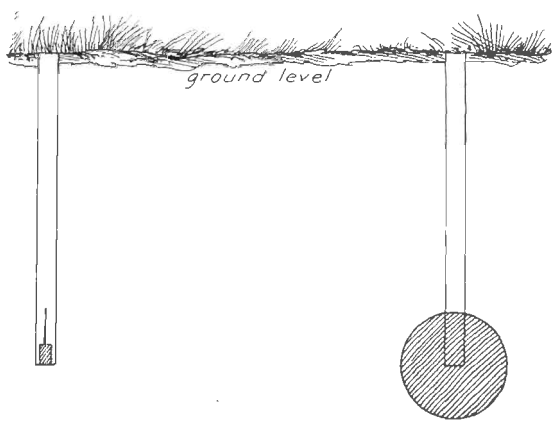


Fig. 7.—"Bulling" a Hole.

A small charge of, say, one-third of a plug is first exploded at the bottom of a hole driven with a bar, and in the chamber so created ten to fifteen plugs can be placed as the "business charge."

every way, which will hold anything from ten to fifteen plugs. To prepare this "bulling" charge of a third of a plug and to explode it in the bottom of the hole, take a No. 6 detonator, free from sawdust packing, and insert a piece of ordinary fuse about 8 inches long in the open end and crimp it on in the usual way with pliers; then, after making a hole with the handle of the pliers or a piece of stick in the piece of a plug, push the detonator with fuse attached into the hole and split the top end of the fuse so as to expose the powder to facilitate lighting. So soon as the fuse is lit and the powder flame spits out, drop the charge quickly into the bulb-bar hole and push it down to the bottom with the tamping stick, then remove the tamping stick and stand to one side, as the explosion throws out a certain amount of

dirt and compressed air straight in front. No tamping of any kind is to be used in this operation, as it is not necessary. After the explosion, push the tamping stick down into the "bull" to make sure everything is clear before putting the final charge in; if necessary, clean out the hole with the earth auger and proceed to drop the charge in, one plug at a time, pushing each plug down into the "bull" chamber with the tamping stick; lastly the primer—the plug with the detonator and sufficient length of fuse attached—is put in gently and pressed home. Now get a wad of paper—any sort will do—and make a ball about the size of a fist; hold the fuse firmly in place with one hand, and press this paper wad down into the hole to a depth of about 3 feet, or two-thirds of the depth of the hole, taking care that the primer is not drawn out from contact with the rest of the charge, while holding the fuse. Having fixed the paper wad firmly, drop in a few handfuls of loose, moist earth; tamp this very gently until it is firm and solid, and is not moving the paper in the hole; then add more earth and tamp it until the remainder of the hole is full of well-tamped earth. To facilitate the lighting of the fuse, cut a diagonal snick in the top end, right into the powder core, and into this insert a small wedge-shaped piece of gelignite; this ignites quickly when the match is applied and is not easily blown out by the wind. The reason for using the paper wad when tamping is that ample air space may be left in the region of the explosion; the effect of such an air chamber is to slow down markedly the rapidity of the action of the gelignite when it explodes—an effect that is of importance, both in regard to the wider area covered by the explosion and also the more economic use of gelignite.

Removing Green Trees.

It is not advocated as a general thing that green trees should be blown out, because of the sweetening of the soil that goes on in a more definite way while timber is dying than if green timber is removed at once. The increased cost due to live trees having a much stronger hold and consequently requiring more explosives must also be considered. It sometimes happens, however, that it is necessary, or at least advisable, to remove green timber. In such cases better results can probably be obtained by firing the charge electrically, putting down three or four holes, so placed round the tree as to do the lifting where the rooting indicates it to be necessary. In this case all the holes should be about 4 feet deep and "bulled," and the same precautions as to tamping and using the paper wad should be adopted, as previously described; then after connecting up the wires of the various charges "in series" round the tree, leaving one wire from the first and last charge to be connected to the twin wire firing cable, lay this firing cable in the direction of the sun, so that when the operator comes to exploding the charges with the battery he will be facing the tree with the sun at his back. Should the explosion throw pieces of timber or stones in that direction, he then will have a clear vision and no glaring sun in his eyes to interfere with him in any movement that may be necessary to avoid injury. The cable is 100 yards long, and it is advisable to use the full length and to get right out in the open, if possible. The practice of getting behind a near-by tree should not be encouraged, as it may happen that a flying piece of timber may be hurled into the branches of the tree and may be diverted sufficiently to fall upon someone there, or it may strike a dead limb overhead and bring it rattling down. Being well out in the open offers many advantages as to safety.

After firing the charges, disconnect the cable ends from the battery terminals at once, and twist them together; take the galvanometer to the tree just blown out and pick up the other two ends of the cable and by placing one on each of the galvanometer terminals, test the cable as to whether any flying timber or stones have broken the continuity of either of the internal wires. This is the time to discover breakages, and not when just about to fire the next batch of charges. In locating a breakage, should there be one, the injury to the outer insulation will frequently be a guide, but by taking the cable in the fingers of each hand and slightly bending it while running along it from one end to the other the breakage can be detected. The outer covering must be cut lengthways, the two insulated inside wires separately exposed, and the broken ends fixed by twisting a piece of naked detonator wire on to each broken end, thereby bridging the fracture, and the repair covered with some insulation tape, so as to prevent contact with the other wire, and also to prevent moisture from affecting it. As this operation often necessitates the splitting or cutting of the outer insulation for 2 or 3 inches, further insulation tape must be twisted round the cable proper to cover and protect the repair.

Hollow Stumps.

It is frequently found that an otherwise solid tough stump of 3 or 4 feet diameter has a pipehole of perhaps a couple of inches, or may be 6 inches across, and filled with decayed vegetable matter offering fair resistance. With the earth augur or bulb-bar put a hole down the pipe, so that the charge will be at least on a level with the ground—a bit below is better—and into this put up to five plugs including the primer (the one with detonator and fuse attached); tamp well, and use the piece of wedge-shaped gelignite to light the fuse end with, remembering that fuse burns at the rate of about 2 feet per minute. Logs frequently have similar pipes, but the difficulty there is to get the hole beyond the charge sufficiently solid to prevent the explosion from blowing right through and out the other end; at times, however, it is possible to get a good basis against which the charge can blow off, and a satisfactory shattering result.

Solid Logs.

In handling solid logs, a hole should be bored from the side as centrally as possible, so as to equalise the burden both ways (diametrically, not longitudinally), and about two-thirds of the way through, standing on the ground to bore, as that is easier than on top of the log. Bore the first hole about 6 to 8 feet from the stump end, unless the timber is exceptionally curly and a bad splitter, when the hole should be closer to the stump end. Charge the hole with from two to five plugs (including primer) according to the diameter of the log, the greater number being for logs of, say, 4 feet. It will be noticed, after firing, that the splitting has extended for a distance of, say, 8 feet beyond the hole towards the end of the log away from the stump, and in the direction of the spot where the next hole is to be. As this first shot split 8 feet beyond the hole, it is fair to conclude that the next one will do so also; the second hole should, therefore, be bored 16 feet away from the first, or 8 feet beyond the extremity of the first split, and it should be treated in just the same way as to the charge, unless very excessive shattering took place in the first explosion. Operations should be continued on this line until the whole log is handled. Of course, if a battery is

available, all the charges can be fired at once, with some saving in gelignite perhaps, but one needs some previous experience in splitting the logs of the district to derive the full benefits of electric log-splitting. A big saving in explosives can frequently be effected by working from the split of the previous shot, and again, what one log has done is no guarantee as to what another may do.

Dead Trees.

Dead trees are handled in the same manner as stumps (and without a battery) by working round the main roots, one at a time, shattering some right up against the butt, and others several feet away. The latter are handled by grubbing a hole on top of the root with the chisel bar and putting the charge right on the timber, tamping the soil down on it with the thick end of the mattock handle after the blade has been temporarily removed. Having shattered all the roots satisfactorily, the trunk can be handled in much the same way as the log was handled, by boring a hole about two-thirds through, but at an angle of about 45 degrees; a hole is easier, both to bore, charge, and tamp at an angle than horizontal. After splitting, a few days may be given to allow of the tree drying out before firing. Should the trunk be hollow, it is unnecessary to split it, as the fire will soon reach the inside when once the roots are shattered close up. With a greater realisation of the advantages of the chisel bar and a correspondingly greater use of it, together with the advantage the grub charge hole has over the auger or bulb-bar hole, much of the difficulty which at present attaches to the handling of big timber without a battery might be overcome, or at least looked at without prejudice. The "bulled" hole, handled as described above, is a further big advantage, both as to the explosives saved and the results obtained.

Comparative Costs.*

Taking gelignite at 2d. per plug, ordinary No. 6 detonators at 1d. each, and fuse at 1s. per coil of 24 feet, which would mean ½d. per foot, some idea can be given of what the cost should approximate in clearing land. It will be conceded that the conditions enumerated earlier are ever varying, and with them the skill of the operator, so that hard-and-fast accuracies as to costs are not so simple as one might believe. As a basis of comparison take a solid hardwood stump of 4 feet diameter, with 4 feet above ground, and five fairly solid hip roots, which it would take to hand-grub, say, about a day and a half, and cost 21s., with labour at about 14s. per day.

With the above prices, if handling it with gelignite, &c., 21s. would purchase twelve detonators and a coil of fuse, and leave 19s., which represents 114 plugs of gelignite. With them such a stump could be blown right out of sight, and instead of taking one and a half days, it would take, say, about one hour to prepare and fire.

As indicated earlier, the method now recommended consists of using only sufficient explosive to split the stump up so that it will burn easily, and working on these lines the total explosives required to split this stump (with its five hip roots) for burning would be thirteen plugs of gelignite, six No. 6 detonators, and 7 feet of fuse, and the total cost 2s. 11½d. In actual practice this cost may be even further reduced.

* The prices quoted on this and the following page are only approximate. The estimates of costs do not take into account the expenditure on plant, such as a galvanometer, firing cable and electric firing battery, that may be necessary.

Blowing out green timber is not advocated, but it may at times be advisable, and a typical case will be given as to costs, &c.

Two green box trees, with ample branch area, had to be removed. One was 3 ft. 6 in. diameter at the ground level, and under it three holes were put with a bulb bar, 4 feet deep and all "bulled." The bar was driven at an angle of about 45 degrees, starting about 18 inches from the trunk, so as to locate the charge in each of the three cases directly under the part of the tree most strongly held on that side; the three holes when "bulled," were probably all within a radius of 18 inches at the "bulled" level. Into one hole thirteen plugs were placed, whilst the other two had nine plugs each, the thirteen-plug hole being on the heavier side of tree. All these holes were tamped with paper wads, and were fired electrically, the tree being blown out and down at a cost of thirty-one plugs and three electric detonators at 3d. each, or, at present values, 5s. 11d. for explosives only; the time occupied would be about an hour.

The other tree was a "twinned" green box, some 4 feet 6 inches long by 3 feet wide at ground level, under which were placed three holes, two of which were "bulled"; the other hole was a tap-root one, and consequently could not be "bulled" in the timber. Into the tap-root hole ten plugs and into the "bulled" holes fifteen plugs each, were placed, making a total of forty plugs, with three electric detonators. In this case the tree was blown out and down at a cost of 7s. 5d. for explosives only. In both instances there was ample evidence of overcharging, the barrels being split up about 15 feet and the trees being blown several feet away from where they had been growing—a happening that is almost inseparable from blowing trees right out. It may be mentioned that for dead trees the operation would be similar in every detail, except that probably 25 per cent. less gelignite would be used.

Boulders and Floating Rocks.

These are frequently found on good farm land, and are a source of constant trouble, necessitating ploughing round them and often causing breakages to machines. With the aid of explosives they can be removed without the tedious work of drilling holes in them, by means of what is termed "plaster" charges. The number of plugs of gelignite in these plaster charges varies from, say, five to twenty, according to the size of the rock that is being handled. Very large rocks are better handled by drilling a hole in them, as only a fraction of the explosive is then necessary to break them up. In fixing these charges, one plug, with detonator and sufficient fuse attached, is placed on the rock surface, and the other plugs of the charge are placed all round and over it. The whole is kept in position by an inch thick covering of stiff plastic clay, well pressed down on to the stone round the edges. The plaster, in addition to keeping the charge in position, serves to exclude the air. Very little material is thrown about by this explosion, but the report is particularly sharp and severe as it is in the open air.

It is necessary to use a little thought in placing these charges, as the angle of fracture, which varies in different types of rock, plays an important part in the success or failure of the work.

When handling "floaters" partially embedded in the earth, it is better to clear the soil away from under them and particularly from directly below the spot where the charge is placed, so as to leave a hollow below, thereby increasing the shattering effect of the explosion.

It must be remembered that only a fraction of the gelignite used in these plaster charges would be needed if a hole was drilled in the rock, but it is not everybody that can successfully use a hammer and drill in rock, especially when that rock happens to be granite. The plaster charge is, therefore, suggested as avoiding the tedious work of drilling at the expense of a little extra gelignite.

Post-hole Sinking.

Although gelignite will render the ground soft and workable for the digging out of post-holes, it is questionable whether it is to be recommended as a general practice, as the subsequent firming and ramming is rendered very troublesome, and after a good fall of rain, posts so fixed are apt to be drawn crooked by the strain put on the wires, due to the loosening up of the ground for several feet around. Hard ground may be troublesome to work, but it is just this hardness that makes for permanent efficiency in fencing.

Storage of Explosives on the Farm.

Regulations as to the handling of explosives have been issued under the Explosives Act, 1905, and persons acting contrary to these render themselves liable to heavy penalties.

Any person is entitled to keep explosives, such as gelignite, &c., as well as detonators, up to a total weight of 25 lb. For any quantity in excess of this amount, a magazine is necessary. Care should, of course, be taken to store the detonators away from the gelignite.

Information concerning magazines and licenses for them may be obtained from the local police and from the Explosives Department, Sydney.

POISONING GREEN TIMBER WITH SODIUM ARSENITE.

A method that has been found useful for rapidly killing off the trees, and at the same time reducing suckering to a minimum, is poisoning with arsenite of soda, though it must not be supposed that this treatment will cause such a change that within a week or so the trees will burn readily. The usual drying-out must take place after the death of the tree before it can be burnt.

Arsenic—the ordinary white arsenious oxide of commerce—is not soluble in water to any great extent, so that soda, either the ordinary washing soda or caustic soda, has to be used to dissolve it. When large amounts of the solution are required, washing soda will be the cheaper, but for small quantities of solution, caustic soda will possibly be found the handiest.

When preparing the solution, whether caustic soda or washing soda is used, first dissolve the soda in a convenient amount of water, using heat, if desirable, to assist and hasten it; then slowly add the arsenic, which has been previously made into a thin paste (as the housewife treats her cornflour), stirring all the time; place on a strong fire, and after it has come to the boil, allow it to remain boiling for at least half an hour; stir from time to time,

and be careful to stand on the side away from the fumes, as they are poisonous and are apt to cause sickness. When the arsenic is thoroughly dissolved the solution may be made up to the required bulk by adding the remainder of the water, either hot or cold.

A useful formula for quick and effective work in all kinds of timber is:—Arsenic, 1 lb.; washing soda, 1 lb., or caustic soda, ½ lb.; water, 4 gallons. An empty kerosene tin makes a useful measure for dissolving in, as it holds 4 gallons.

The best time to carry out the work of poisoning is when the tree is passing into the dormant stage, that is, when the sap flow in the tree is ceasing. This period varies in different districts, but as a rule it commences about February. On parts of the North Coast ringbarking has been carried out to best advantage as late as June, and early July in certain years. The main object in catching the sap at this season is to prevent suckering. Trees can be killed by arsenic or ringbarking at practically any time of the year, but to prevent this suckering it is necessary to operate when the sap is just completing its downward course.

Having decided on the season and dissolved the poison, it is necessary to "frill" the trees. By "frilling" is meant a succession of downward axe cuts completely round the tree, each cut well overlapping the adjoining ones, so as to leave no unsevered section of bark up which the sap can flow. There is no doubt that "frilling" alone would kill timber if allowed time, but the poison does it in a fraction of the time; in fact, trees have been killed in a few days. The cuts must be through the bark and well into the wood proper, and as close down to the ground-level as is convenient to cut them consistent with the shape of the tree, say, from 6 to 10 inches up.

For trees of 4 feet in diameter, pour about a quart of solution into this frilling, right round the tree, using an old teapot or kettle, as the spout makes pouring easy, and less is wasted by spilling. Smaller trees naturally need less solution. Saplings may be cut off low down, and the solution dabbed on with a swab-stick to kill and prevent suckering.

It is very important that the frilling, and the application of the poison be consistently and thoroughly carried out, and not in any way scamped or slummed, if good results are to be looked for.

There need be no fear of stock being poisoned by eating the fallen or dead leaves from poisoned trees, for with the comparatively small quantity of solution used, the likelihood of leaves absorbing any free arsenic is very remote. Nor is there much danger from stock grazing on areas frilled and poisoned, though it is desirable to keep all stock off for three or four weeks, when all possible chance of danger will have disappeared.

No estimate of cost can be given, as this will necessarily depend upon so many factors which vary with each particular area. Although arsenite of soda is obtainable as such from drug merchants, its use when procured in

that form cannot be recommended for the poisoning of green timber, as it is most irregular in its arsenic content. Prices for arsenic, caustic soda, and washing soda are apt to alter frequently. It is therefore advised that when a considerable area is to be treated one or other of the wholesale chemists be written to and quotations obtained.

The Use of Chemicals to Encourage Burning.

Despite the rather frequent expression of views to the contrary, neither saltpetre nor any other chemical is of any value in assisting the burning of stumps. The best way to deal with a stump that burns badly is to build a good pile of logs and brush around it, fire in the ordinary way, and cover the burning material, when well alight, with clay. Such a fire will smoulder for some weeks, and will gradually destroy the stump.

Clearing Coastal Lands for Pasture.

In outlining on page 114 the purposes and methods of clearing, reference was made to those adopted in coastal districts, where the object is to enable grasses and clovers to be sown as early as possible, and cattle to be depastured thereon. To secure a good "burn" is then the concern of the settler, and usually it is obtained by felling the brushwood, ringbarking the larger timber, and firing some months later. The accompanying short articles indicate the methods more fully, but several of those described in the foregoing pages, especially explosives, are of use in either bringing the larger trees down or disposing of old stumps.

Clearing Brush Lands.

Commence operations during the month of March, when the risk of running fires has passed. First with brush-hooks carefully cut all the vines and undergrowth; then, if all softwood, fell everything. If there is hardwood through it, those up to 10 inches should be felled also, and the larger hardwoods ringbarked deeply, cutting right through the sapwood. In felling care should be taken to get the trees to fall as nearly as possible in the one direction. This gives a more even distribution of the fallen stuff and ensures a more rapid and effective burning. When the brush has been felled it should be left untouched for at least eighteen months. After that period it may be fired, but very great care should be taken in selecting the day to light it. Greatest success in burning is obtained, not on the hottest days or days when the wind is strong, but on a day on which the atmosphere is dry and a light breeze blowing. It should be lighted as quickly as possible all along the side from which the wind is blowing, and on the low land first if the wind is favourable. If the brush so dealt with is softwood, nothing will be left after the fire but a few charred stumps, and the land is ready for sowing as soon as the ashes have cooled.

When brush has been felled during the cold weather no growth is likely to show through it till the spring, but with rains and warm weather up come many shrubs, weeds, and vines of endless variety, the seeds of which appear to be stored in the brushes waiting for sunlight to germinate. The result is a rank growth, increasing as time goes on, and in parts hiding the felled timber. Several varieties of softwood brush throw out suckers, which by the second year will have grown to a height of 10 or 12 feet. To the inexperienced this gives an idea that there may be a difficulty in firing; as a matter of fact it rather aids the fire. The green growth is not amongst the decaying rubbish, but above it, and seems to hasten its decay. It acts as a protection against rain; frequently rubbish so covered is found to be perfectly dry after heavy showers. With the hot winds of summer, soft weeds and vines, which would resist much hot weather if close to the ground, quickly shrivel when dependent on spindly stems which have found their way through the rubbish by a long winding course, and burn readily with the dry material. If the fire is a success very few stumps sucker; weeds of various kinds come up, but most of these are edible. Parramatta grass is found to be a most troublesome weed, but it only lasts two or three years. If grass seed is sown immediately after the fire it will continue to grow even amongst the Parramatta grass. Black thistles may be expected to come up in abundance, but they are an advantage. If the burn has not been a clean one, or Parramatta grass is very thick, the thistles make a second and a clean burn a very simple matter. When the thistles begin to wither and the down is abundant one match thrown down on a hot day will start a running fire which will cover the whole area in a very short time.

The actual cost of clearing the average forest country on the coast districts is difficult to get at because it is done gradually; first ringbarked, then suckered and grubbed. This may require to be done annually for some years. Finally, say five years after being ringbarked, it may be burned off at a cost of 14s. to 20s. per acre. For grazing purposes only, many people do not burn the dead timber off forest country, and quite overlook the fact that brush country may be dealt with for grazing purposes in the same way. Brush timber requires to be more deeply ringbarked than forest trees, and some varieties take longer to die than forest trees; but after a brush is ringed and the undergrowth cut, stock find their way into it, and that they get abundance of food is proved by their condition.

Felling and Burning Scrub Lands.

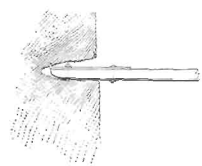
The burning of felled scrub is a very important operation. A good fire cleans up all but the large stumps and logs; a bad fire means endless and constant hard work afterwards. Usually the scrub is felled early the previous autumn. The undergrowth and young trees of 2 to 3 inches diameter are first cut down with a brush-hook. This is very important, for the "running" of the fire is materially influenced by the thoroughness with which this work is performed. Then comes the felling of the trees. Those of small diameters

are felled in the usual way, but the larger hardwoods have to be "rung." In districts where the larger timber is not so hard, but the trees have abnormally developed butts, it is necessary to use the "spring-board."

By means of this contrivance the tree is cut some distance from the ground, usually 8 to 12 feet, occasionally as high as 20 feet. A great deal of labour is thereby saved, as in addition to the smaller diameter, the wood is straighter and freer in the grain, which renders the cutting much easier. The spring-board is made of some light, tough wood, is about 4 feet 6 inches

Using the spring-board to fell a Carrabeen tree on the Dorrigo.
A belt of typical scrub forms the background.

long, and 6 to 8 inches wide. At one end an iron shoe with turned-up edge is securely bolted. This is necessary to "bite" into the recess cut in the side of the tree, and prevent slipping. At this end the board is about 2 inches thick, but it tapers to about 1¼ inches at the other end. Red cedar is prized amongst expert axemen for the purpose. It is tough and light, and with the imprints of nails from the boots, affords sure foothold for the men whilst at work. Where hardwood timber has to be employed, the "board" may be reduced to 1 inch in thickness as it is essential that the springboard be light as well as tough. It has to be lifted and placed in position, or lowered, with one hand, the other being engaged in holding on to the tree; and should the tree crack unexpectedly and commence to fall, the descent has to be made very quickly.



Showing how the spring-board is secured to the tree. The leverage on the outer end causes the edge of the shoe to "bite," so that it cannot slip.

Another form of platform is sometimes used in the form of a trestle, but the one described is more serviceable and universally used by expert axemen, and it may be adapted to any tree and at any height.

Drive Trees.

When possible, a "drive" tree should be used. A number of trees are cut half-way through, or a little more, and left standing. Then the drive tree, which is usually a large one, is felled so as to strike its partially-cut neighbour and snap it off. This one in turn strikes others, and if favoured with a suitable wind, trees covering from one to several acres in extent may be brought down at once. Occasionally trees "miss," and have to be gone over again.

Scrub-felling is dangerous work, and should never be undertaken by a man alone. A quick eye and keen ear are indispensable, and even with the best judgment, a tree may snap unexpectedly, or rebound off another. The tools must have keen edges, and be kept in good order by occasional use of the grindstones, and more frequent application of the small carborundum stone.

Burning.

The length of time required for drying before burning is governed by several factors, viz., elevation, season, size and thickness of timber, whether isolated or surrounded by other brush, the area felled in one block, and the date of felling. Some settlers prefer to allow the scrub to lie for eighteen months before firing, which means that the burn takes place the second summer after felling. The more general practice is, however, to fire during favourable weather the first summer after felling, the drying period thus ranging from seven to about ten months, which is ample for all the leaves, light branches and smaller trees to become sufficiently dry for burning. An additional twelve months means that the larger timber is dry and will burn more readily, but the leaves and light twigs and branches have been destroyed by the weather, and there is an additional undergrowth of suckers from the stumps and other green vegetation, which rather retards the free advance of a good fire. The leaves and small branches favour a good sweeping fire,

that cleans up all the small timber, and the heat so obtained kills the suckering growth of the green stumps, thereby ending this trouble for all time. With favourable, hot, dry weather, a large proportion of the larger trees will also be burnt.

The selection of a suitable day is very important. A hot, dry day with a breeze should be chosen. Westerly winds are drier than the sea breezes. If the scrub is felled early and is dry, such a favourable day may be obtained in October, November, December or January. After December, monsoonal rains usually set in, and the humidity of the atmosphere is not conducive to the best results. Usually December is the best month. If neighbours are

"A good burn." Portion of a block of 120 acres burned only a few weeks before.

also clearing, it will be found of great mutual benefit if they can all agree to fell and fire their respective areas as one block. In any case, it is advisable to give the necessary notice to neighbors. Do not light the scrub if a particular wind is likely to carry the flames beyond control and burn out a neighbour's homestead and grass.

Before the date of firing is decided upon, preparations should be made to ensure the fire starting quickly, by arranging a continuous line of readily combustible material, such as dead leaves, bushes, light twigs or other rubbish, all round the edges. If there is danger of the fire getting beyond control, its spread can be largely prevented by clearing a strip several yards wide all round. This is best performed with a garden rake or forked stick, the refuse being heaped along the line of scrub.

A breeze is essential to a good fire. It acts as a forced draught, and much timber is consumed which on a perfectly calm day might be barely charred. When it is decided to fire, plenty of help should be available to ensure that

the fire shall start, as it were, all at once. Dry bushes, torches saturated with kerosene, or even a plentiful supply of matches, are used to start the fire in numerous places on the running front, so that the wind may drive it forward as one unbroken sheet of flame. This is performed by lighting the edge of the scrub every few yards, and running on ahead to escape the heat. If it is desired to confine the fire strictly to the area felled, it should also be set alight beforehand on the leeward side, so that it will burn slowly against the wind and meet the windward flame some considerable distance from the edge. With a fair breeze, the fire travels very rapidly, and it is only a matter of a couple of hours before a whole block of 100 acres is burnt out.

Should the area to be fired be in close proximity to farm buildings, it is advisable to provide beforehand suitable fire-beaters and a few vessels of water. It frequently happens that the wind changes after the fire has been

A paddock of cocksfoot, rye grass, and white clover; twelve months after the scrub was fired and nine months from the time of planting seed

burning some time, and any precautions made along these lines need never be considered too much trouble. After the fire has burnt itself out, any timber which may not have been burnt, and which can be easily handled, should, in the course of a few days, be heaped up against large logs and set fire to. The land surface will thus be cleaned up and the sowing of grass seeds later facilitated. As most of the scrub timbers consist of softwood, logs that are not burnt can be left alone. In the course of a year or so they will readily rot, and a fire-stick applied on a hot, dry day will speedily get rid of them with a smouldering fire. In this connection it is advisable to exercise extreme care, for the weather that suits this operation also favours fire running through the somewhat dry grass of adjacent pastures.

FENCES AND FENCING.

The methods of fencing differ widely in different parts of the State, and a complete statement of the subject from the point of view of the New South Wales farmer would involve the treatment of the subject in relation to the district, the nature of the fencing required, and the material available locally or most easily obtainable. It is obvious that such a work would occupy much more space than can be afforded in this Handbook, and all that has been attempted in the following pages is to make suggestions which may be of assistance to the settler in determining what class of fence he should erect, to give the specifications for certain complete fences, and to describe one or two other less expensive fences that have proved suitable for special purposes and districts.

In the days when fencing timber was plentiful, posts were usually placed about 10 feet apart, and experience has shown that the most efficient fences are those with panels of about that width. However, the increasing scarcity of suitable timber, together with much higher labour costs, have in recent years compelled landholders to exercise greater economy in the use of posts, and the panels are now of much greater width; in extreme cases posts are as much as 1 chain apart.

In erecting a fence, however, efficiency must be taken into consideration as well as cost, and it is very bad economy to endeavour to save a little on the original cost by reducing the number of posts if the result means higher cost of maintenance or a fence that will not give the desired protection. Such serious loss may occur through weak fences that it is very desirable that the fences shall be strong. The loss consequent upon several valuable working horses breaking through a weak fence on to ripe wheat, for instance, may be much greater than the saving effected in the erection of the fence.

While, however, it has been found that the strongest wire fences are those with panels of from 10 to 12 feet, experience has also shown that fences strong enough to resist all reasonable strains can be erected with panels of much greater width, provided suitable droppers are used. The extra cost involved in erecting a fence with narrow panels where fencing timber is expensive or difficult to obtain is therefore not always justified. In general, if posts are comparatively cheap and plentiful panels can be made about 12 feet apart, but where posts are not easily obtainable the panels should be made wider, and droppers used instead. The limit to the width of panels is still a subject of controversy. Frequently they are made 22 or 33 feet in width, and in some cases even 1 chain. It is practically agreed, however, that 22 feet is a very suitable width, and unless posts are very expensive that is the panel which should be adopted.

When wide panels are used it is essential to use droppers, and it is the difficulty experienced in securing good droppers at reasonable prices which makes many landholders reluctant to erect fences with wide panels.

A number of different types of steel droppers have been placed on the market, but a perfect steel dropper has not yet been devised. Defects that are commonly found are lack of strength and ineffectiveness of the hold which the dropper has upon the wire, the result being that the dropper shifts and fails to serve its purpose.

The wooden dropper of about 2 inches by 1 inch hardwood is undoubtedly the most satisfactory. Its greater efficiency should lead to preference being given to it, provided the cost is not unduly greater than the steel dropper. Wooden droppers are used by the Railway Commissioners, and their fences are models of efficiency.

Timber for Posts.

While certain kinds of timbers are undoubtedly the best for fencing, choice is limited by the kinds available in the vicinity of the area to be fenced. As a rule, too, more than one kind is available. Moreover, in many districts timbers are available which are useless for fencing purposes, and care must therefore be exercised in making a selection. Careful local inquiry should be made in regard to this point. In Section 1 of this Handbook, "Farm Lands of New South Wales," details are given of the timbers suitable for fencing purposes that are available in the different districts.

The chief points to be considered are strength and resistance to decay and to the attacks of white ants, and also to fire. Size is also an important consideration, though this depends on the kind of timber used, and upon the age of the tree from which the posts are cut; as a rule small trees are sappy and decay quickly. The most desirable size for posts is about 3 inches by 4 inches; they are then strong and usually durable. Some kinds of trees, however—notably, the buddah of the western country—are extremely durable and strong, and posts of 4 inches to 5 inches diameter are quite satisfactory.

Struts.

A quite common defect in the construction of a wire fence is that of placing the strut too near the top of the post, and consequently at too great an angle with the line of fence; the result is that when the wires are strained the post is pulled out of the ground. In order to prevent this happening, various plans are tried, the least effectual of which is that of weighting the post, as shown in the illustration (Fig. 2). Placed as the strut is in the illustration it is practically doing no good, as can be seen.

Another and more effectual method adopted by some is to place two long struts, one on each side of the wires. This is unnecessarily cumbersome and costly, when the same result can be obtained by placing the end of the single strut lower down on the post, but not lower than half-way. The longer the strut the better it will do the work it is intended to do.

Wire.

In cattle districts strong wire is required, and No. 8 gauge should be used. In districts where sheep are kept a greater number of wires in the fence is required, and the usual practice is to use a heavy gauge (No. 8) for the two top wires, and a smaller gauge (principally No. 10) for those below. In recent years a strong galvanised steel wire, No. 12 gauge, has been placed on the market; it has given excellent results, and is economical. In inland districts, black No. 8 or No. 10 is generally used, but in coastal districts, where the air is humid, galvanised wire is most satisfactory, owing to its immunity from rust.

Wire-netting.

The rabbit pest has made wire-netting absolutely essential on most holdings in western districts, on the tableland, and on portions of the coast. Netting is classified according to the gauge of the wire, the width of the netting, and the size of the mesh. It is generally recognised by experienced landholders that to make a fence rabbit-proof, a galvanised netting, No. 17 gauge, 42 inches wide, and 1½ inch mesh, should be used. When placed in position, the height will be sufficient to stop rabbits, while a gauge of No. 17 insures long life to the wire. Tying-wire of No. 16 gauge is usually used to attach the netting to the supporting wire, which must be of No. 8 gauge.

Barbed Wire.

The use of barbed wire very largely increases the efficiency of any fence to which it is attached. Objections are sometimes raised to it on account of the injuries occasionally caused to stock, but these injuries are, in most cases, brought about by misuse. For boundary or ordinary subdivision fence it is very useful, and the likelihood of stock being injured is very remote, provided it is kept reasonably well strained. Barbed wire should never be used in yard fences, or in fences where horses congregate, such as near stables, as in the fighting or playing which goes on amongst them, there is great danger of the animals being badly torn.

Barbed wire is most dangerous when it is allowed to lie around loose, or is allowed to become very slack in the fences. It cannot be condemned, however, merely because a few people are careless in its use.

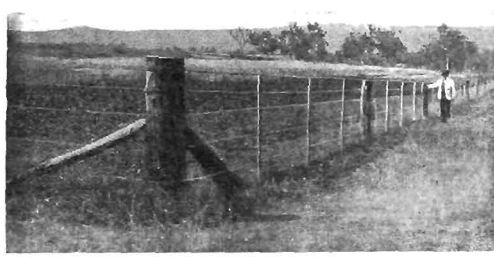


Fig. 1.—A wire-netted boundary or subdivision fence; two posts and six droppers per chain.

Insurance of Fencing.

Owing to the risk of destruction by fire to which fencing is subject, and the great expense incurred in securing new posts nowadays, all fencing in districts where fires are likely to occur should be covered by insurance. A number of firms are prepared to accept the risk at very reasonable rates. The insurance may be taken at per mile or at per post. The latter is most satisfactory, as payment is made on the posts actually destroyed, and therefore little dispute can arise in regard to the extent of the damage.

Specification for Wire Fence, Netted.

The following specification of an actual fencing contract is presented as likely to be useful. The details would, of course, vary in accordance with local conditions:—

All fencing is to be on and in proper line. The posts when erected are to be straight, uniform and upright. The split posts are to be in line along the tops, and are not to follow the lesser irregularities of the ground.

Timber.—White and yellow box may be used in the construction of the fence.

All timber is to be taken from large trees. It is to be thoroughly sound, free from splinters and other defects, barked and straight. All measurements specified are to be taken to mean at the smallest dimensions.

Posts.—All posts are to be sawn square on top, and when erected are to have the earth placed properly around them and well rammed.

The distance between posts will be 16 feet.

All posts are to be bored properly with §-inch auger holes, as required for the proper placing and spacing of the wires.

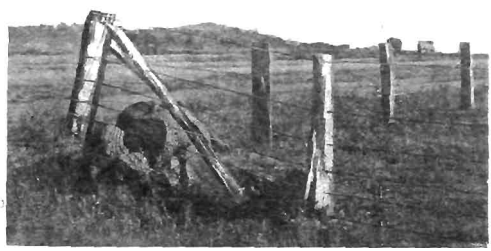


Fig. 2.—An improperly-stayed corner-post. Note the stones piled against the post in a vain endeavour to keep it in the ground.

Split posts are to be 6 feet 6 inches long, and to have mean dimensions which range between 7 inches wide by 5 inches thick, and 8 inches wide by 4 inches thick. Centres are to be backed out to within 24 inches of the large end. No face is to be less than 4 inches, and one edge is to be rough-dressed.

Split posts are to be placed in the ground to a depth of 24 inches.

Round posts.—Corner posts are to be 8 ft. 3 in. long, not less than 12 inches in diameter, and are to be placed 3 ft. 6 in. in the ground.

Straining posts are to be 7 ft. 9 in. long, not less than 10 inches in diameter, and are to be placed 3 feet in the ground. Straining posts are to be erected at distances of about 7½ chains throughout the fence.

Gate posts are to be 9 feet long, to be placed 4 feet in the ground in a direct line with the fence. They are to be not less than 12 inches in diameter.

The tops of gate-posts in each gateway are to be level.

Permanent struts are to be placed at all angles and corners of fences and at every second straining-post. They are to be firmly mortised into the posts 22 inches from the top, and are to be firmly butted against the adjoining post or against a short post placed in the ground to a depth of 2 feet, and situated at least 10 feet away from the bottom of the post which they are supporting. Struts are to be not less than 6 inches in diameter.

Gateways.—Four gateways are to be placed where directed. Gateways are to be 15 ft. 6 in.* from gate-post to gate-post; the fence posts nearest gateway are to be similar to corner posts.

Between the gate-posts a sill, 10 inches in diameter, and flattened to 6 inches at the small end, is to be firmly bedded. The flat face is to be level, and on a level with the ground on the high side of the gateway.

Droppers.—Between the posts, one, two, or three droppers, as required, are to be placed equidistant from the posts and from each other.

The *wooden* droppers, 2 in. x 1 in. hardwood, are to be secured to the plain wires with staples, which pass over the wire through a hole in the dropper, and are then clinched on the opposite side of the dropper; they are to be tied to the top wire with No. 12 galvanised tying wire, which is to pass through a hole in the batten about 1¼ inches from the top of it.

The *metal* droppers, if used, are to be properly secured to the wires according to their kind.

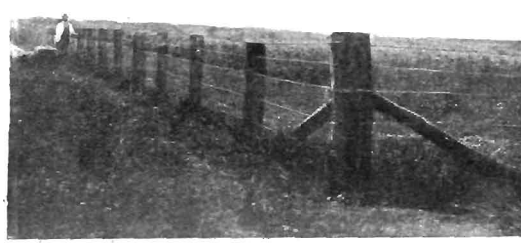


Fig. 3.—A corner-post properly strutted. A wire-netted boundary or subdivision fence; eight posts per chain.

Wires.—The fence is to contain four wires, including one galvanised barbed wire No. 12 B.W.G., which is to be placed 43 inches from the ground.

The other wires are to be three No. 8 wires, with the following spacings *from the ground*:—18 inches, 36 inches, and 51 inches.

All wires are to be thoroughly strained and secured in position.

Netting.—A selected brand of netting, 17 gauge, 42 inches wide x 1¾ inches mesh, is to be erected, so as to have the straight selvedge at the top. The netting is to be properly strained in an approved manner. A

* *As most farmers use headers and other machinery of great width, a very wide gateway is required where the paddocks are under cultivation.*

portion of the netting is to be placed, without bending, underground (in a suitable trench, previously dug the required depth, i.e., 6 inches), so that the netting can be securely fastened to, and in line with, the second wire from the ground.

The netting is to be secured to the top and bottom wires with galvanised tie wire; to the top wire with 24 ties, and to the bottom wire with 16 ties to the chain (No. 16 gauge).

The barbed wire to be placed just above the wire to which the netting is attached; that is 43 inches from the ground.

All work to be finished in a workmanlike manner, and to the satisfaction of the officer in charge of the work.

Rail Fences.

Whilst it has been superseded by the wire fence for boundaries and general subdivision work, yet for some purposes, such as yards, approaches to gates, bridges &c., the rail fence, or the stub or sapling fence, is still

Fig. 4.—Three-rail fence; eight panels per chain.

Fig. 5.—A two-rail fence with two wires.

required. Such fences are more easily seen than wire fences, and their appearance indicates that they are a more effective barrier than even barbed wire. Some details regarding them and their construction are therefore likely to be of interest.

Three-rail fence (Fig. 4).—It is quite unusual now for a new fence of this type to be erected. The two-rail fence, with one or two wires underneath the bottom rail and between the rails, is effectually taking its place.

The two-rail fence (Fig. 5) is largely used as indicated in the illustration —that is, for enclosing tanks, also for the yards about the homestead, stable or dairy, and for other similar purposes.

Fig. 6.—Top-rail and wire fence; eight posts per chain.

The single-rail fence (Fig. 6), with three, four, or five wires beneath the rail, is very suitable, and is popular in some districts for enclosing town and suburban allotments. With the increasing scarcity of timber, it is now being used in many situations and for purposes for which, formerly, only a two or three rail fence would have been considered suitable.

With or without wires, it is a suitable fence on hillside roads, to act as a barrier at dangerous places, to prevent travellers leaving the road.

The construction of the three kinds of rail fence is very similar. The following specification, which is suitable for many localities, will serve as a basis for those who contemplate erecting fences of this description:—

Specification for Rail Fences.

All fencing is to be on and in the proper line. The posts when erected are to be straight, uniform, upright, and in line along the tops; they are not to follow the lesser irregularities of the ground.

Timber.—White and yellow box or other approved timber may be used in the construction of the fence.

All timber is to be taken from large trees. It is to be thoroughly sound, free from splinters and other defects, barked and straight. All measurements specified to mean at the smallest dimensions.

Posts.—All posts are to be sawn square on the top, and when erected are to have the earth placed properly around them and well rammed. The distance *between* posts is to be 8 ft. 3 in. from centre to centre.

Split posts are to be 6 feet 6 inches long, and to be 9 inches wide and 3½ inches thick. They are to be placed 24 inches in the ground, and are to be mortised as per gauge herewith with holes 6 in. x 3 in.

Round posts for corners and ends are to be 7 feet long, and not less than 12 inches in diameter; they are to be placed 2 ft. 6 in. in the ground, and are to be mortised as per gauge herewith. The mortises are to be 6 inches long, 3 inches wide, and 6 inches deep.

Rails.—The rails are to be 9 feet long, 8 inches wide, and 3 inches thick. The tenons on ends of rails are to be 6 inches long, adzed carefully to *fit into the mortises; they are to be shouldered and finished so as to* fill the mortise and to butt up to the posts.

Gauge for Mortising.—The posts will be mortised as follows, the measurements being taken from top of post to top of mortise:—

	Three-rail fence.	Two-rail fence.	Single-rail fence.
1st mortise ..	6 in.	6 in.	6 in.
2nd „ ..	21 in.	28 in.	..
3rd „ ..	36 in.	..	..

The Homestead Fence.

The homestead fence (Fig. 7) is a neat ornamental type of fence which appears very suitable for enclosing the garden or front portion of the farm-house. The *fence illustrated is built of sawn timber, but where this is* difficult to procure, and where straight saplings are plentiful, a very similar

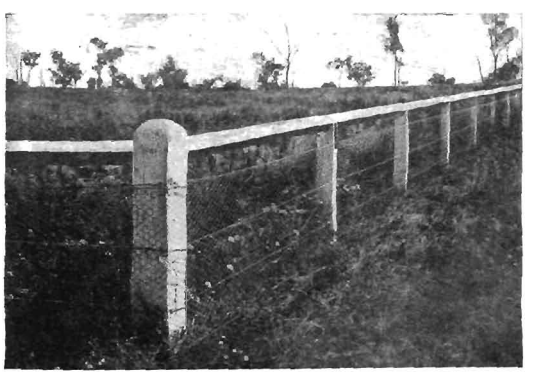


Fig. 7.—A homestead fence. The wires do not run through, but are tied on the outside edge of the posts.

fence can be built with round posts and straight saplings for rails. A fence of this description, when painted white, adds considerably to the attractiveness of the home.

The particulars of the construction of the fence illustrated are as follows:—The posts are hardwood (ironbark), 5 ft. 6 in. long, 6 inches wide and 4 inches thick, placed 2 feet in the ground and set 9 feet apart. The rails are hardwood, 4 in. x 4 in., laid edge upwards in notches cut in the tops of the ordinary posts and mortised into the end and corner posts.

The rails are secured to the ordinary posts with hoop-iron No. 10 gauge straps, 2 feet long by 2 inches wide, bolted to the posts with two 7 in. x ½ in. bolts.

Six inches beneath the rail, rabbit-proof netting is attached by clips to three plain galvanised wires, which are secured to the outside edge of the posts by tying wire, which passes through a hole 2 inches from the edge of the post. With this plan of fixing the plain wires, the netting can be strained as tight and as flat as a board, and when secured presents, as may be seen from the illustration, a neat, even, flat surface.

Sheep and Pig Proof Fences.

A useful subdivision fence where pigs or crossbred sheep are kept is constructed as follows:—Posts, three to the chain, 22 inches in the ground and 4 feet 2 inches out; bored on the edge for five wires, which are attached to the side of the posts by tie wires that pass through the holes in the post. To the three bottom wires is attached 2 feet 6 inches netting, 4-inch mesh, gauge 15 or stouter. One wire is attached to the posts along the ground, one about the middle of the netting, and one at the top. Two galvanised barbed wires are spaced between the top of the netting and the top of the post, and two to three droppers are used between the posts. A steel fencing wire, No. 8 gauge, is preferable for the top of the netting, and No. 10 wire for the middle of the netting. The netting is attached to the wire by No. 14 tie wire, and the wire to the posts by No. 12 tie wire.

Sheep and Cattle Proof Fences.

A very effective sheep and cattle proof wire fence can be erected with posts 22 feet apart, using two droppers between the posts, or, if it is desired to still further reduce the number of posts, with panels of 33 feet, using three droppers in the panel. It is essential, however, that the droppers shall be strong, and, therefore, wooden droppers, if procurable at a reasonable price, should be used. The fence posts should be placed 2 feet in the ground and 3 feet 10 inches out. The straining posts should be 3 feet in the ground and well strutted. The wire should be spaced as follows, measured from the ground:—6 inches, 12 inches, 18 inches, 25 inches, 34 inches, and 46 inches.

Sometimes the barbed wire is placed on the top of the posts, but where cattle are to be controlled greater efficiency is obtained by making it the fifth wire, as cattle as a rule feed through and not over a fence. If only horses are to be controlled, the barbed wire can be placed at the top, as horses generally reach over a fence to feed.

The barbed wire is frequently attached to the outside of the posts, and held in position by a No. 12 tie wire, run through a hole bored in the fence. This method is very effective in protecting a crop which adjoins a grazing

paddock, but it is not so effective if stock are run at times on either side of the fence; in the latter case the barbed wire should be run through 1¼ inches auger-holes, bored in the centre of the post

The three lower wires may be No. 10 gauge, the two upper No. 8, and the barbed wire No. 12 gauge.

Specification for Wire Fence for Cattle.

All fencing is to be on and in proper line. The posts when erected are to be straight, uniform, and upright. The split posts are to be in line along the tops, and are not to follow the lesser irregularities of the ground.

Timber.—.....* may be used in the construction of the fence.

All timber is to be taken from large trees. It is to be thoroughly sound, free from splinters and other defects, barked, and straight. All measurements specified are to be taken to mean at the smallest dimensions.

Posts.—All posts are to be sawn square on top, and when erected are to have the earth placed properly around them and well rammed.

The distance between posts will be 10 feet.

All posts are to be bored properly with ⅝-inch auger holes, as required for the proper placing and spacing of the wires.

Split posts are to be used and to be 6 feet 6 inches long, and to have mean dimensions, which range between 7 inches wide and 5 inches thick, and 8 inches wide by 4 inches thick.

Centres to be backed out to within 24 inches of large end.

Split posts are to be placed in the ground to a depth of 24 inches.

Corner posts are to be round, 8 feet 3 inches long, not less than 10 inches in diameter, and are to be placed 3 feet in the ground. Straining posts are to be erected at distances of about 7½ chains throughout the fence. They are to be round, 7 feet 6 inches long, and placed 3 feet in the ground.

Gate posts are to be round, 9 feet long, to be placed 4 feet in the ground in a direct line with the fence. They are to be not less than 12 inches in diameter.

The tops of gate-posts in each gateway are to be level.

Permanent struts are to be placed at all angles and corners of fences and at every second straining post. They are to be firmly mortised into the posts 22 inches from the top, and to be firmly butted against the adjoining post or against a short post placed in the ground to a depth of 2 feet, and situated at least 10 feet away from the bottom of the post which they are supporting. Struts are to be not less than 6 inches in diameter.

Gateways.—..... .....† gateways are to be placed where directed. Gateways are to be 12 feet from gate-post to gate-post; the fence posts nearest gateway are to be similar to corner posts.

Between the gate-posts a sill, 10 inches in diameter, and flattened to 6 inches at the small end, is to be firmly bedded. The flat face is to be level, and on a level with the ground on the high side of the gateway.

Wires.—The fence is to contain four No. 8 wires.

All wires are to be thoroughly strained and secured in position.

The following are to be the spacings, measured from the ground upwards, 18 inches, 28 inches, 39 inches, 51 inches.

Time.—The erection of the fence shall be duly completed within.....‡ months from date of signing contract.

* State kind of timber according to kinds desired. † State number of gateways.
‡ State number of months.

HINTS ON WIRE FENCE CONSTRUCTION.

The quantities of materials required for the construction of the more common types of wire fence are given in tabular form in Section XV, "Farm Measurements," of this Handbook.

Digging the Post Holes.

In putting up a wire fence only—supposing the timber is already laid on the ground—the first thing to do is to dig the post holes, and there are, even in connection with such an apparently simple operation as that, a few things worth remembering.

The holes should be from 22 inches to 24 inches in depth. They should *not be made too big, as this involves unnecessary labour both in digging,* filling, and ramming; besides, the post will not have such a firm grip in the ground. They should be a little more than large enough to receive *the posts comfortably, and leave room for the rammer to work to the bottom* of the hole. Dig the full depth straight away; if a little too deep it is easy to put in some loose earth to make post the required height. Sight the posts from the centre, and fill in and ram the bottom—say, the first

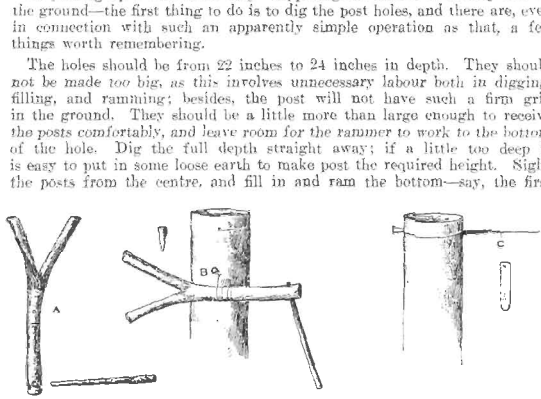


Fig. 9.—Forked Wire-strainer, Wire-key, and Plug.

6 inches—thoroughly. The bottom, and near it, is the place where ramming is most required; as the top is approached less ramming will do. Place earth that remains neatly around the post to allow for subsidence.

The tools required for post-hole sinking are a medium-size iron bar with *rammer head and chisel point, and a long-handled shovel. This latter tool* should have a round nose and be bent inwards at the sides, so as to form a kind of scoop. Small post-holes cannot be dug with wide shovels.

Sink post-holes, if possible, when the ground is in good condition—not too wet and not too dry. Ground saturated with moisture cannot be well rammed.

When boring, use ⅝-inch auger, if No. 8 wire is to be used. Bore *straight and right through, so as to push out anything that may impede* easy threading of the wire.

Unwinding the Wire.

An easy and simple way of running or threading wire through split posts is to place the coil on a reel made on the capstan principle; this allows the wire to run off freely, and prevents it getting entangled, &c. The wire is

then pulled through the holes from one strainer post to the next, and strained up tight. It can, however, be fastened anywhere between the posts with a patent strainer, which can also be made to work at a post. Another way is to bore right through the strainer posts and pull up either with rollers or forks.

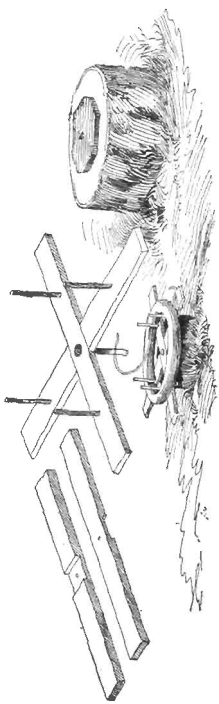


Fig. 10.—Reel for carrying and unwinding wire.

Strainer posts are the mainstay of a wire fence, and should be of the best timber procurable, with a diameter of not less than 12 inches. Those used at angles should be mortised to receive stays or struts. The strainers should be let into the ground at least 3 feet and be very thoroughly rammed. All posts should have the bark taken off before being put into the ground.

A Useful Barbed-wire Winder.

The accompanying sketch of a barbed-wire winder (Fig. 11) has been supplied by Mr. A. B. Paddison, Perthville. Most farmers have, at some time or other, to face the necessity of detaching barbed-wire from an old fence, and storing it for future use. Under ordinary conditions, the result is a cumbersome, loosely wound mass of wire, difficult to handle, and still more difficult to put to profitable use later.

Mr. Paddison uses a piece of ½-inch piping, about 6 feet long, and costing about 3s. This makes a first-class light windlass by heating and bending to the shape shown in the illustration. It is operated by two men, and the man operating the crank carries only about a third of the weight, and has the other hand free to turn the crank.

By means of such a device wire can be wound almost as tightly as the factory turns it out, and as fast as the men can walk.

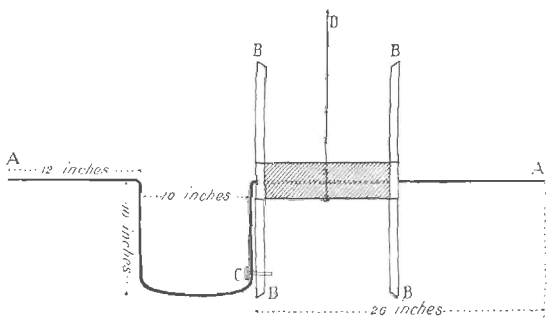


Fig. 11.

A. Piece of ½-inch water-piping, 6 feet long before bending, and about 4 feet long after the crank is made.
B. Empty barbed-wire reel slipped on to pipe.
C. Strong cord fastening reel to the crank in pipe to prevent the reel turning.
D. Barbed-wire to be wound up, fastened to reel with small staple.
When the reel is filled, cut the cord, take off and slip on another empty reel.

Gates and Gateways.

No fence is complete without an entrance, and therefore without a gate, for slip-rails at the best are only makeshifts, and are a source of loss both of time and temper. It is surprising that slip-rails are as common as they are, for excellent and serviceable light gates can now be purchased very cheaply, and even where the lack of cash is an obstacle to this being done, a handy man can, with the aid of an auger and a tomahawk, build and hang a strong useful bush gate, with no other outlay than the expenditure of a few hours' labour, and certainly in less time than is required for continual putting down and up of the slip-rails.

There are some who prefer something a little neater than the bush gate, but who wish the outlay to be as small as possible; for such, the batten-gate is admirably suited. The cost of the material required is not great, the gate is easily and quickly constructed, and if by accident it is injured, it is easily repaired.

It is the more common practice to make these gates of hardwood; but an objection to hardwood is its heaviness—for a heavy gate is generally the principal cause of its own inefficiency and final destruction. For this reason the gates at Cowra Farm (which are similar to those illustrated in Figs. 12 and 13) have been made of Oregon pine, which is light. It may be thought that Oregon pine is not strong enough for the purpose; but that supposition is not borne out by actual results.

The pair of gates illustrated in Fig. 12 are 16 feet wide. As reaper-threshers are now largely used, wider gates are required, and wheat paddocks should be provided with 20-feet gates. It will be noticed that the bottom batten is put down to within an inch of the sill. This is in readiness to carry the netting when the paddock is made rabbit-proof.

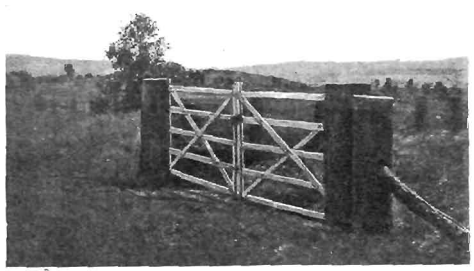


Fig. 12.—Gateway and round untrimmed posts.

For openings up to 12 feet wide, a single gate, if made of light wood, may be made to do. The cost will be less, and a single gate is certainly more convenient than a double one.

The pair of gates, as illustrated, can be made ready for hanging in half a day. The materials required are—

160 feet run. = 40 super. feet, 3 in. x 1 in. Oregon dressed all round.
3 lb. bolts, 3½ in. x ⅝ in., 3 in. x ⅝ in., 2½ in. x ⅝ in.; washers, nails.
Two pairs hook-and-eye hinges, 2 ft. x 2 in. x $\frac{1}{16}$ in.

The gates cannot be said to be finished until they have been painted, and the soundness of painting as an investment cannot be gainsaid. It will be better, and a saving of time, if the timber, after being cut up for the gates, is given a couple of coats before being put together. The gate, after it is completed and hung, can be given a final coat. The first, or priming coat, should be very thin, in fact may be nearly all raw linseed oil. The second and last coats will, of course, be a little thicker, and in order to dry hard, and with a

little gloss, should contain a small quantity of turpentine and boiled oil. *With regard to colours, tastes differ, but judging by results,* white, in this climate, seems to give the most satisfaction, and a first-class quality of white paint is a mixture of white lead and oil. Painting the ironwork (hinges) black will make a slight contrast, and will rather add to the appearance of the gateway.

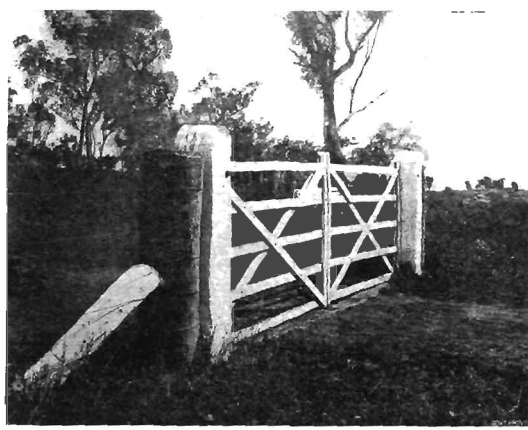


Fig. 13.—A gateway with squared and trimmed posts.

The gate-posts should be quite separate and distinct from posts used in the construction of the fence. A better effect is obtained without additional trouble if they are slightly higher than the uprights in the gate, and also higher than the fence-posts adjoining the gateway. The main entrance to the farm, and also the gateways around the dwelling, *may* be still further improved if a little additional trouble be taken to square the gate-posts and round off the tops. The amount of improvement effected by this may be judged from a comparison of the illustrations (Figs. 12 and 13). The four posts in the gateways shown were practically identical as they left the bush. The cost of trimming is not very great.

SQUARING A GATE-POST.

For a gate-post, a bushman likes to have a perfectly sound log. He is not *always able to secure this, and often has to be content with one containing a* small hollow or "pipe," which may be plugged up when the squaring is completed.

A log with a straight free-running grain is the more easily worked, but one *with a curly grain is the more durable*

A suitable tree having been chosen and felled, and the necessary logs having been cut off, the first operation consists of removing the bark; the sooner this and the subsequent operations are done after felling, the easier they will be.

The tools necessary for squaring a log are—an American axe, a squaring or road axe, a level with a plumbing bulb, a rule or measure, a pencil, a line or string, and some chalk or other material for coating the string so that it will make a mark on the log.

For the sake of stability, as large a butt as is possible is left on the gate-post; only that portion, therefore, which is to stand above the ground is squared. The length of this portion is measured off, and the log fixed so that it will remain steady while the ends are marked, and at the same time in such a position that the most can be made of the timber it contains. The ease and readiness with which this is done depends entirely upon the skill and judgment—largely the result of practice and experience—of the axeman.

Fig. 14.—The log barked ready for squaring.

The squares or rectangles are now marked on the ends with the aid of the level and rule. The first line (a vertical one) is obtained by drawing a pencil *along the face of the level when it is held "plumb" and as close to the edge* as it is deemed advisable to go. The line at right angles to this is obtained by drawing a line along the top of the same instrument when it is held level. The other lines, necessary to complete the rectangle, are then obtained without difficulty by measurements. Another way of marking the first line on both ends is with the aid of a plumb-line. The other lines are then marked off it with the aid of a blacksmith's or other square and a measure.

It is very necessary that some method be adopted to prevent a "wind" or twist in the squared log. Marking the first line on each end with the plumb-line or level is an easy and satisfactory way of preventing this; but, in the absence of either a plumb-line or a level, the "wind" may be prevented by marking the first line on each end with the aid of two laths, or light battens, used in the following manner. A lath, or batten, is tacked to one end of the log in either a vertical, or a horizontal position, the other lath is then held on the opposite end of the log, so that the edges of both laths "line," or correspond with each other, when sighted across. The longer the laths the more accurate is the work likely to be.

The ends having been marked, it is necessary to connect these marks with lines which will show the axeman how deep to chop. These lines are marked or "struck" in a similar manner to that adopted by a carpenter for marking a chalk line on a board. A carpenter's line, a piece of fishing-line, or failing these, a piece of string or sewing-twine, is used. Instead of coating the string with dry chalk as the carpenter does, it is found better, for the work in hand, to use a black or a white liquid. Black is to be preferred, as it makes a better mark than white on the log. A suitable liquid is made by mixing charcoal, soot, or burnt straw with water. To make a white mark, lime-wash or whiting and water is used

A knot is tied in one end of the string, which is then wound crossways on the thumb and little finger of the left-hand; it is then placed in the black or white mixture until saturated, when it is taken out, the knotted end is taken hold of, and the wound-up portion thrown out with a smart

Fig. 15.—Marking the ends.

jerk; it should fall out quite clear and free from tangles. The knotted end is now placed in an axe-nick previously made on the end of the log and in a line with one of the vertical marks on one end of the log; the other end of the line is taken and held at the point where a continuation of the corresponding vertical line on the other end would meet the uppermost surface of the log. With one hand the line is pulled tight and held firmly at this place, whilst it is seized towards the middle with the other hand and stretched upwards, held for an instant, and then released. It strikes the log with a smart smack and leaves a straight but somewhat bespattered mark connecting the uppermost end of the two vertical lines on opposite ends of the log. Another line is now "struck" on the other edge of the log. The log is then rolled over and corresponding lines "struck" on both edges of the other side of the log (Fig. 16).

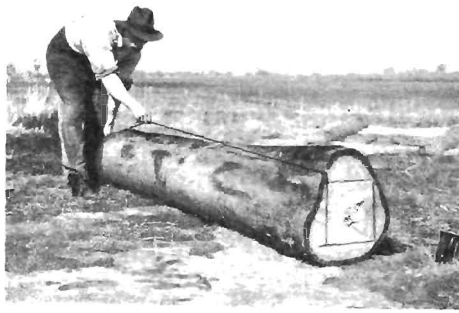


Fig. 16.—"Striking."

Fig. 17.—*Chopping to the Line.*

Fig. 18.—Splitting to the line.

Fig. 19.—Squaring the edges.

Fig. 20.—Striking after the first two edges have been squared.

Cuts, or kerfs, at intervals of 9 to 12 inches, are now chopped with a common axe, almost to the lines "struck." The intervening blocks are then split off with the same axe, after which the edges are finally trimmed with the squaring axe (Figs. 17, 18 and 19).

The partially-squared log is now rolled over until the remaining marks on the ends are in a vertical position; lines connecting these marks are "struck"

Fig. 21.—Finished.

and the edges squared as the others were squared. The top is then rounded off with axe and adze. This completes the squaring, the post is finished, and is ready for setting in the ground.

CONCRETE FENCE POSTS.

Concrete fence posts are easily and quickly made. Their initial cost is greater than that of wood posts, but they have a decided advantage in that they are practically everlasting. Where long lines of fences have to be run their weight is certainly a disadvantage.

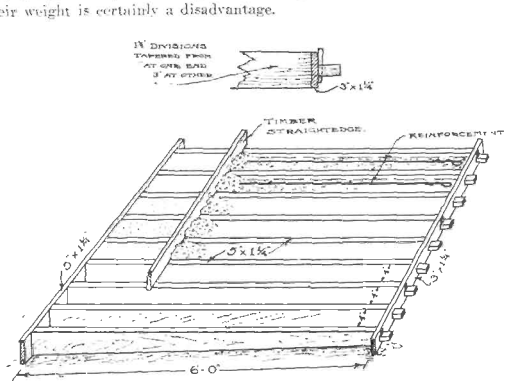


Fig. 22.—Sketch of Moulds for Concrete Posts.

A detailed statement on the mixing of concrete is given later in this section, commencing on page 192, and should read in conjunction with the present matter.

A mould suitable for making posts for a sheep fence is shown in Fig. 22. Five such moulds, each containing eight compartments, would be required to hold a yard of concrete, but moulds with any number of compartments may be used.

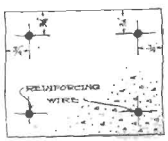


Fig. 23.—Cross Section of Concrete Post.

The posts cast in this mould will be 6 feet long, 5 x 4 inches at the base, and 4 x 3 inches at the top. It is essential that each be reinforced, and four No. 6 gauge wires may be used. Theoretically 1 cubic yard of concrete will make forty such posts, but in actual practice thirty-eight or thirty-nine are more likely to be made, according to the class of aggregate used.

The concrete for the posts should be gauged one part cement, three parts sand, and five parts metal, broken to ¾-inch gauge, and, as will be seen from the table given on page 196, the quantities of material required for 1 cubic yard of concrete of this mix are 4.52 cubic feet of cement, 13.77 cubic feet of sand and 22.95 cubic feet of metal, while for the reinforcement, 1 cwt. of No. 6 wire will be required. The cost of these materials in Sydney is approximately £3 10s., so that the cost per post, materials only, and exclusive of the cost of the moulds, reckoned at *forty posts per yard*, would be 1s. 9d. each.

The dimensions of the gauge boxes for measuring the materials will depend on the size of the batch it is proposed to mix. Assuming that a half-yard batch would be the most convenient for farmers, the box for the metal should be 4 feet x 3 feet x 1 foot deep, and for the sand 3 feet x 2 feet 3 inches x 1 foot deep, internal dimensions. A box will not be necessary for the cement; the above quantities call for 2½ bags. A half-yard batch will fill two moulds of the dimensions shown, and half of a third.

A clean and level site should be selected, and the forms thoroughly coated with oil—creosote oil is cheap and suitable for the purpose.

The method of placing the concrete and reinforcement is as follows:—Place a bed of concrete ¾-inch thick in each compartment. On top of this lay two reinforcing wires, placed ¾-inch from each partition, fill on top of this with concrete to within ¾-inch of the top, place two more wires as before, and fill to the top. (See Fig. 23.) It is essential that the concrete be well packed, but in a manner that will not damage the mould. When the mould is filled, take a timber straight-edge and scrape off the surplus material. It will usually be found necessary to add small quantities of fine stuff here and there to get an even surface. Now take short lengths of ¾-inch diameter steel, and drive them through the wet concrete to form holes for the fencing wire, but take care to withdraw them before the concrete grips them too hard.

After casting, the concrete must be left to harden, but the moulds must be drawn a few hours after the concrete has been poured, otherwise they will be difficult to get apart. It is essential that the moulds when drawn shall leave the concrete freely—without pieces adhering to the sides—and this is facilitated by the coating with oil before filling with concrete. The forms should be given a thorough scraping and oiling each time they are to be filled.

For the best results the posts must be protected from the sun or hot drying winds for about three days by means of wet bags. If frosts are likely, these bags must be replaced at night with dry ones.

The gate posts, straining-posts, and struts are made in a similar way to the ordinary posts in moulds of the proper sizes, stronger reinforcing rods of ¾-inch round iron being used. The hooks for the hinges should be bolted through the gate posts; they may be set in position when casting the post, or holes may be made through which the hooks may be fixed later. The tops of the gate posts may be rounded by placing a block of wood the required shape at the head of the mould.

The straining-posts should be made 7 feet 9 inches long, with a cross section of 8 inches x 6 inches. At 1 foot 10 inches from the top, a slight rectangular recess is moulded obliquely in the centre of one of the narrower

sides for the reception of the end of the stay or strut. The straining-posts are placed 3 feet in the ground. The stays or struts are 9 feet long, with a cross section of 4 inches x 3 inches.

The wires are fixed to the posts, as shown in Fig. 24, by tying wire which passes through the holes in the post. Where only plain wires are used on a

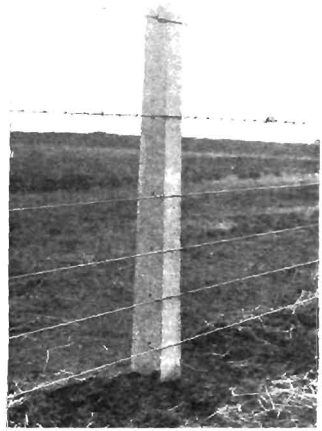


Fig. 24.—A Concrete Fencing Post in Position.
Showing wires fixed by tying-wire to the face of the post.

fence, they can, if desired, be run through the holes in the post, but because of the ease with which a broken wooden or concrete post can be replaced, and because a much neater and better job can be made when affixing netting, the method of affixing wires by means of the tie-wires to the face of the post is preferable.

Essentials to Success.

Work cleanly.

Have proper boxes for gauging the material.

Have a good clean site, preferably a wood or concrete floor, on which to mix the concrete.

Mix the materials thoroughly by turning them over twice in a dry state, then twice whilst adding the water.

Add the water gradually, and through a sprinkler if possible.

Neither an insufficiency nor an excess of water is desirable. The concrete should not be so dry as to require tamping, as when of the correct consistency it may be consolidated easily with a small spade.

Pack the concrete with the purpose of making it solid, and also to obtain clean surfaces.

Make the moulds substantial, so that they will not yield under pressure of packing.

Thoroughly clean all moulds before filling.

Place the concrete in position immediately it is mixed.

Protect concrete from drying too rapidly and also from frosts.

Do not attempt to handle cast concrete while it is "green," but rather wait until it is quite certain that it is hard enough for the purpose.

THE PRACTICAL USE OF TIMBERS.

Although the following notes refer more particularly to western timbers, the principles enunciated apply nevertheless equally to timbers from other districts.

All trees that provide us with timber are outward growing trees—that is to say, they increase in girth by developing successive layers round the trunk next to the bark. Each year generally adds one of the layers or rings, and consequently they are called "annual rings." In addition to the annual rings, trees have medullary rays, which are thin and generally broken lines, radiating from the centre, or pith, to the bark, and *vice versâ*. These rays are not very apparent in some trees, but in dry cypress pine they are easily seen. Cabinetmakers call these rays the "silver grain."

The trunks and branches of trees consist of two kinds of wood—the hard, dead heartwood, or duramen, and the soft sapwood, or alburnum. The latter is much lighter in colour than the former. The bark consists of an outer and inner layer. Heartwood is much stronger and more durable than sapwood, and the outer portion of the heartwood is stronger than that near the centre, or pith, more particularly if the wood is "pipy," because then it has been subjected to decay and is very brittle. Old wood is stronger, though lighter, than young wood. The strength of timber is influenced by the quality of soil on which it grows. Evenness of grain in the annual rings denotes strong wood.

By strength of wood is meant the resistance it offers to force acting at right angles to its grain. This is called "transverse strength." It must be patent to all that where the strongest parts of timber are preserved the structure built will have a much longer life than where the weaker tissues are made to stand the strain.

Cypress pine is very fissile, but will stand very little transverse strain; and when using it, workers should aim at conserving the strength in every possible way. Anyone familiar with pine used in stockyards knows that the rails most frequently break at or near the middle, and at the tenon which fits the mortise of the post. When pine saplings are used as rails the posts should be close together to lessen the strain when stock bump against

Fig. 25

the rails. *Little or nothing but the bark should be removed from young* pine in making a tenon, because the young wood is much weaker than that from mature trees, and by removing the harder heartwood of an already weak timber the strength and durability are very materially lessened.

Rails for Stockyards.

In Fig. 25 the stockyards are made of split pine. To the casual observer they appear to be very substantial and as strong as that timber will allow. Both the posts and rails are from mature and fairly sound trees. For Fig. 26 *the photograph was taken much closer to the posts and rails than* Fig. 25, and from inside the yard.

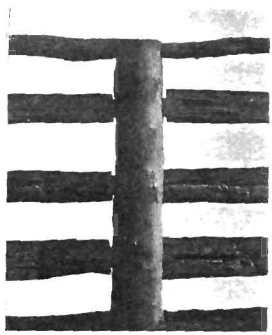


Fig. 26.

The reader will observe that about half the rail has been cut away and a very small tenon left to fit the mortise of a very substantial post. A chain is no stronger than its weakest link, and so here the strength of this fence depends on the strength of the tenon. Furthermore, even the tenon has been weakened by adzing wood from the convex outer hardwood, instead of from the inner wood towards the vicinity of the pith. Obviously, to make the yards as strong as possible with this class of timber, much larger mortises should have been made in the posts, and there should have been no adzing from the rails.

Fig. 27 is a picture of yards made of hardwood, which at first sight appear very substantial, but while they are strong enough to hold sheep, goats, or quiet milch cows, they frequently fail to stem the rush of frightened cattle. The rails are of sawn timber of a short, curly grained hardwood, and about $1\frac{1}{4}$ inches thick. They are much too narrow in comparison with their length. Being so narrow and long, they bend to only a moderate pressure upon their middles. To guard against the rails being forced out—which frequently happens—the mortises should be at least 2 inches deep; but, instead, they are only half that depth in the post.

Fig. 27

Fig. 28 shows how two rails gave way when a mob of cattle became frightened. These are comparatively new yards. Split timber is much stronger than sawn timber, and therefore for such purposes as stockyards the split hardwood is better than sawn, because the grain is not broken so often. Here strength has been sacrificed for neatness.

Fig. 28

Fig. 29.

Fig. 29 is an example of using rails out of all proportion to the strength of the posts; the former have also been weakened by cutting away such a large amount for the tenon.

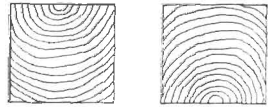
Attention to some of the points enumerated above relating to the construction of stockyards, may avoid the annoying occurrences of wild stock breaking away at, say, branding-time, through a weak rail being broken by the animals in their caperings round the yard, to say nothing of loss through broken limbs when they essay to jump out of a yard through an opening left by a broken rail.

How to Lay Timbers for Flooring.

Slabs of pine and old railway sleepers are frequently used as flooring for stables and cow-bails on farms and stations. At times they are not used to the best advantage, and consequently are heavy with the smell of urine, no matter how the attendant may try to keep the place clean.

Fig. 30 represents logs showing the rings plainly.

If the logs were placed as in *Fig. 30a, urine would find its way* through the space of the rings when the logs were seasoned, and there set up decomposition, decay, and an objectionable odour. Obviously *they should be set as in Fig. 30b.*



a *b*

Fig. 30.

As milk absorbs odours very readily it is necessary that cow-bails should be as free from bad smells as possible. The same thing applies to the decking of bridges and culverts. If placed as in Fig. 30*a*, rain would find its way into the rings, and, when evaporated by the sun, would cause warping and, consequently, weakening of the timber for traffic.

CONSERVATION OF WATER.

Tanks and Dams.

Many areas of land taken up for grazing or cultivation have no natural permanent water supply, and in these cases the provision of ample storage should be a first consideration with the settler. During recent years, sub-artesian water has been found in many localities, and, the Government having taken steps to assist liberally in the cost of sinking, bores and wells are taking the place of tanks and dams in these areas. In many others, however, tanks and dams must still be relied upon to provide water for stock requirements, and the periodical occurrence of droughty periods necessitates ample storage capacity and the maintenance of the storage facilities in good condition.

Provide Ample Storage.

It is very important that the tank should be of ample capacity, so that the water will last through long periods of drought. In estimating the

Fig. 1.—Excavated Tank.

probable requirements, allowance must be made not only for the watering of stock, but for the loss by evaporation. From a water surface at ground level the evaporation in the western districts is equal to about 80 inches per annum. From the tank the loss would not be quite as great, for the water being below the surface, is protected in some measure by the banks, but if no water were to find its way into a tank for a year evaporation alone would be responsible for the reduction of its depth by 5 to 6 feet. This indicates that in excavation as great a depth as possible should be obtained the best tanks in the western district are from 14 to 15 feet deep.

It is somewhat difficult to arrive at the quantity of water that will be required for sheep and for cattle, say, over a period of twelve months. Every person must be his own judge as to whether the conditions of the climate warrant him in providing for a shorter period, or whether in the driest part it will not be wiser even to provide for a longer period, but there are a few points that are worthy of consideration in determining the size of a dam.

Sheep, more especially when there is plenty of green feed with a moderate temperature, require very little water; indeed, they have been known to go months without any and do well. When, however, feed is dry and dusty they drink a great deal. When there is a drought and the weather is very hot they almost live on water, and they also carry out a lot of water in their wool. Taking these things into consideration, and also the evaporation from the surface, it is considered that 1¼ gallons per day for each sheep should be provided. This makes the requirements of each sheep for one year 456¼ gallons. Each cubic yard of water contains 168¾ gallons, which works out at about 2¾ cubic yards per sheep; as it is always safer to provide a little more it is recommended that 3 cubic yards of water be provided for each sheep intended to be watered at the tank, or tanks. For 100 sheep, therefore, provide 300 cubic yards of water per year; for cattle and horses provide from 24 to 30 cubic yards for each beast per year.

The methods of estimating the capacity of tanks and of calculating the measurements that will give a required capacity are described in Section XV, "Farm Measurements," of the Handbook.

Selection of the Site.

Very careful consideration should be given to the selection of a site for a tank. The most important point is a good catchment, and this, on some holdings, is almost the sole determining factor. In undulating country catchments are generally good, and no difficulty is experienced, but in the level country of the western plains a new settler would do well to secure the advice of a more experienced man. Very often shallow watercourses exist, and the tank should be located on or near these. Roads provide good catchments, and a good flow of water can be obtained off the hard bare patches which exist on the plains. In selecting catchments attention should also be given to the nature of the country; for instance, a drain running over hard, compact soil will carry more water into the tank than one running over black soil, which develops large cracks during drought periods, and which absorbs a large amount of water before any reaches the tank. Land often appears level when it has a fall of several inches, and in very level country it is often well worth while to have levels taken before fixing the site. The catchment must have sufficient area to catch enough water to fill the excavation in good heavy rains; a large area with a gentle grade is preferable to too steep a catchment, as the latter carries too much soil and rubbish down during heavy rains.

Tanks or dams may be placed so as to water more than one paddock if required. If the paddocks are large, however, it is better to place the excavations as near the centre as possible, in order that stock may not have to travel too far to water, and will not tread down the grass so much going to and fro. See that the area is kept clean and does not contain pigsties, sheep yards, &c. Shade-trees should not be left in the catchment, but rather below it, so that the excreta from stock camping under them may not be washed into the tank and pollute the water. Stock come to water in the morning and like to linger round in the shade, taking frequent drinks before moving off in the afternoon. If shade is not available they probably take only one drink in the day, and consequently do not do as well as they otherwise would.

After locating what is apparently a good site, the nature of the soil should be ascertained. On some country a tank will hold well almost anywhere, but in other classes of soil some considerable difficulty is experienced, and

recourse must be made in some cases to puddling. The nature of the timber is usually indicative of the character of the subsoil, but is not always reliable. Occasionally the country is patchy; while the subsoil in portion of the tank is good, a band of a porous character may be struck, which will cause a leakage. Before sinking is commenced trial shafts should be sunk to the depth it is proposed to excavate the tank, and if it is considered the country is patchy two or three should be put down. An experienced man can tell by the nature of the subsoil whether or not it will be "good holding," but if there is any doubt a test should be made by partly filling the shaft with water, so that its holding capacity can be ascertained.

Shape of Tank.

If there is much of a fall in the land the tanks should be made long and narrow across the fall. If the length were made parallel with the fall the water would reach the surface at the lower end while it was still very low at the upper end, and consequently much of the storage capacity would be lost.

Very steep sides are soon trodden down, mud and clay falls in, and the shape of the excavation is spoiled. This applies to tanks that are not fenced in and to which stock are allowed access all round. Sheep only should be watered at these, and the slopes should not be less than 3 to 1. If made with bullocks, ploughs, and earthscoops, they can be taken out at this grade all round, but 3 to 1 is too steep for cattle and horses to water at.

All excavations intended to be used for large stock should be fenced in, and access given at one side only, which is generally termed the roadway. This should have a grade of from 4 to 1 to 5 to 1, and should be corduroyed or stone-pitched—the latter is more lasting and safer in every way. This can be done by making an excavation 7 or 8 inches deep, filling in with large stones placed on edge, all interstices being tightly wedged with small stones to an even surface and then blinded with gravel a few inches deep.

The *Scoop*.

In the actual work of making the excavation a good deal obviously depends on the implements used and the manner in which they are handled. It will be noticed that on the bottom of the scoop are two rods of iron called

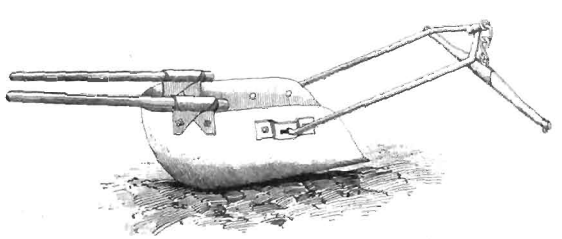


Fig. 2.—Type of small scoop generally used.

NOTE.—The scoop figured serves to illustrate the points referred to in the text, but scoops, of larger capacity and suitable for teams of two to four horses, are on the market.

cradles (Fig. 3). These, after some use wear very thin, and should be removed and replaced. If this is not done the whole of the bottom of the scoop comes into contact with the ground, causing much more friction, and requiring considerably more exertion on the part of the horses. In the illustration the handle of the scoop is, as usual, straight, but some men prefer to have the handles bent upwards, arguing that less strength is then required to fill and turn the scoop. When scoops are new they are always bevelled at the mouth, as in Fig. 4 (a) which makes them hard to raise to the surface when full, and likely to "bite" as well as giving them a tendency to work downwards. When bevelled as in Fig. 4 (b) much less pressure on the handles sends them up, and they glide over the top of the loose earth without any trouble. When used for a considerable time the mouth of the scoop wears very thin, and will easily buckle. To counteract this a piece of quarter-inch steel, 3 inches wide, is riveted across the mouth and bevelled at the same angle as in Fig. 4 (b).

Removal of the Earth.

The ground should be carefully ploughed before scooping commences, particular attention being paid to the uniformity of depth, so that the scoop will not bob up and down. The earth on which the embankment is to be built

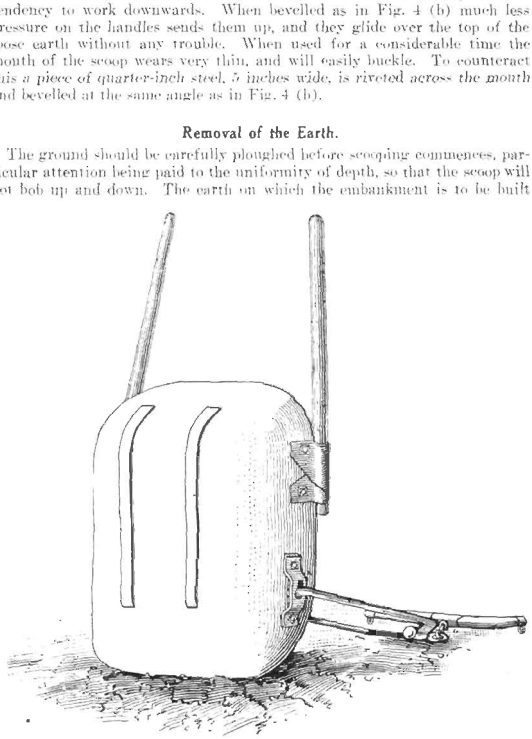


Fig. 3.—Back of Scoop showing Cradles.

should also be ploughed, so that the removed earth will incorporate with it should the water overflow the excavation. If this is not done there is a risk of the water percolating between the hard undisturbed soil and the loose soil of the embankment, causing "weeping," and creating the possibility of a breakaway.

A frequent error of judgment on the part of tank-sinkers is the practice of placing the first scoop of earth near the margin of the excavation. This means that the horse has to drag the next filled scoop over the banks so formed. It is obvious that the operations should be reversed, and the earth placed at the back first and the embankment built up from behind. To increase the storage capacity the embankment should be built well forward. Usually the earth is banked on two or three sides, but it is an advantage to bank it right round to prevent evaporation as much as possible.

Facilities for Inflow.

To get the water into the tank, pipes are laid under one bank and the silt tank placed just outside it. On small holdings, where the tanks can be kept under observation, some means should be devised to divert the water as soon as the tank is full. If the water is allowed to continue to flow into the tank it gradually silts up, and the water which overflows is clearer than the water which is flowing in.

A chute should be provided where the pipe enters the tank, and a drain made right round the edge, leading to the chute, for the purpose of preventing water from running down the banks and causing scouring.

Silt Tanks.

Usually one silt tank is provided, but it is a decided advantage to have two or more, as then more silt is deposited and the water reaches the tank in a cleaner condition. Every possible opportunity should be seized upon to keep the tanks clean. They should be kept under constant observation, and whenever the water gets low as much silt as possible should be removed. Many landholders have discovered at the commencement of a drought that tanks which they had thought contained several feet of water actually contained several feet of silt and only a few inches of water.

Drains.

Wide shallow drains, in which the flow of water is slower and there is little scouring, are preferable to narrow deep ones. A drain 4 feet wide and 9 inches deep is much better than one 2 feet wide and 18 inches or 2 feet deep. When scouring is likely to take place the following method is very successful in preventing it:—A trench about 1 foot wide and 18 inches deep, and extending a couple of feet each side of the drain, is dug across it and filled with stone of 2 or 3 inch gauge. The efficacy of aprons such as this can be seen along roads and railways where they are used for the prevention of washaways. Where drains curve they should be widened: the sharper the curve the greater should the width be: and as a double safeguard an embankment can be placed on the outer side. Should drains meet before reaching the tank the main drain should be widened at the confluence, and the junction made at an acute angle. Otherwise considerable quantities of silt will settle.

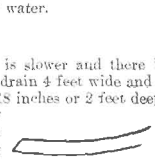


Fig 4.

Drains should always be kept in first-class order. When surface tanks are depended upon every shower is of importance, and unless the drains are clean, water from light showers does not reach the tank. Light road delvers are very useful for this purpose, but if the size of the holding does not warrant the purchase of such a delver, a crowdey or delver should be made from a log or plank by the fitting of a steel point. A plough or shovel can also be used for this purpose.

Measuring Drains.

The method of calculating the amount of earth removed in the construction of a drain is given in the "Farm Measurement" Section of this Handbook.

When the total length of drainage required runs to several miles it is a very tedious proceeding to measure for a contractor's payment. The chain tape is in common use, but involves considerable risk of error. The following method used in measuring up road work is very simple, yet accurate, and could be applied to measuring drains, as well as fencing, &c:—A piece of white cloth is tied round the spoke of the wheel of a buggy, and the vehicle then advanced until the wheel has made a complete revolution. A mark having been made on the ground before starting, the circumference of the wheel is easily obtained. Then by driving along the proposed route of the drain, and counting the number of revolutions of the wheel, the total distance is easily arrived at. With two persons in the vehicle, one counting in tens, and calling "ten" each time, and the driver counting the number of "tens," there is no danger of mistake. When, for example, the driver has counted 43 "tens," and the other man has six towards the next ten, the number of revolutions must be 436. If the wheel were 14 ft. 8 in. in circumference, then the total distance would be 6,394 ft. 8 in., or nearly 97 chains.

FARM BUILDINGS.

Suitably designed, conveniently located, and well constructed buildings are a necessary part of the equipment of the modern farm, and they contribute in no small way to the success of the undertaking by making for economical working of the property and increasing the contentment of the farmer and his family.

The Farmer's Residence.

The first that must be considered is the residence. Though there are doubtless many farmers—particularly new settlers—who cannot afford to spend a large sum of money on a home, there are a number of factors to be taken into consideration in the construction of even quite a humble abode, if the maximum of comfort and convenience is to be obtained.

Individuality enters so largely into the design and planning of a home that for this reason alone it would be impossible to plan a residence suited to all tastes. There are, however, considerations of vital importance which should be carefully observed in all cases when planning a residence.

Unlike the city dweller, the farmer is usually free to select the site on which to erect his residence, and he should first of all select a site that is high and well drained. This advice may seem unnecessary, but it is surprising how often this consideration is overlooked. Place the building so that the sun will shine on every room at some time of the day, and

preferably so that the bedrooms and morning or breakfast room will get the morning sun. Determine whence the prevailing winds blow, and have as few doors facing this direction as possible. Place the larder or pantry in *some cool position and where the sun will not shine on any of its walls.* Do not place the kitchen on the west or north side of the house, or it will be hottest at a time when the evening meal is being cooked. Have a verandah on which the morning sun will shine and on which children may play sheltered from winds and driving rain. This verandah might be enclosed with gauze and thus provide a pleasant retreat on summer evenings.

Keep the floor of the house well up from the ground and provide ample ventilation under the floors; lack of ventilation will cause dampness in a house and induce dry rot and white ant attack.

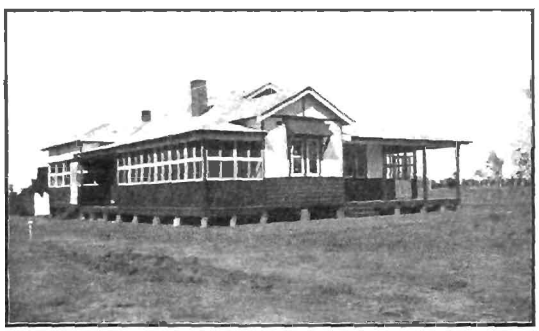


Fig. 1.—A Well Designed Farm Residence.
Erected in a Western District for £1,225.

Consider the water supply. If roof water must be conserved, use squat *tanks, that is tanks of not more than two sheets high.* These may be of large diameter, and by setting them as high as possible under the eaves gutters, their full contents may be drawn off at the kitchen sink, bath, laundry, tubs, &c.

The plan given in Fig. 2 is that of a residence recently constructed by the Department for one of its farm managers. It is not held to be a model for all and sundry to follow, but rather to illustrate how the factors just outlined were given effect to in this particular instance. In this case a dwelling had to be designed for a climate which is extremely *hot* in summer with scorching hot winds, and very cold in winter with biting westerly and south-westerly winds.

The house faces north. Note that the breakfast room and two bedrooms get the early morning sun, the third bedroom is sheltered from the midday and afternoon sun, and the kitchen and pantry are away from the afternoon sun. The absence of doors on the western side gives protection from the westerly winds, and the closed porch or wide verandah gives protection

from winds and rain yet admits the morning sun. The bottoms of the squat tanks are on a level with the kitchen sink, tubs, &c. The floor of the building is 2 feet above the ground, thus providing plenty of ventilation. Water being scarce, and consequently a septic tank out of the question, a chemical sanitary system was installed. Waste water from the kitchen,

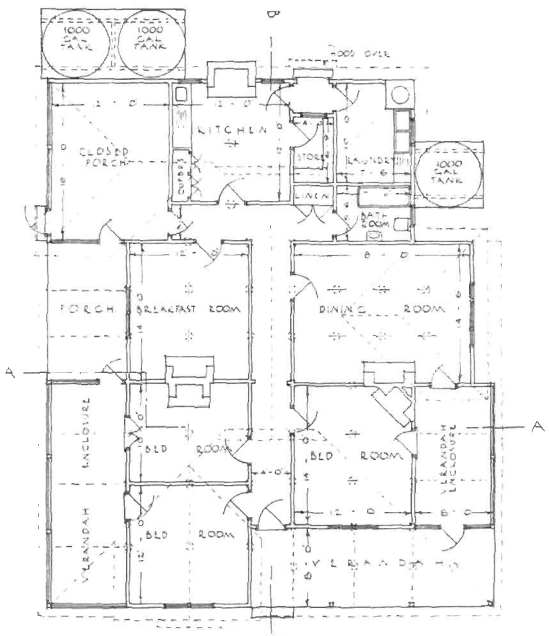


Fig. 2.—Plan of Residence shown in Fig. 1.

laundry, and bathroom is conducted by means of stoneware pipes to an absorption pit; there is consequently no fouled surface water anywhere about the place.

The contract price for this building, which was erected in a district where building materials are dear and skilled labour scarce, was £1,225.

PLANS OF STABLES, IMPLEMENT SHEDS, &c.

Substantially constructed buildings that, by the convenience of their arrangement, facilitate the operations of the farm, and that are yet within the financial resources of their owner, are essential to the economical working of a property. The Department is frequently asked to provide farmers with plans or designs for buildings for various purposes, and is prepared in many cases to loan working drawings for construction purposes.

The accompanying plans are those which have been used quite recently in the erection of buildings on various Departmental farms. They have been selected out of a good many that have been prepared from time to time as being those most likely to be suitable to farmers' requirements—or at least those likely to be most suggestive to farmers who wish to erect something of this kind.

The specifications which accompany several of these plans are sufficiently explanatory. The plans comprise the designs for erection of the following structures:—

Combined stables (six stalls) and implement shed (as erected at Griffith Viticultural Nursery).

Implement shed only (as erected at Wagga Experiment Farm).

Wheat storage barn or grain shed (as erected at Trangie Experiment Farm).

Hay shed (as erected at Temora Experiment Farm.)

Water troughs (as constructed at Trangie Experiment Farm).

Sheep yards.

Shearing shed.

Sheep dip (as constructed at Hawkesbury Agricultural College).

A Six-stalled Stable and Implement Shed.

The specifications connected with the plan of a six-stalled stable and implement shed erected by the Department at Griffith Viticultural Nursery (*Fig. 3*) were as follows:—

Materials.—All timbers unless otherwise specified to be of Cypress pine.

Roof.—Construct pitched gable and roof as shown, rafters to be either 4 inches round timber, or 5 inch x 2 inch sawn with similar collar ties to each pair, and projecting rafters at gables, notched and projecting over top wall plates, and splayed to 6 inch x 1½ inch ridge board. Brace with 3 inch x 1½ inch battens, two to each end, well spliced to underside of rafters, ridge and wall plates. Batten for iron with 3 inch x 1½ inch, spaced not more than 30 inch centre. Rafters spaced as indicated on plan. Collar ties to be scarfed and bolted to rafters with ⅝-inch bolts. Tie beams where indicated to be 6 inches round or 6 inch x 3 inch sawn, set into, and bolted to post heads as indicated on drawing. Over each fix struts of 4 inches by 3 inches to collar ties and rafters, and spike to same.

Walls.—Scarf out top of posts and secure with ½-inch cup head bolts and nuts, one to each post, 6 inch x 3 inch top plates to outer walls of stalls and implement shed. To gable and back wall of implement shed, fix to posts as indicated 4 inch x 3 inch rails, and cover same with vertical slabs, 8 inch x 1½ inch, close jointed and double spiked to rails. Walls of harness and food rooms to be constructed with 4 inch x 2 inch common studs spaced at 18 inch centres, set ⅝ inch deep into 4 inch x 4 inch bottom and 4 inch x 2 inch top plates, 4 inch x 4 inch corner studs, braced at angles with 3 inch x 1½ inch battens, halved and

sunk flush in outer face, and covered with 6 inch x 1 inch rusticated weatherboards finishing against 3 inch x 1½ inch batten fillets, on corner studs and 1 inch wrought and beaded stops to doors and windows.

Trim for doors and windows as required. Fill in gables of roof with 4 inch x 2 inch studs spaced as before specified for walls, and cover with weatherboards cut close to underside of iron, and lapping over top ends of slabs.

Partition between two rooms to be covered with weatherboards on harness-room *side up to top plate. In two rooms, weatherboards between feet of rafters to be* cut to fit close to iron.

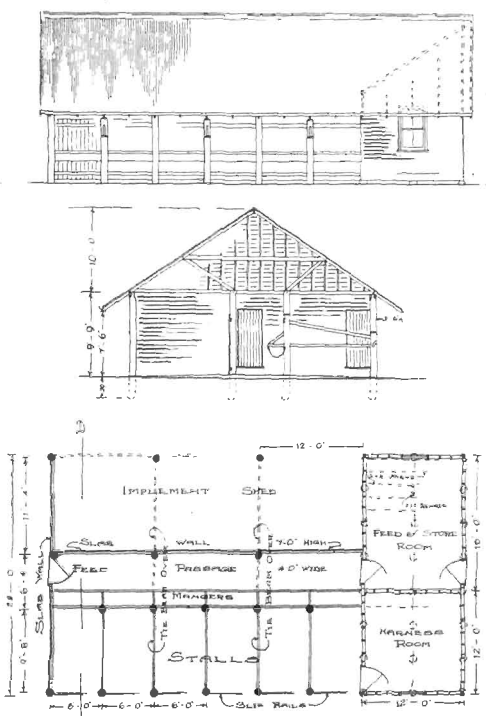


Fig. 8.—Combined Stables (six stalls), Implement Shed, &c.
Top—Elevation. *Centre*—Section AA. *Bottom*—Plan.

Floors.—*Floors of two rooms to be 5 inch x 2 inch joists, spiked to 5 inch* x 4 inch centre bearer and bottom plates, spaced as indicated, and covered with 4 inch x 1 inch tongued and grooved flooring, cut to fit close around studs and up *to weatherboards, double nailed, punched, and flushed off at joints.*

Stalls.—Construct stalls with 10-inch diameter head and heel posts, trimmed on top as shown, 4 inch x 2½ inch hardwood sawn rails, set into posts, the lower rail *to run through to carry manger as shown. Provide continuous 6 inch x 2 inch* name-plate on outside of head-posts. Construct mangers (continuous) with 4 inch x 3 inch rails x 1 inch wrought capping, 4 inch x 2 inch stays, outer rail to be bolted to lower division rails with ½-inch bolts as shown.

Provide to each manger 1-inch division board of colonial pine, sliding in fillets.

Provide to each stall 3 inch x 2 inch hardwood slip-rail, notched into posts as indicated on section AA.

Mangers to be of 24-gauge plain galvanised iron, fixed between rails with coneheaded galvanised screws.

Harness Fittings.—*Provide and fix approved harness pegs, one to each stall,* and six in each harness room of ¾-inch galvanised pipe 15 inches long, fixed as directed; also three saddle racks of 4 inch x 2 inch, with 4 inch x ¾ inch top *board, well secured to wall studs in harness room.*

Doors.—Provide and swing to studs (four) ledged and braced doors, 6 feet 8 inches x 2 feet 8 inches x 1 inch, made of 6 inch x 1 inch ledges, 4 inch x 1 inch braces and 4 inch x 1 inch tongued and grooved and V-jointed Dorrigo pine, wrought both sides, hinged with 14-inch japanned T hinges and secured with approved 6-inch rim lock and M.E. brass furniture.

Fit to each opening ¾-inch beaded stops of the required widths. Put housed *sills to each of 6 inches x 3 inches.*

Windows.—Between studs, and over 2½-inch sloping sills, fit in two pairs of 5 feet 1½ inch x 2 feet 10 inch x 1½ inch light pine sashes, glazed with 21 oz. glass, and fitted with sash prop and fastener of approved pattern, stops to be fitted as for doors.

PLUMBER.

Cover the whole of the roof with 26-gauge galvanised corrugated iron, secured *to battens with 1¾-inch galvanised screws and lead washers as may be directed,* sheets to have one and a half laps at sides and 6 inches at ends. Finish at gables with neat 2-inch rolls.

To eaves, provide and fix 5-inch quarter round guttering, 24-gauge, secured with stout galvanised brackets and top straps (one to each rafter), and lapped, riveted, and soldered on both sides at all joints. Provide and fix two stacks of 3-inch down-pipe, secured with straps, and fitted with proper shoes to deliver on the ground.

Cover ridge with 16-inch 26-gauge ridge capping, secured with screws to every fourth corrugation, and box in ends at gable.

PAINTER.

With best white lead and linseed oil paint in colours as will be directed (paint *three coats) the whole of the external face of gable weatherboards and rafters,* and one side and two ends of harness and feed rooms, also both sides of doors and windows. Paint in three coats with red oxide in oil the slabs on gable wall *and the weatherboards on the stall and shed side of two rooms.*

The implement shed in this plan could, with convenience, be increased in width so as to take a double row of implements.

An Economical Implement Shed (Fig. 4).

In this case, the design, which was prepared for Wagga Experiment Farm, provides for an implement shed of six open bays, constructed with round posts, and roofed with cypress pine frame and galvanised corrugated iron.

The specifications follow:—

Timber.—The timber throughout to be of first-class cypress pine, and spaced as indicated on the drawings.

Posts.—Posts to be of uniform shape not less than 9 inches diameter at small ends, spaced as indicated on drawings, set 3 feet into the ground and well rammed. To the six posts shown on plan, put 6-inch x 3-inch sole plates and 4 inch x 2 inch struts well spiked at joints and to posts. All timbers sunk into the ground to be first coated with a heavy coat of hot tar, the tar to be dried hard before the holes are filled in. *Tops of posts to be scarfed out to take top plates* and collar ties, holed for ½-inch bolts.

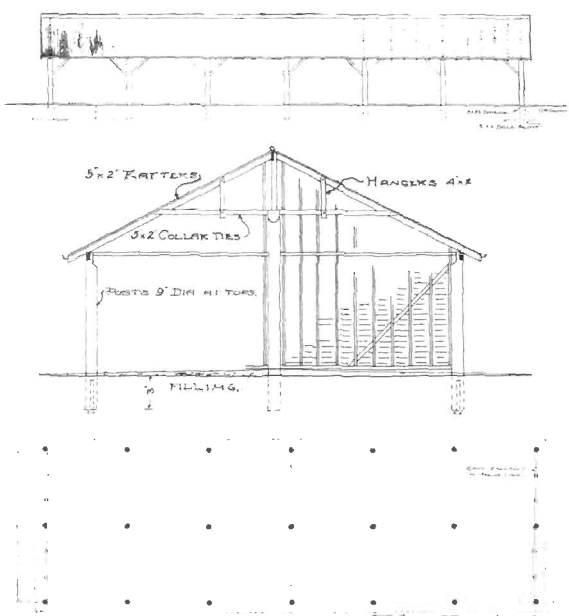


Fig. 4.—An Economical Implement Shed.
Top—Side Elevation. *Centre*—Cross Section. *Bottom*—Plan.

Roof.—Construct roof with 7-inch x 3-inch wall plates, secured to posts with ½-inch cup head bolts and nuts, 4-inch x 3-inch struts under, toed into plates and to posts, 5-inch x 2-inch rafters, birdsmouthed over plates and cut and spiked to 8-inch x 1¼-inch ridge board, 5-inch x 2-inch collar ties scarfed ¾-inch on to alternate pairs of rafters, 4 inch x 2-inch braces to collar ties, also 4-inch x 3-inch centre piece supporting ridge board from centre posts, all bolted together with

⅝-inch cup head bolts through crossings and top of centre posts. Brace ends of roof on all sides with 3-inch x 1¼-inch diagonal braces spiked to under side of rafters.

Walls.—Enclose each end of shed, including gables, with 4-inch x 2-inch studs at 18-inch centres, shouldered ⅝-inch, and tenoned 2 inches into 4-inch x 4-inch bottom plate and 4-inch x 3-inch plate. Bottom plates to be supported with 9-inch diameter wood blocks set 18 inches into the ground. Brace studs, with 3-inch x 1½-inch diagonal braces halved and sunk flush, or 1¼-inch x 16-gauge galvanised hoop iron, nailed to each stud. Line over studs with 6-inch x 1-inch rusticated weatherboards neatly cut against posts and double nailed on each stud.

Guttering.—Provide and fix to eaves on strong long-tailed galvanised iron brackets (one to each rafter) 5-inch quarter round 24-gauge galvanised iron gutters with lapped, rivetted, and soldered joints and the necessary stop ends.

Down Pipes.—To each end of guttering fix 3-inch 24-gauge galvanised iron down pipes, securely strapped to posts and provided with shoes to discharge on to the ground where directed.

Roof Iron.—Cover the whole of the roof with 26-gauge galvanised corrugated iron fixed to 3-inch by 1½-inch battens with 1¾-inch galvanised screws and lead washers, four to each batten in each sheet; to have one and a half corrugations lap at sides and 6-inch lap at ends. Finish with 2-inch roll over rafter at gable ends, and fix 3-inch by 1½-inch batten under rolls.

Ridge Capping.—Cover ridge with 16-inch 24-gauge galvanised ridge capping boxed in at gables, and screwed down at every fourth corrugation.

Painter.—With boiled linseed oil, and one-sixth part varnish added; paint with two coats all weatherboards to gable ends of building.

A Wheat Storage Barn (Grain Shed).

The following extracts are from the specification for a wheat storage barn or grain shed constructed with round posts, sawn rails, and galvanised-iron erected at Trangie Experiment Farm (Fig. 5):—

Timber.—Except where otherwise specified the timber used to be approved quality cypress pine, cut square and full to the sizes stated. Principal wall posts to be not less than 10 inches in diameter at the small end. Intermediate posts to be 6 inches in diameter and the whole stripped of bark, and uniformly straight. All timbers underground to be coated with coal tar.

Concrete.—The cement to be government-tested Portland cement. The sand to be clean and sharp and free from vegetable matter. To be mixed in the proportion of one part cement, three parts sand, and six of approved aggregate, broken to pass through a ring not larger than 1½-inch diameter. To be mixed on a proper wood platform, turned twice in a dry state, and twice whilst being wetted from the rose of a watering can or hose, placed in position immediately it is mixed, graded, packed, and rendered ⅝-inch thick with cement mortar immediately the concrete is sufficiently set to work on. Cement rendering to be gauged two parts sand to one of cement.

Walls.—Construct walls with round posts, spaced as figured on plan, sunk 4 feet and 2 feet 6 inches into the ground; 6-inch x 3-inch top plates with 4-inch x 2-inch rail under; 4-inch x 2-inch brackets to projecting ends of top plates; 26 gauge galvanised plain iron bands 24 inches wide with galvanised clouts fixed to posts. Cover in walls with 24-gauge galvanised corrugated iron fixed horizontally with 1¾-inch galvanised screws and iron washers to posts. Door posts to be square on two sides. Put 6-inch x 3-inch rail over head of door and fill in with 4-inch x 2-inch studs bolted on and sheeted over with corrugated iron up to top plate. Enclose gables with vertical 26-gauge iron cut hard against roof iron. All iron to be lapped one corrugation at sides.

Bird-proofing.—Bird-proof under eaves with ½-inch mesh 20-gauge galvanised wire netting taken up to roof purlin and fixed with staples.

Dwarf Walls.—Erect on each side of waggon entrance, portable dwarf walls constructed with frames of 3-inch x 1½-inch Oregon with painted dowell joints, sheeted with galvanised corrugated iron as for walls, and secured with ⅝-inch iron dowells set in the floor for bottom, and 4-inch neck bolts at top to 4-inch x 4-inch hardwood posts set 18 inches into the ground. Door posts to be rebated to receive ends of panels.

Roof.—To be constructed with Oregon 5-inch x 2-inch rafters, 6-inch x 3-inch tie beams, 4-inch x 2-inch collar ties, 4-inch x 2-inch hangers, all bolted together and to posts with ⅝-inch cuphead bolts and nuts; 4-inch x 2-inch purlins at approximately 30-inch centres, with cleats out of 4-inch x 2-inch to each purlin, and *8-inch x 1¼-inch ridge board. Brace the whole with 3-inch x 1¼-inch diagonal* braces.

Guttering.—To be 5-inch 24-gauge quarter round on brackets spaced two to *each length and top strapped. Joints to be lapped 3 inches, rivetted, and sol*dered both sides.

Downpipes.—Fix four (4) lines of 3-inch 24-gauge downpipe connected with *gutters, clipped to posts, and fitted with shoes to discharge on to ground.*

Corrugated Iron.—Cover in roof with 26-gauge corrugated iron secured to purlins with 1¾-inch galvanised screws and lead washers. To have 6-inch lap at ends and one and a half corrugations lap at sides. Finish with 2-inch rolled edge over gable rafters, and 3-inch x 1-inch batten planted on face of rafters.

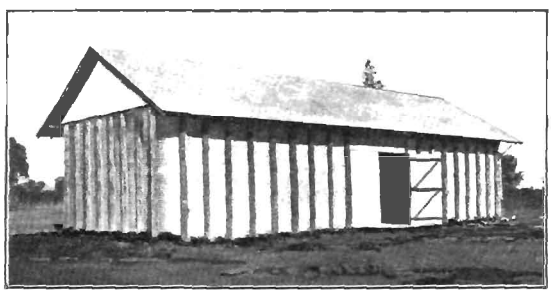


Fig. 5.—A Wheat Storage Barn (Grain Shed).
Erected at Trangie Experiment Farm.

Ridging.—To be 16-inch 24-gauge, and boxed at the ends, fixed with screws and washers on to each fourth corrugation.

Iron, ridging, downpipes, guttering, brackets and straps *all to be galvanised.*

Cowls.—Fix two 12-inch diameter W.S. and S.B. pattern galvanised cowls, set at side of ridge board and flashed with 5 lb. sheet lead. Shafts to be continued down 12 inches and have bell mouthed lower ends 20 inches wide.

Doors.—To be 10 feet by 12 feet wide, in two leaves, constructed with Oregon frames, properly mortised and tenoned and glued, wedged and pinned at the joints, and the frames covered on the face with 24-gauge corrugated *iron, each* leaf hung to posts with three wrot 2-inch x ⅜-inch iron strap hinges, the top hooks to be bolted through the posts, and each pair of doors secured with 24-inch *monkey tail bolt on top, 10-inch tower bolt on bottom, and 1¼-inch x ⅜-inch link* locking chain around centre stiles, all to be galvanised and strongly fixed.

Doors to be fitted close in opening, and the edges of the iron turned and screwed to frames. Provide and fix to posts, *one for each* leaf, heavy galvanised cabin hook with staple eye in door stile to hold door back to wall.

Grading.—Fill in with soil against bottom of walls, all round building to floor *level and slope out 3 feet wide as will be directed.*

PAINTER.

Paint with three (3) coats all projecting feet of rafters, gable rafters, and door and shutter frames.

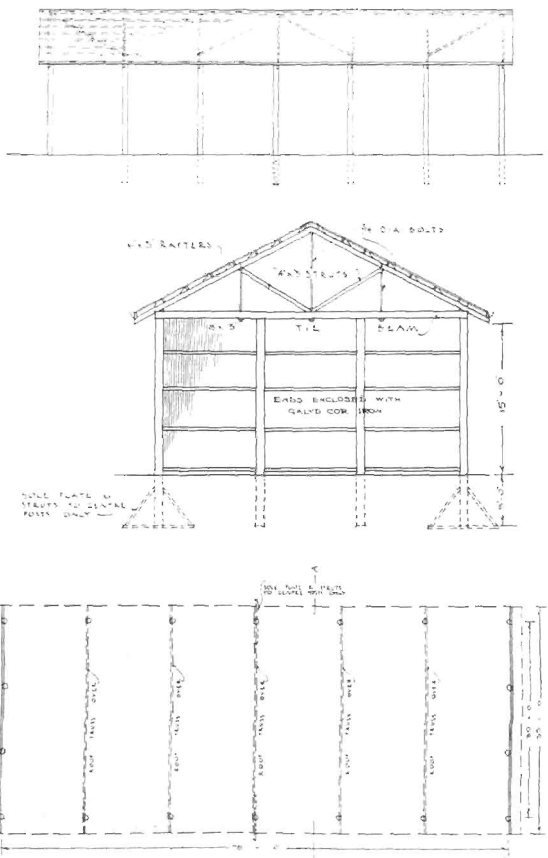


Fig. 6.—Details of Hay Shed.
Top—Side Elevation. *Centre*—Cross Section (A.A.). *Bottom*—Plan.

A Hay Shed.

The plans given in Fig. 6 on page 184, which are almost self-explanatory, give details of a useful type of hay shed which the Department erected at Temora Experiment Farm.

Useful Water Troughs.

The concrete water trough illustrated in Fig. 7 was made on the Trangie Experiment Farm, and should prove a useful addition to the equipment of any farm property. The mould used in its construction is shown in Fig. 8.

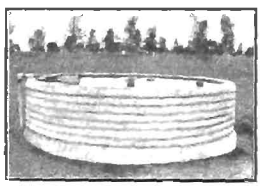


Fig. 7.—A Concrete Water Trough

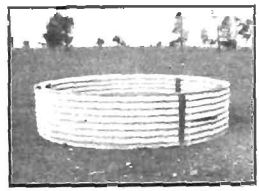


Fig. 8.—The Mould used for the Construction of the Trough shown in Fig. 7.

Sheep Drafting Yards.

A convenient design for drafting yards, that takes into consideration the requirements of the shearing shed and the dip, is illustrated in Fig. 9.

A Farmer's Shearing Shed.

The following specification is for the small shearing shed of which a plan is given in Fig. 10. Fig. 11 shows an end elevation of the structure:—

Timber.—The dimensions specified for timber are for cypress pine.

Foundation Stumps.—*To be 12 inches in diameter cut square at both ends, set* 2 feet into the ground and out of the ground 3 feet 6 inches, spaced not to exceed 6 feet 3 inches centres. The parts set into the ground to be twice coated with creosote oil and the tops capped with 26-gauge galvanised stump caps.

Walls.—To be constructed with 4-inch x 3-inch studs at 3 feet 2 inches centres to take 10 feet sheets of corrugated iron, to be housed ½-inch into 5-inch x 4-inch *bottom and 4-inch x 2-inch top* wall *plates; corner and door studs are to be* 4-inch x 4-inch. Brace walls with 3-inch x 1-inch diagonals sunk flush with outer face of studs. Trim for heads of doors with 4-inch x 4-inch.

Corrugated Iron Wall Lining.—*Cover in all walls externally with 26-gauge* galvanised corrugated iron fixed horizontally to studs with 1¾-inch galvanised screws and lead washers. Finish at angles with 2-inch x 1-inch wood stops.

Wire Netting.—At 12 inches below top plate of side walls fix a *3-inch x 1-inch* batten sunk flush with studs, and fix ½-inch mesh bird-proof netting for ventilation.

Gables.—Frame up gables and line with corrugated iron as for walls. Form louvre vents with leaves of 24-gauge plain galvanised iron set in saw cuts in the studs made at an angle of 60 degrees. The bottom leaf is to be turned down over the corrugated iron.

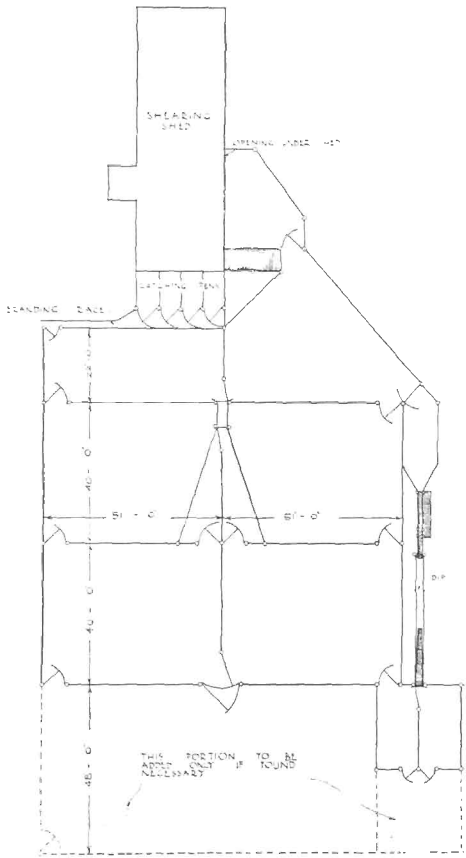


Fig. 9.—Plan of Sheep Drafting Yards.

Designed for use in Connection with both Shearing Shed and Dip.

Roof.—Construct the roof with 4-inch x 2-inch rafters spaced not to exceed 36 *inches on centres, birdsmouthed over wall plates, projecting* 18 *inches from* walls and cut plumb to a line. Fix 8-inch x 1-inch ridge board and 5-inch x 1½-inch collar ties to each pair of rafters. Hang up each collar tie with two 5-inch x 1½-inch bolted on, also to each third pair of rafters put 5-inch x 2-inch tie beams from plate to plate, bolted to feet of rafters and hung up to rafters similar to *collar ties with two 5-inch x 1½-inch bolted on. Put a pair of rafters to each* gable set 16 inches out from the wall and brace roof with 3-inch x 1-inch diagonals at each end, fixed to underside of rafters.

Floors.—To be constructed with stumps as for walls, 5-inch x 4-inch bearers and 5-inch x 2-inch floor joists spaced not to exceed 18 inches centres. In sweating and catching pens the floors are to be of 3-inch x 1-inch battens, with arrised *edges and spaced ½-inch apart and well nailed. Remainder of floor, from* shearing board throughout wool room, to be 4-inch x 1-inch T. and G., tightly cramped and double nailed.

Catching Pens.—Construct *the front of catching pens with 4-inch x 2-inch* studs and top plate, and 3-inch x 2-inch or 4-inch x 3-inch plate at top of lining, housed ½-inch into studs. Frame for chute openings with 4-inch x 2-inch vertical and trimmer, and line with 4-inch x ⅝-inch T. and G., double nailed.

Construct the divisions to pens with 4-inch x 4-inch posts, well bolted at bottom to floor timbers, and 6-inch x 1½-inch rails 6 inches apart, mortised into posts. Posts for balanced gates are to be built up as specified under *Gates.*

Loading Race.— To be constructed with round posts not less than 8 inches at the small end, and splayed on one side for 6-inch x 1½-inch rails spaced 6 inches apart and well nailed on. Construct the floor with four 5-inch x 2-inch joists and 1½-inch x 1-inch battens laid alternately flat and on edge ½-inch apart, and well nailed down.

Landing.—To be built up with round posts not less than 8 inches at the small end, 4-inch x 2-inch joists and 4-inch x 1-inch shot edge flooring double nailed. Steps are to have 8-inch x 2-inch strings and treads of two 4-inch x 2-inch to each set, ½-inch apart and housed into strings ⅝-inch at each end.

Chutes.—Construct the chutes with 4-inch x 1-inch lining nailed to 4-inch x 2-inch uprights. The uprights are to be well secured to 4-inch x 2-inch sloping top rails, *one on each side. To the bottom of these uprights fix 4-inch x 2-inch cross pieces* to carry the floor of chute. Cover in the tops of chutes with boards laid the short way and nailed down at each end to the 4-inch x 2-inch sloping rails.

From the ends of chutes run fences to the counting pens with rails of 6-inch x 1½-inch, spaced 6 inches apart double nailed to stumps.

Doors.—To loading race, also landing, put doors 6 feet 6 inches high and 6 feet wide, *constructed with Oregon; to have 5-inch x 2-inch stiles and head, 8-inch x* 1-inch bottom and middle rails and 4-inch x 1-inch T.G. and D.V. sheeting. Each to be fitted with garage pattern sliding door fittings.

Doors to Catching Pens.—To be 3 feet high and 30 inches wide in two leaves. Each leaf to be constructed with 3-inch x 1½-inch hanging stile and 4-inch x ⅝-inch T.G. and V.J. vertical lining, fixed to 4-inch x 1-inch ledges on both sides. *Hinge each leaf with two 3-inch double acting spring hinges.*

Balanced Gates to Catching Pens.—To be constructed with 4-inch x 1-inch battens spaced 6 inches apart, projecting each end ¾-inch beyond 3-inch x 1-inch ver*tical so as to slide in 1-inch x 1-inch rebate or groove in post. To be hung with* sash cord, brass faced axle pulleys and suitable cast-iron weights.

Put a similar balanced hurdle across door opening at the loading race.

Fleece Bins.—To be constructed with 4-inch x 1-inch flooring fixed horizontally to 4-inch x 1-inch verticals. The whole to be fixed temporarily with 4-inch x 1-inch rails to top and bottom. (When not in use these bins are dismantled and laid aside.)

Wool Table.—To be 11 feet long, 4 feet 6 inches wide and 3 feet high, with six 4-inch x 4-inch legs, 5-inch x 2-inch top rails, 3-inch x 2-inch centre rail, 4-inch x 1-inch stays and braces, and the top of 1-inch x 1-inch, housed cornerwise into *rails at 2¾ inches centres. Fix around table on the floor* 12-inch x 1-inch movable boards fitted in between fillets to legs of table.

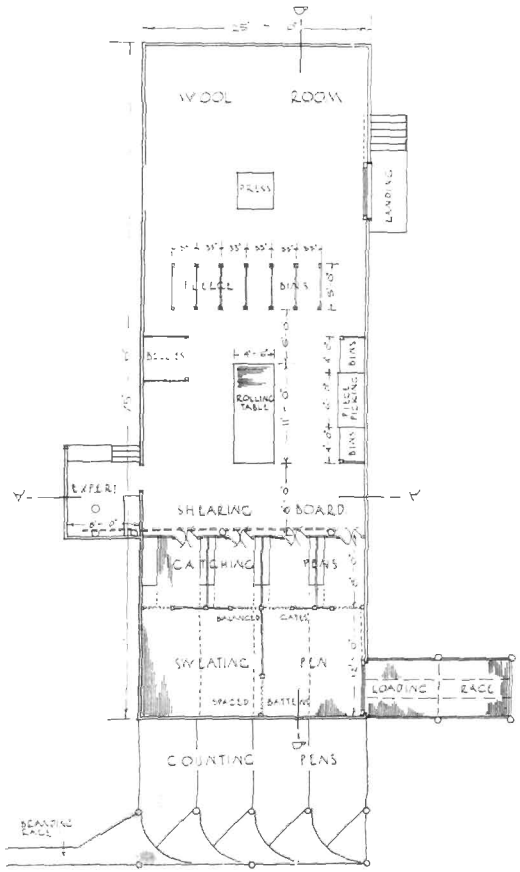


Fig. 10.—Plan of a Small Shearing Shed.

Piece Picking Table and Bins.—Construct piece bins with moveable centre table similar to wool sorting table and made to slide between fillets fixed to inner ends of bins. The latter to be 4 feet long by 4 feet wide, constructed with 6-inch x 2-inch T. and G. lining, fixed to corner studs, top rails and cleats.

Shafting Beam.—For the shearing board fix a 10-inch x 4-inch beam, secured with ⅞-inch diameter bolts to 10-inch diameter round posts. The beam to be 6 feet 9½ inches clear of the floor.

In expert's room set up a 12-inch diameter short post to take grinder. Machinery posts must be sunk well into the ground and rammed tight.

Provide for the wool press, four heavy foundation blocks and to these fix 5-inch x 4-inch bearers immediately under the press.

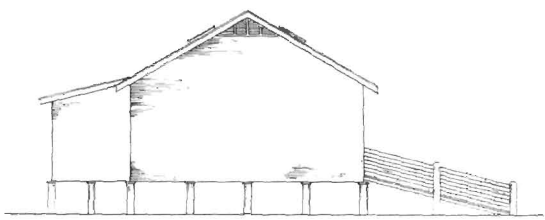


Fig. 11.—End Elevation of Shearing Shed

PLUMBER.

To eaves put 5-inch 24-gauge galvanised quadrant gutters with bracket and top stay fixed to each rafter. Guttering to be given a fall from the centre of the building towards each end and connected with 3-inch 26-gauge downpipe to discharge on to ground or into tanks as required. Cover in the whole of the roof with 26-gauge galvanised corrugated iron secured to 3-inch x 1½-inch battens with 1¾-inch galvanised screws and lead washers. Allow for 1½ corrugations lap at sides and 6-inch lap at ends. Fix 16-inch 26-gauge galvanised ridging well screwed down and boxed in at the ends. Also fix skylights to both sides of roof, as indicated, glazed with ⅛ inch mill rolled glass; hinged to open, and operated with the necessary cords.

PAINTING.

Paint doors internally and externally with three coats of best white lead, or rectified zinc and linseed oil paint.

A Concrete Sheep Dip.

The following particulars will be found useful in constructing the concrete sheep dip illustrated in Fig. 12:—

Excavate for the dip to the dimensions shown, and neatly trim down the sides, also cut the bottom and incline to an even grade.

For the walls and bottom of the dip the concrete should consist of one part cement, three parts sand, and five parts metal broken to ¾-inch gauge; for the floor of the drainage pens one part cement, three parts sand, and six of metal broken to ¾-inch or 1-inch gauge. If river shingle or coarse gravel is available, the proportions may be one part cement to six parts shingle, the shingle to contain only sufficient sand to produce a dense concrete. The concrete should be mixed as described on page 194, only sufficient water being added to produce a plastic and easily workable

mixture. Immediately the concrete is mixed it should be placed in position in the forms or boxing, care being taken first to see that the steel reinforcement is in position and wired so that it will not shift whilst the concrete is being packed or spaded.

It is important to reinforce the walls with steel, otherwise they will crack and leak so badly as to be useless. Another cause of leaky concrete walls is the junction of new concrete to old. *It is therefore advisable before placing concrete on top of that of the previous day, to lay a* ½-inch thick bed of mortar gauged one part cement to two parts sand. If this mortar is placed on a clean wet surface, a proper junction or bond will be made between the new concrete and that which has gone hard.

The walls of the dip are to be 6 inches thick, and the floor 4 inches thick. The floor should fall from one end as indicated on the drawing. To *strengthen the walls, piers called counterforts are built up with the walls* — these together with the steel reinforcement resist the overturning effect of the embankment.

When the walls have been concreted, it is necessary, in order to make *them water-tight, to render or plaster the interior of the dip to a thickness* of ½ inch, with cement mortar gauged one part cement to two parts sand. The best time to do this is a few days after the concrete has been poured. The walls should first be wet, and the finished rendering protected with wet bags or sheets of iron laid over the top of the dip, for if exposed to a hot sun the rendering will dry rapidly and be robbed of the water so necessary to enable it to become hard.

The Approach.

It has been found that sheep are not difficult to get up to the top of the ramp, but that at this point the first sheep will endeavour to turn back. It is therefore important to have the approach no wider than shown on the drawings. A platform constructed at the side of the approach is a great benefit, as an assistant operating here can get the sheep forward or control a rush, which, if not checked, may result in sheep being drowned.

The main features of the ramp are to provide a floor with 1½-inch x 1-inch battens laid alternately flat and on edge to provide a foothold, and *to space them* ⅝*-inch apart, so that dust and dirt from the feet will not* be carried into the dip. The top of the ramp should have a smooth floor and be slightly tilted towards the dip to reduce the sheep's resistance. From this floor into the dip the slope should be smooth and inclined, not less than shown on the drawings if a conveyor is to be used and preferably a little steeper if no conveyor is to be fitted.

The conveyor is of immense help and well worth its cost, for once on this the sheep slide on their hind-quarters into the dip in a very satisfactory manner. A few, of course, jump and otherwise take the water in various *frantic ways, but at the end of the dipping it will be found that few, if any, have been injured. The conveyor is merely a series of pipes set close* together and arranged so as to revolve freely. No foothold is to be provided about this conveyor. It was found in one case that a ⅝-inch bar which formed one side of the conveyor enabled a sheep to plant its feet so firmly as to defeat the purpose of the conveyor.

The wings of the approach end of the dip are necessary to prevent the *dip liquid being splashed over the sides, and also to prevent sheep jumping* sideways over the dip.

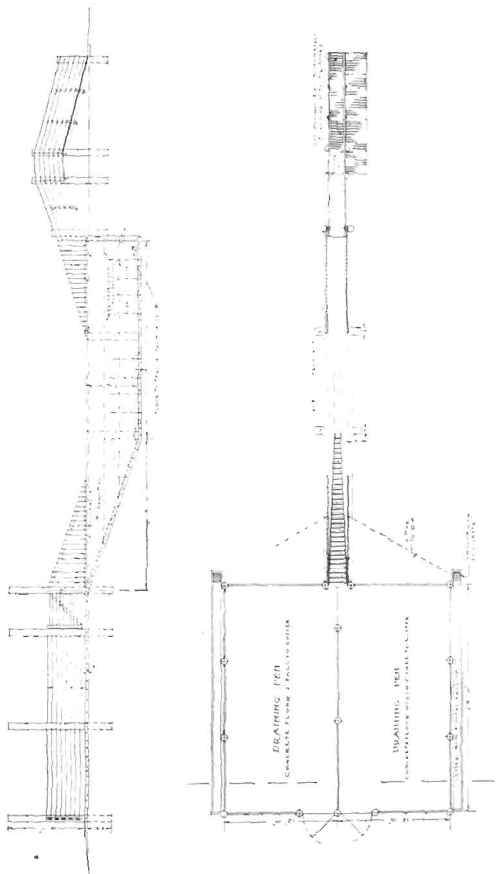


FIG. 12.—Details of Concrete Sheep Dip.
Top—Longitudinal section. *Bottom*—Plan.

The ramp and wings consist merely of substantial posts and 1¼-inch planks. Between the round posts are 4-inch x 3-inch uprights to further stiffen the walls, and to the bottom end of these 4-inch x 3-inch cross members are bolted, and additional supports for the floor. The ramp should be 16 inches wide at the bottom and 20 inches wide at the top between the boards.

The wings are constructed with a 4-inch x 3-inch bottom plate bolted to the top of dip, and a similar rail fixed to the bottom plate at one end, and the top of the post at the other end. To these rails 6-inch x 1¼-inch planks are nailed.

DRAINING PENS.

The essential requirement of the draining pens is a good fall to the floors and gutters so that the liquid will run back quickly into the dip. The floors, which are of concrete, should be reinforced, otherwise they may crack. This can easily be prevented, and the method recommended is to place in the concrete while it is being laid—about 1 inch from the top—lengths of No. 8 fence wire about 12 inches apart and then a second lot at right angles to the first, so as to form a series of wire meshes 12 inches x 12 inches. The ends of these wires should be bent or looped to prevent them slipping through the concrete. A couple of wires should also be laid lengthwise in the gutters to prevent cracking. The rails to draining pens should be 6 inches x 1½ inches and mortised into posts. For the gates 3-inch x 1-inch hardwood is used. The posts are carried up high enough to carry a tarpaulin in very hot weather to protect the sheep from scald.

CONCRETE.

The following statement on concrete has been compiled to indicate to the farmer how this material, with its wide range of utility, can be made and applied on the farm.

The term concrete is now generally held to imply a mixture of Portland cement, sand, and crushed stone, river shingle, coke, breeze, &c. Plain concrete is distinguished from reinforced concrete in that reinforced concrete is strengthened by means of steel—usually in the form of rods or wires to give it greater tensile strength.

Portland Cement.

Portland cement was invented by Joseph Aspdin, a bricklayer, in 1824, and the name "portland" was given to it because of the resemblance of its finished surface, when set, to English portland stone. It is an artificial cement and is now made in almost every country. Because of the demand made upon it for engineering and structural purposes, it has been raised to a uniformly high-class material. Failures in concrete work are mostly due to inferior aggregate, *i.e.*, sand and stone, or to workmanship, and seldom to the cement. By this it is not inferred that the quality of any parcel of cement may be taken for granted, but rather that cement, as at present manufactured in this State, is of uniformly high grade when it leaves the manufacturer's works.

Good cement is free from hard lumps, and to preserve this quality it should be stored away in a dry place on a non-absorbent floor. If stacked on the ground or a brick floor it will draw moisture and then quickly deteriorate. Cement was formerly marketed in sacks, eighteen of which

made a ton, and each contained 1¼ cubic feet. It is now usually sent out in paper bags, twenty-four of which make a ton, and each contains 1 cubic foot of cement.

The Sand.

To make good concrete the sand must be clean—free from vegetable material (such as leaves, grass, &c.) and any other foreign matter. The best sand is that which has been washed. To make a rough test of the amount of dirt contained in sand, rub it between the hands, when, if it is clean, there will be little or no stain.

Sand uniformly graded from coarse down to fine grains makes the strongest and most impervious concrete. Fine sand makes a weaker concrete than coarse sand, and screenings from crushed rock usually produce a stronger concrete than sand.

Metal.

The term metal is generally used to distinguish the coarse aggregate—crushed rock, gravel, &c.—used in the making of concrete. For general use about the farm almost any hard rock may be used for concrete. Like the sand it should be graded from large stones down to small pebbles, the purpose being to produce a dense concrete with a minimum of sand and cement. A uniformly graded metal has a minimum of voids or interstices, and therefore requires less cement and sand to bind the stones together.

The largest stones of the metal should not be too large for the particular job in hand. It is usual to specify that the metal shall be of a certain gauge. The gauge is a ring through which the largest stones will pass. As an indication of suitable gauges, 1½ inches may be used in the foundations of a cottage, 1 inch for walls, floors of sheds, stalls, cow bails, &c. For walls where steel reinforcement is used such as a fodder silo, ¾-inch gauge will be quite large enough; if the gauge is larger than this, difficulty will be experienced in packing the metal round the reinforcement.

In very thick walls where weight is the principal consideration, such as retaining walls for dams, "plums," or large stones are often buried in the concrete. In such construction this is quite permissible and saves concrete.

Gravel, sometimes called river shingle, should be evenly graded from coarse stones down to sand. The difference in strength of gravel concrete as against crushed rock is so slight, that the cheaper material may be used.

Metal or gravel used as aggregate must be free from clay or any substance that will prevent cement mortar adhering to it and bonding the whole together.

Where loco. ashes are obtainable, a very useful concrete for floors or sheds and verandahs, walls of cottages and sheds, small water tanks, and many other jobs not requiring great strength, may be made with one part cement, one part sand, and five parts of ashes.

Density is an important factor in the strength of concrete; with the same proportion of cement, the strength and water-tightness of concrete usually increases with its density.

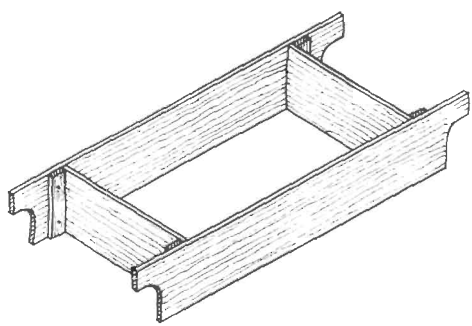
Mixing Concrete.

Concrete should be mixed on a wood, concrete, or other paved floor. If mixed on the ground, soil, grass, and other foreign matter is shovelled up with it and the concrete is weakened; the same result obtains if the mixer walks across the mixing floor with muddy boots.

The mixing floor should be reasonably watertight, otherwise the liquid cement will escape and impoverish the concrete. Mixing should be done as near the work as possible to expedite the job, and also because wheeling concrete long distances in barrows causes the water and cement to rise to the top and the metal to settle hard in the bottom, necessitating a good deal of scraping out, particularly when the metal and sand are poorly graded.

Proportions.—The proportions of cement, sand, and metal vary according to the work in hand, and, to a great extent, with the quality of the sand and metal. For foundations of a cottage, bases for engines, thick retaining walls and the like use one part cement, three parts sand, and six parts metal of 1½-inch gauge. For walls of a cottage, floors of sheds, verandahs, &c., one part cement, three parts sand, six parts metal of 1-inch gauge. For fence posts, fodder silos, water tanks, &c., one part cement, two and a half parts sand, and five of metal of ¾-inch gauge.

Gauge Boxes.—It is unwise and uneconomical to guess at the proportions. For small jobs the ubiquitous petrol or kerosene tin may be used for measuring the cement, sand, and metal. For large jobs, however, it pays to make wooden gauge boxes of the type illustrated below, which are not difficult to construct.



An Isometric Sketch of a Gauge Box.

As previously stated cement is now usually received in paper bags containing 1 cubic foot. A useful gauge box for a 1–2½–5 mix is 2 feet 6 inches wide, 4 feet long and 12 inches deep. This is filled with metal, and as the amount of sand used is half that of the metal, the same gauge box can be used by half filling it with sand. This quantity of metal and sand will require exactly two bags of cement.

For a 1–3–6 mix, a useful size is 2 feet 8 inches wide, 4 feet 6 inches long, and 12 inches deep. This may be used for the sand by half filling it, and the batch will require two bags of cement.

The gauge box is placed at one end of the mixing floor, and filled with metal; it is then lifted off, and the metal spread out to a depth of about 6 inches. The gauge box is then placed on top of the metal and half filled with sand: it is again lifted off and the sand spread evenly over the metal. The required amount of cement is then emptied on to and evenly spread over the sand. The whole is then turned over with a shovel, not throwing it into a heap, but rather spreading it out in a thin layer. By turning back once more, the cement, sand and metal will, if the turning is correctly done, be well mixed together in a dry state. The mixture should then be turned twice more while the water is sprinkled on through the rose of a watering can or hose. It is important to add only sufficient water to make a workable mixture. Too much water weakens the concrete. It tends to separate the cement and sand from the metal, and when wheeling the cement in barrows, the slurry rises to the top and the metal consolidates on the bottom. Immediately it is tipped, the slurry runs away to the lowest level, leaving a mass of impoverished metal. If the mix is too dry, it is hard to spread and pack in position, particularly in moulds. Well mixed concrete is spongy, quakes like jelly, leaves the barrows and buckets freely, is easily spread and worked into position. It does not require tamping; in fact, it cannot be tamped or rammed, rather is it consolidated by spading. It tends to consolidate itself, and when cast in moulds will, with a minimum of spading, present a clean, even surface when the moulds are removed.

Placing the Concrete in Position.

Immediately the concrete is mixed, it should be placed in its final position. It is necessary to prepare for it by excavating, grading, levelling off, &c., *or if it is to be placed in moulds these should be all ready to receive* it. The ground should be well sprinkled with water just prior to placing *the concrete. Moulds should be painted with a cheap grade of oil so that* they will leave the concrete freely when taken down. Concrete will become *quite useless if allowed to remain on the mixing board for hours.*

Bonding.

It is often necessary to place new concrete on top of concrete that has set hard, as, for instance, when building a wall. The joining of new work to old is called bonding, and should be understood, particularly when constructing water tanks, silos and the like, where a water-tight junction is necessary. Leave the top of the old concrete fairly smooth; then immediately before placing the new concrete on top of it sweep it clean, flush at intervals with water, and spread over it a ½-inch thick layer of mortar consisting of one part cement to two parts sand. This mortar will lie evenly on the old work, and the stones of the new concrete will bed down into it. If the surface of the old work is left rough and only a coat of slurry spread over it, the stones or metal of the old and new work will meet without any matrix or mortar between to bond them together, and a weak and leaky junction is the result.

Curing of Concrete.

In the process of setting or hardening, concrete uses up water, and its ultimate strength will be seriously impaired if this vital constituent is *allowed to evaporate through exposure to a hot, dry atmosphere* induced

by the sun or hot winds, or artificially by the lighting of a fire in a furnace, oven, &c., before the concrete is quite hard. To counteract the action of the sun and hot winds, concrete floors and similar structures should be covered with bags or sand and kept wet for several days. Walls and the like are, of course, protected by the moulds for some time, and it is not usual in ordinary structures to take special precautions with these, except where severe frost is likely. Frost will interfere with the setting of concrete until it is at least forty-eight hours old. It is therefore necessary to protect it with dry bags or iron, timber, and the like.

Rendering.

Rendering is the term applied to plastering or surfacing with cement mortar, *i.e.*, sand and cement. For floors, the proportions are one part cement to two parts sand. For walls it may be one part cement to three parts sand, but will not then be waterproof; for water tanks, dips, &c., it should be one to two. Rendering is usually laid on from ¾ inch to ½ inch thick. If required to be more than ½ inch thick, it should be done in two-coat work, the first coat being scratched in criss-cross fashion to provide a key for the next coat. Rendering must always be applied to well-moistened surfaces. For floors it should be put down a few hours after the concrete is laid, otherwise it will lift off the concrete and be what is known as "drummy." If it is found necessary to render floors of concrete that is old or has dried hard, or even of brick, it is necessary to soak the surface with water for some hours, and to brush over it a slurry of equal parts cement and sand immediately before applying the rendering.

Quantities of Materials.

The question is often asked as to how much cement, sand, and metal will be required for a particular job. The table given below, together with a brief explanation, should enable anyone to compute these quantities.

MATERIALS Required for 1 Cubic Yard of Concrete.

Mixture.			Required for 1 cubic yard.		
Cement.	Sand.	Stone.	Cement.	Sand.	Stone.
			Cub. ft.	Cub. ft.	Cub. ft.
1	2	4	5·84	11·88	23·76
1	2·5	4	5·44	14·04	22·14
1	2·5	5	4·76	12·42	24·57
1	3	5	4·52	13·77	22·95
1	3	6	4·00	12·42	24·84
1	3	6·5	3·84	11·88	26·65

An example will perhaps make the matter more clear. If for instance, it is desired to lay a concrete floor 4 inches thick gauged 1–3–6 in a room 12 feet by 14 feet, the total quantity of concrete required will be 12 by 14 by ⅓ = 56 cubic feet = approximately 2 cubic yards. From the table of quantities for a 1–3–6 mix it will be seen that for 1 cubic yard of concrete, the materials required are 4 cubic feet of cement, 12.42 cubic feet of sand, and 24.84 cubic feet of metal. Therefore, for 2 cubic yards, twice

these quantities will be required. If, say, 8 cubic yards of concrete were required for a job, the quantities in the table would be multiplied by eight. As a bag of cement contains 1 cubic foot, the quantity of cement required, as computed in cubic feet, is the quantity in bags.

For rendering a bag of cement mixed with two equal bags of sand will cover about 8½ square yards ¾ inch thick, and 6½ square yards ½ inch thick.

TREES ON THE FARM.

In the early days of settlement, when the process of clearing was essential for the progress of settlement, many landowners came to regard tree life as an enemy and something to be destroyed, an idea which still persists in the minds of many. It should, however, be generally recognised that the prosperity, fertility, and comfort of any country is intimately associated with the existence and preservation of forest cover.

Apart from the general benefits of forest cover, trees may be usefully employed on the farm or pastoral areas in the following capacities:—

1. As windbreaks and shelter belts.
2. As isolated or scattered shade and shelter trees.
3. As a reserve supply of fodder for periods of drought.
4. As tree plantations to supply the timber and fuel requirements of the farm, in addition to providing a source of revenue by the sale of products.
5. As screens around dams and tanks to prevent silting up by dust, and undue evaporation of the water contents.
6. As a means of preventing erosion on slopes and along the banks of creeks and rivers.
7. As ornamental trees in improving the appearing of the homestead.

Windbreaks and Shelter Belts.

Windbreaks and shelter belts play an important part in the economy of farm management, and practically every district in New South Wales has a greater or lesser need of them. They break the mechanical force of the wind, thus preventing undue damage to crops; they provide very necessary shelter for stock of all kinds; they prevent soil erosion and removal of top soil due to unrestricted wind action; they reduce evaporation and help to conserve moisture, and when planted near dwellings greatly add to the comfort of the farmer and his family by giving protection from the extremes of winter cold and summer heat, and from dust storms.

One objection to windbreaks is that trees composing the breaks rob adjoining ground of moisture and food material. Usually, however, the crop gain in the protected zone is more than sufficient to balance the effect of sapping, which can also be reduced to a minimum by deep ploughing or even trenching every year along the windbreaks to cut off surface roots, and by deeply ploughing the site for the break before planting, so as to encourage deep rooting.

Shade and Shelter Trees.

Scattered single trees or clumps of trees are necessary, particularly on pastoral and dairying areas, for the protection of stock during the heat of summer and the cold winds of winter. In many districts paddocks have been cut right over when clearing, and no provision made for shelter or shade trees. In our western districts especially, stock have an imperative need of sufficient shade for summer months, and in big open paddocks they are usually found gathered under the sparse shade of the few trees left standing.

Generally speaking, the settler has been too free with the axe in certain districts, and he frequently justifies his action by stating that it was necessary in order to provide a good growth of grass. Standing trees, however, within limits, do not interfere with the value of land from a pastoral point of view. Out in our western districts trees undoubtedly improve pasture land, apart from their shade and fodder value. When denuded of trees the surface soil is swept away. Moreover, the leaves provide a litter in which the seeds of native grasses lodge and find a suitable seed-bed.

Fodder Trees.

The advantage of having fodder trees on pastoral areas has been so frequently demonstrated during periods of droughts that most pastoralists recognise their importance and are provided for them to some extent. Fodder trees also function as shade and shelter trees, and thus have a double value, but shade trees other than fodder trees should also be provided for, as fodder trees when lopped cease to function as shelter trees, and this at a time when shade is urgently required, viz., drought periods.

Tree Plantations or Wood-lots.

There is in certain districts a marked lack of timber supplies for local needs. Even fuel has to be carted 10 to 20 miles where previously it was available practically at the farmer's back door. When timber is required for fencing or building the farmer finds he has no longer a convenient supply. In many districts, of course, there are still ample supplies close at hand, but even in these a future shortage appears to be inevitable.

It is the business of the Government to see that the State forests are so managed that a supply of timber for future generations is assured, but it is also to the advantage of the farmer and pastoralist to see that a supply is available on his own area to meet his personal needs. The only reasonable way of meeting the situation is by growing a plantation of trees on his holding, from which he can obtain all his timber and fuel requirements, and possibly add to his income by the sale of its products.

There is another aspect to the matter. A well-managed farm is a farm where every inch is growing the crop most suited to its particular features. Most farms have certain parts which, by reason of steepness of slope, rocky nature, poor soil, &c., cannot be profitably employed in the raising of an ordinary crop. The best way of utilising such an area is by converting it into a tree plantation.

Trees as Screens Round Dams or Tanks.

An adequate water supply is an all-important point in the drier parts of the State. Stock are largely dependent on the water gathered in open earthen tanks or dams, and during the hot dry months of summer, particularly when winds are blowing, evaporation from the surface of the water

goes on unchecked, and reaches considerable proportions. A belt of trees on the windward side would help considerably to reduce evaporation. In the case of cleared paddocks, it would pay to fence off an area and plant it with young trees. Such a break would also provide shade and protection for stock. Silting up would also be lessened, as in open areas a considerable amount of dust and light soil is blown into the depressions formed by the tanks.

The Utility of Trees in Preventing Erosion.

A fair amount of good soil is lost, particularly on hilly country, through erosion. Every farmer can protect his own area by maintaining trees on those parts of his farm where erosion might be expected. The tops of small hills and ridges might be used as small tree lots, and apart from reducing erosion, would provide shelter for stock. A considerable amount of good land is frequently lost along the banks of creeks and streams, by the action of flood waters; the effects are aggravated by the removal of trees and shrubs along the banks.

Preparation of the Ground.

Thorough preparation of the soil is necessary. Where a number of trees are being planted together, as in the case of windbreaks, avenues, or tree lots, the land should be first ploughed. New land should be broken up before winter and allowed to lie until planting time. A plan which has its advantages is to make the first ploughing only deep enough to cover the grass and herbage. Shortly before planting the ground should be cross-ploughed deeply and then harrowed. Ground previously under crops would probably contain many weed seeds, and to enable the young trees to become established before the weed growth becomes unduly aggressive, such land should be ploughed and harrowed, and planted immediately afterwards with the trees. When hillside planting is being carried out, the ploughing should follow the contour of the hills as far as possible.

Planting.

Nursery-raised stock provide the most healthy and suitable plants, and if correctly handled show little interruption to their growth and very few total losses. Raising stock by the landowner himself has much to recommend it, particularly where it is intended to plant a fairly large number of trees. The operations involved are simple, and present few difficulties except in certain species.

The object of windbreak and shelter belt formations is to protect the largest possible area from the effect of injurious or unpleasant winds, and this result is secured by the planting of a row or belt of trees at right angles to the direction of the wind against which protection is sought. Both the efficiency of the break and its landscape effect are increased, however, if it be placed somewhat obliquely or curved, instead of strictly at right angles to the direction of the wind. The most effective type is where two or more rows are planted. This permits the employment of several different species of varying height growth, so that the density of the break from top to bottom is more uniform. A windbreak consisting of more than one species is usually the more effective. The ideal windbreak should have more or less the contour of an earth mound with the tallest trees in the centre and graduating down to low, shrubby species on either side. Generally speaking, in breaks consisting of more than one row, conifers should be planted about

10 feet apart, and eucalypts about 12 to 15 feet apart in the rows, the rows themselves being the same respective distance apart. Closer or wider planting varies with local conditions and requirements. Where more than one row is employed, the planting should be triangular, the second row being planted so that the trees come opposite the centre of the space between the trees in the first row.

The spacing of the plants in the tree-lot depends on the nature of the species and the object of growth. Close planting makes for clean timber free of knots, so that where the timber is being raised for milling purposes the spacing should be fairly close. Where only fuel is required the question of spacing is not so important. In the majority of cases the most suitable spacing distance to adopt will be 8 feet by 8 feet, that is, 8 feet between the trees in a row and 8 feet between the rows themselves. This is the usual planting distance adopted for conifers in New South Wales, but a closer spacing of 6 feet by 6 feet would probably produce cleaner timber, and, on poor coastal soils particularly, would help to prevent weed growth and establish the forest canopy. Close planting has the desirable feature that the trees grow quickly, shade the ground, and keep out grass and weeds, whereas wider spacing lengthens the period during which cultivation is necessary.

When stock is obtained from a nursery the plants will arrive either in pots or open rooted. Potted plants will merely require to be placed in a sheltered spot and kept watered until needed for planting out, but open rooted ones should be immediately heeled in. If the roots are at all dry they should be first dipped into a mixture of clay and water, and then placed in a narrow trench in a slanting position, the earth being well pressed down about the roots and thoroughly watered. The soil should be kept moist until the stock is planted out. If exposed to sun the tops should be shaded in some way to prevent excessive loss of moisture. Provided they are properly heeled in, the plants may remain in the trenches for several weeks without injury, but the period should be kept as short as possible. When being removed to the planting site, the roots should be protected by immersing in water, or covering with wet sacking, as a few minutes' exposure to bright sunlight or to a drying wind will jeopardise their chance of survival.

A hole should be made large enough to accommodate the full spread of the roots comfortably, and with a raised mound in the bottom sloping down towards the sides. The roots should be spread over the mound in a natural position, so that no cramping or intertwining takes place, and with the ends of the roots all pointing in a downward direction. Fine soil should be filled in about the roots, firmly pressed down so that no air cavities are left, and thoroughly watered. After the water has soaked in, the remaining soil should be filled in, but kept loose and dry. In this way it acts as a mulch and retards evaporation. Plants should be placed slightly deeper than they were in the nursery to allow for the loose soil settling, but the final depth should be the same as in the nursery. Plants from pots and ones with balls of earth attached should be planted without disturbing the roots unduly, but some advantage is to be gained by slightly loosening the soil round about the bottom of the roots. Pressing the soil heavily down about the roots, watering well, and mulching with loose, dry soil on the top are the main essentials for successful planting. In dry, hot localities a saucer-like depression should be formed at the surface round the plant to collect moisture.

Planting Period.

The best time for planting is when the plant is at its resting period, and when moist, cool conditions prevail. Generally speaking, May to August are the best months. The effects of frosts must be studied, and spring planting is often necessary in some localities, except for deciduous species. Where the rainfall is heavy and conditions generally cool, the planting period may be considerably extended. A cool, cloudy day and a fairly moist soil provide ideal conditions.

Protection and Care of Planted Trees.

Any care exercised in planting trees is rendered ineffective unless they are protected from injury, and a degree of assistance is given to their proper development. The chief danger threatening young trees on the farm and pastoral area is damage by stock, and it is useless making plantings unless the whole of the area is effectively fenced off from animal invasion. Stock not only destroy or injure young plants, but by trampling and packing the soil nullify the effect of preparatory cultivation.

The fence should be stock-proof, and either permanent in character or sufficiently well constructed to keep out stock until the trees are beyond the reach of the largest animals. As the trees grow older, stock can be admitted from time to time with advantage, as they serve to destroy weed growth and lessen the danger of fire by removing surface litter. A permanent fence with a properly constructed gateway permits the regulation of such entry. Where it is only intended to protect the trees until sufficiently well grown to be proof against stock damage, a barbed wire fence is very effective. Where single shade or ornamental trees are planted out they should be protected by some form of tree guard. Protecting fences or tree guards should be provided for before the young trees are planted out.

It may be imagined that an ordinary ground fire running through an area of well developed trees would do little harm, but such fires are often hot enough to scorch and kill the living cambium layer just beneath the bark and outer wood, without the tree showing very evident injury. This results in cessation of growth in that portion, and commencement of decay, such fires being often the cause of many trees being rotten at the base. Fire scars are also formed which deepen with every burn, eventually undermining the tree and paving the way for the entrance of timber destroying fungi and insects. The surface roots of trees are injured and valuable humus burnt out. Any young growth is destroyed.

The area under trees should be cultivated two or three times a year, especially for the first two or three years, in order to keep down weeds, prevent undue evaporation of moisture, and maintain good soil conditions. Weed growth in the early stages is particularly injurious, as it tends to suppress or completely destroy young tree growth, especially of the slower growing species. Weeds, moreover, increase the danger from fire, and reduce the available moisture supply. Under certain conditions, however, weed growth is of value in providing shelter for trees which are liable to injury by excessive heat, frost, &c., and on slopes and shifting sandy soil is of assistance in binding the soil. Where a cultivator can be used, operations are simplified, but where it is not possible to employ a machine, the trees should be periodically hoed around. Cultivation is particularly desirable in dry areas, and frequently means the difference between success

and failure. Cultivation may usually be discontinued as soon as the canopy of leaves offers protection to the soil, or when surface roots interfere with operations. In rabbit-infected country the trees may have to be protected by netting.

Mistletoe growth should be removed as soon as observed. As the roots of this parasite extend below the surface of the wood the whole of the branch infested should be sawn off and burnt where possible.

In many cases there will be a small amount of loss in the trees planted, and these should be replaced as early as possible. Most losses will occur in the first month or so, and replanting should be made immediately. If left until the next season, the "replants" will seldom catch up to the older trees, and are liable to suppression, except where spacing is wide.

Trees Recommended for Various Districts.

The selection of the right species is the foundation of all tree-planting work, and the landowner cannot exercise too much care in this matter. A mistake in selection is disastrous, especially as the early growth of a tree is no sure indication of its suitability for the locality.

THE WESTERN PLAINS.

The following list gives the species recommended for planting for different purposes in this division. All the species mentioned are not suitable for every portion of the division or for all situations. A selection might be made to meet the individual requirements of a particular locality:—

Shade and Shelter Trees.

Wilga (*Geijera parviflora*).
Kurrajong (*Brachychiton populneus*).
Pepper (*Schinus molle*).
Silky Oak (*Grevillea robusta*).
White Cedar (*Melia Azedarach*). (Deciduous.)
Myall (*Acacia pendula*).
Gruie (*Owenia acidula*).
Belah (*Casuarina lepidophloia*).
Ironwood (*Acacia excelsa*).
Flooded Box (*Eucalyptus bicolor*).
Gum (*Eucalyptus dealbata*).
Rosewood (*Heterodendron oleaefolium*).
River Red Gum (*Eucalyptus rostrata*). In clumps.
Sugar Gum (*Eucalptus cladocalyx*). In clumps.
Mugga (*Eucalyptus sideroxylon*).
Willows (*Salix babylonica*). River banks in eastern portion.
Cooba or Native Willow (*Acacia salicina*). River banks.
Wild Orange (*Capparis Mitchelli*).
Coolabah (*Eucalyptus microtheca*).
Bloodwood (*Eucalyptus terminalis*).
*Evergreen Oak (*Quercus virginiana*).
*Morton Bay Fig (*Ficus macrophylla*) and other *Ficus* species.
**Lagunaria Patersoni*.
*Olive Tree (*Olea europea*).

[illegible] and artificial watering is possible.

Windbreaks and Shelter Belts.

Group I—

Wilga (*Geijera parviflora*).
Kurrajong (*Brachychiton populneus*).
Belah (*Casuarina lepidophloia*).
Myall (*Acacia pendula*).
Pepper (*Schinus molle*).
Silky Oak (*Grevillea robusta*).
Tree Lucerne (*Cytisus proliferus*).

Group II—

Sugar Gum (*Eucalyptus cladocalyx*).
Mugga (*Eucalyptus sideroxylon*).
River Red Gum (*Eucalyptus rostrata*).
Flooded Box (*Eucalyptus bicolor*).
Bimble Box (*Eucalyptus populifolia*).

Group I includes shorter-growing species, from which the outer rows of two or more rowed breaks may be selected, and Group II represents the taller-growing species, from which the inner or central row may be chosen. For example, the following combinations may be made:—Kurrajong and Sugar gum, Silky Oak and Mugga, Wilga and River Red Gum. Any of the species from either group may be used for a single line break, or a multiple-row break of one species.

Fodder Tree Plantations.

Although a number of the western trees provide useful fodder, it is wise to restrict selection to the best species, viz., Kurrajong. In localities where this tree will not do well, plantations may be made of those local trees which make good growth, such as Mulga, Myall, or Supple Jack, as the case may be.

Trees for Timber.

White Pine (*Callitris robusta*). House construction, &c.
River Red Gum (*Eucalyptus rostrata*). General hardwood purposes.
Mugga (*Eucalyptus sideroxylon*). General hardwood purposes.
Flooded Box (*Eucalyptus bicolor*). Fencing and heavy work.
Belah (*Casuarina lepidophloia*). Fencing and general utility.

Trees for Fuel.

The various species of *Acacia*, including Myall (*Acacia pendula*) and Yarran (*Acacia homalophylla*).

The Belah (*Casuarina lepidophloia*) and some of the Eucalyptus species might also be planted.

A fairly large number of the species mentioned cannot be obtained from the ordinary nurseryman, who includes a very limited selection of trees in his list. Where such is the case, plants should be raised from seeds collected from local trees.

WESTERN SLOPES DIVISION.

Where conditions are very dry and approximate those of the Western Plains, the list of recommendations for that division should also be consulted.

Trees for Shade and Shelter.

Kurrajong (*Brachychiton populneus*) F.
Wilga (*Geijera parviflora*) F.
Myall (*Acacia pendula*) F.
*Yellow Box (*Eucalyptus melliodora*).
Drooping She Oak or Mountain Oak (*Casuarina stricta*). F.
Fuzzy Box (*Eucalyptus conica*).
Red Gum (*Eucalyptus deatbata*).
River Gum (*Eucalyptus rostrata*).
Sugar Gum (*Eucalyptus cladocalyx*).
*Red Stringybark (*Eucalyptus macrorrhyncha*).
Apple (*Eucalyptus Stuartiana*).
*River Oak (*Casuarina Cunninghamiana*) F. Along banks of streams.
Willow (*Salix babylonica*) F. Along banks of streams.
Cooba (*Acacia salicina*). Along banks of streams.
Tree Lucerne (*Cytisus proliferus*) F.
Pepper (*Schinus molle*).
*White Box (*Eucalyptus albens*).
*Apple (*Angophora intermedia*) F.
Plane Tree (*Platanus orientalis*). Deciduous.
White Cedar (*Melia azedarach*). Deciduous.
*Almond (*Prunus amygdalus*).
*Walnut (*Juglans* spp.).
*Elm (*Ulmus* spp.).
*Camphor Laurel (*Cinnamomum camphora*).
*Carob Bean (*Ceratonia siliqua*) F.
Agonis flexuosa.
Moreton Bay Fig (*Ficus* spp.).
Red Ash (*Alphitonia excelsa*). F. Northern subdivision.
*Insignis Pine (*Pinus radiata*).
*Stone Pine (*Pinus pinea*).
*Aleppo Pine (*Pinus halepensis*). On limestone.
*Cootamundra Wattle (*Acacia Baileyana*).
*Queensland Silver Wattle (*Acacia podalyriaefolia*).
Motherumbah (*Acacia Cheelii*). F. Northern subdivision.

Windbreaks and Shelter Belts.

Group 1.—Shorter-growing species.

†Kurrajong (*Brachychiton populneus*).
Wilga (*Geijera parviflora*).
Myall (*Acacia pendula*).
†Almond (*Prunus amygdalus*).
†Walnut (*Juglans* sp.).
†Olive (*Olea europea*).
†Tree Lucerne (*Cytisus proliferus*).
Motherumbah (*Acacia Cheelii*).
†Carob Bean (*Ceratonia siliqua*).
Camphor Laurel (*Cinnamomum camphora*).
Agonis flexuosa.
Pepper Tree (*Schinus molle*).
†Osage Orange (*Maclura aurantiaca*).
Cootamundra Wattle (*Acacia Baileyana*).
Some Cypresses.

F. indicates fodder trees.

*Generally speaking, best adapted to the eastern half of the division, or where conditions are fairly favourable. Some require some artificial watering for successful establishment.

†The most suitable ones for orchard breaks.

Group II.—Taller-growing species.

Insignis Pine (*Pinus radiata*).
Canary Island Pine (*Pinus canariensis*).
Aleppo Pine (*Pinus halepensis*).
River Gum (*Eucalyptus rostrata*).
Red Gum (*Eucalyptus dealbata*).
Yellow Box (*Eucalyptus melliodora*).
White Box (*Eucalyptus albens*).
Apple (*Eucalyptus Stuartiana*).

Trees for Timber.

Hardwoods—

Ironbark (*Eucalyptus crebra*).
Red Stringybark (*Eucalyptus macrorrhyncha*).
River Gum (*Eucalyptus rostrata*).
Red Gum (*Eucalyptus Blakelyi*).
White Box (*Eucalyptus albens*).

Softwoods—

White Cypress Pine (*Callitris robusta*).
Insignis Pine (*Pinus radiata*). Only where conditions are favourable.
Canary Island Pine (*Pinus canariensis*). Only where conditions are favourable.

Trees for Fuel.

White Box (*Eucalyptus albens*).
Yellow Box (*Eucalyptus melliodora*).
Acacia spp., including *Acacia pendula* and *Acacia homalophylla*.
Oaks (*Casuarina Cunninghamiana* and *Casuarina Luehmanni*).
Belah (*Casuarina lepidophloia*).

THE TABLELAND DIVISION.

Shade and Shelter Trees.

Camden Woolly Butt (*Eucalyptus Macarthuri*).
Peppermint (*Eucalyptus radiata*).
Apple (*Eucalyptus Stuartiana*).
A messmate (*Eucalyptus aggregata*).
Yellow Box (*Eucalyptus melliodora*).
Snow Gum (*Eucalyptus coriacea*).
Blackwood or Hickory (*Acacia melanoxylon*).
Cedar Wattle (*Acacia elata*).
Green Wattle (*Acacia decurrens* var. *normalis*).
Cootamundra Wattle (*Acacia Baileyana*).
Insignis Pine (*Pinus radiata*).
Stone Pine (*Pinus pinea*).
Deodar (*Cedrus Deodara*).
†*Willow (*Salix babylonica*).
Magnolia (*Magnolia grandiflora*).
She Oak (*Casuarina leptoclada*).
Chinese Elm (*Ulmus parvifolia*).
†Pin Oak (*Quercus palustris*).
Sweet Gum (*Liquidambar styraciflua*).
Pecan Nut (*Carya pecan*).
†English Elm (*Ulmus campestris*).
†Plane Tree (*Plantanus orientalis*).
†Honey Locust (*Gleditschia triacanthos*).
†Horse Chestnut (*Aesculus hippocastanum*).

* Along watercourses. †Deciduous.

Trees for Windbreaks and Shelter Belts.

Group 1.—Smaller-growing species to be used for small breaks, or in association with taller species in multiple-row breaks.

- Walnut (*Juglans* sp.).
- Chinese Privet (*Ligustrum lucidum*).
- Almond (*Prunus amygdalus*).
- Tree Lucerne (*Cytisus proliferus*).
- Osage Orange (*Maclura aurantiaca*).
- Cootamundra Wattle (*Acacia Baileyana*).
- A wattle (*Acacia aduncа*).
- Strawberry Tree (*Arbutus unedo*).
- Cypresses (various) (*Cupressus* spp.).

Group 2.—Taller-growing species.

- Insignis Pine (*Pinus radiata*).
- Yellow Pine (*Pinus ponderosa*).
- Camden Woolly Butt (*Eucalyptus Macarthuri*).
- Yellow Box (*Eucalyptus melliodora*).
- Tasmanian Blue Gum (*Eucalyptus globulus*).
- Peppermint (*Eucalyptus radiata*).
- Broad-leaf Peppermint (*Eucalyptus dives*).
- Cedar Wattle (*Acacia elata*).
- Poplar (*Populus* spp.).

Hardwood Timber Trees.

- Red Stringybark (*Eucalyptus macrorrhyncha*)—lower elevations.
- Blue Topped Stringybark (*Eucalyptus agglomerata*).
- Mountain Ash (*Eucalyptus gigantea*).
- Cut-tail (*Eucalyptus fraxinoides*).
- Eurabbie (*Eucalyptus bicostata*).
- Caley's Ironbark (*Eucalyptus Caleyi*)—lower elevations of New England.
- Red Box (*Eucalyptus polyanthemos*)—fencing, lower elevations.
- Yellow Box (*Eucalyptus melliodora*)—fencing, &c., lower elevations.
- Snow Gum (*Eucalyptus coriacea*)—for fencing where better species will not grow.
- Peppermint (*Eucalyptus radiata*)—where better species not suitable.

Softwood Timber Trees.

- Insignis Pine (*Pinus radiata*).
- Yellow Pine (*Pinus ponderosa*).
- *Mountain Gum (*Eucalyptus Dalrympleana*).
- *Mountain Ash (*Eucalyptus gigantea*).

Fuel Trees.

- Yellow Box (*Eucalyptus melliodora*)—lower elevations.
- Stringybarks (*Eucalyptus macrorrhyncha* and other species).
- Snow Gum (*Eucalyptus coriacea*).
- Brittle Gum (*Eucalyptus microneutha*).
- Peppermint (*Eucalyptus radiata*).
- Black Sally (*Eucalyptus stellulata*)—on damp flats, &c.
- She Oak (*Casuarina leptoclada*).
- Wattles (*Acacia* spp.).

*These species are not true softwoods, but are suitable for many softwood purposes, such as cask-making, &c.

THE COASTAL DIVISION.

Trees for Shade and Shelter.

Brush Box (*Tristania conferta*).
Apple (*Angophora intermedia*).
Teak (*Flindersia australis*).
Black Bean (*Castanospermum australe*).
Wheel Tree (*Stenocarpus sinuatus*).
Tulip (*Harpullia pendula*).
Rosewood (*Dysoxylon fraserianum*).
Tallow Wood (*Eucalyptus microcorys*).
Swamp Mahogany (*Eucalyptus robusta*).
Bangalay (*Eucalyptus botryoides*).
Blue Gum (*Eucalyptus saligna*).
Ironbark (*Eucalyptus paniculata*).
Spotted Gum (*Eucalyptus maculata*).
Yellow Box (*Eucalyptus melliodora*).
*Yellow Bloodwood (*Eucalytpus eximia*).
Figs (*Ficus* spp.).
†Flame Tree (*Brachychiton acerifolius*).
†Coral Tree (*Erythrina corallodendron*).
‡Red Cedar (*Cedrela australis*).
†White Cedar (*Melia azedarach*).
†Jacaranda (*Jacaranda ovalifolia*).
Cape Chestnut (*Calodendron capense*).
Lillipilli (*Eugenia Smithii*).
Weeping Lillipilli (*Eugenia ventenantii*).
Camphor Laurel (*Cinnamomum camphora*).
Tea Tree (*Melaleuca leucodendron and M. styphelioides*).
Turpentine (*Syncarpia laurifolia*).
Wattles (*Acacia* spp.).
*Smooth-barked Apple (*Angophora lanceolata*).
Insignis Pine (*Pinus radiata*).
Live Oak (*Quercus virginiana*).

Trees for Windbreaks and Shelter Belts.

Group 1.—Smaller growing species to be used for small breaks, or in association with taller species in multiple-row breaks.

Queensland Nut (*Macadamia ternifolia*).
Olive (*Olea europea*).
Camphor Laurel (*Cinnamomum camphora*).
Tulip (*Harpullia pendula*).
Lemon-scented Backhousia (*Backhousia citriodora*).
Carob (*Ceratonia siliqua*).
New Zealand Christmas Bush (*Metrosideros tomentosa*).
‡Lillipilli (*Eugenia Smithii*).
‡Weeping Lillipilli (*Eugenia ventenanti*).
‡Pittosporum (*Pittosporum undulatum*).
Magnolia (*Magnolia grandiflora*).
§Turpentine (*Syncarpia laurifolia*).
Davidsonia pruriens.
Chinese Privet (*Ligustrum lucidum*).
Cypresses (*Cupressus* spp.).
Wattles (*Acacia* spp.).

Group 2.—Taller-growing species.

Insignis Pine (*Pinus radiata*).
Cluster Pine (*Pinus pinaster*).
Turpentine (*Syncarpia laurifolia*).
Brown Pine (*Podocarpus elata*).
Wheel Tree (*Stenocarpus sinuatus*).
Silky Oak (*Grevillea robusta*).

*On poor, rocky sandstone soils. †Deciduous.
‡ Subject to wax scale. § Can be cut back as a tall hedge.

Group 2.—Taller-growing species—*continued.*

Teak (*Flindersia australis*).
Kaffir Plum (*Harpephyllum caffrum*).
Black Bean (*Castanospermum australe*).
Tallow Wood (*Eucalyptus microcorys*).
Blackbutt (*Eucalyptus pilularis*).
Blue Gum (*Eucalyptus saligna*).
Ironbark (*Eucalyptus paniculata*).
Swamp Mahogany (*Eucalyptus robusta*).
Pink-flowering Ironbark (*Eucalyptus siderozylon*).
Woolly Butt (*Eucalyptus longifolia*).
Bangalay (*Eucalyptus botryoides*).
Tea Tree (*Melaleuca leucodendron and M. styphelioides*)

Trees for Hardwood Timber.

Stringybarks (*Eucalytpus eugenioides* and *E. Muelleriana*)—On sedimentary soils.
White Mahogany (*Eucalyptus acmenioides*)—On fairly good moist soils in northern portion.
Ironbark (*Eucalyptus paniculata*)—Various soils except poor sandy types.
Narrow-leaf Ironbark (*Eucalyptus crebra*)—On moderately good soils.
Blue Gum (*Eucalyptus saligna*)—On fairly deep soils.
Tallow Wood (*Eucalyptus microcorys*)—Good deep fairly moist soil.
Blackbutt (*Eucalyptus pilularis*)—Various soils.
Grey Gum (*Eucalyptus punctata*)—Rather poor siliceous soils.
Bloodwood (*Eucalyptus corymbosa*)—For fencing on poor sandy soils.

Trees for Softwood Timber.

Hoop Pine (*Araucaria Cunninghamii*).
Norfolk Island Pine (*Araucaria excelsa*).
Brown Pine (*Podocarpus elata*).
Insignis Pine (*Pinus radiata*).
Cluster Pine (*Pinus pinaster*).
Coachwood (*Ceratopetalum apetalum*)—Not a true softwood species, but

SECTION IV.

Wheat Culture.

THE present important position of wheat-growing in New South Wales is the result of a development extending over the past forty years. In 1891 the area devoted to this cereal was only one-third of a million acres; to-day it is more than ten times that. In 1891 wheat occupied less than 40 per cent. of all our cultivated lands; to-day it represents over 80 per cent. For the year 1926-27 the area sown with wheat was 3,700,108 acres, of which 3,352,736 acres were harvested for grain, and yielded 47,379,200 bushels, or an average of 14.1 bushels per acre, and 331,213 acres were cut for hay, and yielded 393,915 tons. The area sown in 1927-28 was 3,998,760 acres, but the season was extremely unfavourable and the crop harvested was much below average, being only 27,041,100 bushels of grain and 342,974 tons of hay.

Upon the many factors that have influenced this development it is impossible to dwell here, but two or three of the most important may be briefly indicated.

In the first place, wheat is a staple article of food with all white people and the number of consumers is being steadily increased, not alone in obedience to natural law, but by other races becoming eaters of bread. An assured market thus awaits the grower, and for the most part at a payable price.

The comparative ease with which wheat can be grown has also influenced the rapid extension of our wheat areas. For many a year wheat could be sown on land that had been prepared in a rough and casual manner with a reasonable chance of a profitable return, and it was under the influence of such conditions—cheap land, cheaply farmed—that wheat-growing became far the most important agricultural pursuit in New South Wales. The rapid increase in area that marked the first epoch in the history, however, has been steadied by several factors—notably by the increase of land value, the enormous rise in wages, and the advance in the price of all machinery and all other necessities. The crop is still profitable if properly handled, however, and it has an assured and essential place among our primary interests.

Two other factors of much significance have also operated to make wheat-growing of first-rate importance; first, the production of improved varieties, and, second, the evolution (for such it has largely been) of better cultural methods and of better machinery. For the first of these the plant-breeders of the Department are largely responsible. By the crossing of numbers of varieties they have produced wheats of such yielding capacity under dry conditions as Federation, Canberra, Waratah, Firbank, Florence, and Clarendon, thereby enabling large areas hitherto considered outside the wheat belt to be brought under cultivation. Prior to the introduction of these wheats, the varieties in use were principally the purple straw types of wheat—late in maturing, tall-growing and flaggy, forming a high percentage of straw to grain, and requiring a very favourable growing period.

The improved types of wheat are marked by early maturity, short straw, sparse foliage, and high percentage of grain to straw; their demand upon soil moisture is thus less than that of the old wheats, and they are therefore particularly suited to the drier portions of the State. The change has been of the greatest importance. The growing of the midseason wheats has enabled the production of more reliable crops in the favoured portions of the wheat belt which have a rainfall of 20 inches or more per annum, and the early wheats have extended wheat-growing into the drier areas.

Improved farm methods and modern machinery have done hardly less for wheat-growing in New South Wales than the introduction of new varieties, and it may be anticipated that the practice of fallowing will enable still further extension of the industry into dry districts, while a better understanding of the working of different soils will result in more reliable yields in the safer districts. To all this may be added considerable improvements in the machinery used for cultivating, sowing and harvesting the crop—factors that have acted as some set-off against the increasing rates of wages and prices of necessary commodities. These improved machines have generally been Australian inventions. It is largely by reason of the up-to-date implements used that Australia can continue profitably to extend her wheat-growing operations. Combine drills, by enabling seeding operations to be carried out much quicker, have relieved much of the anxiety associated with the sowing period. Rigid tine scarifiers, on which different sized points can be used, have resulted in improved fallows, and the introduction of the modern reaper-thresher with crop-lifting attachments has greatly lessened the risk at harvest time.

The Wheat Districts of New South Wales.

The districts of New South Wales in which wheat is grown may, for convenience and for purposes of easy identification, be classified briefly as follows:—

1. South-western Slopes and Eastern Riverina (of which Wagga, Temora, Wyalong and Barellan are representative).
2. Central-western Slopes (of which Dubbo, Gilgandra, Wellington, Cowra, Grenfell, Forbes, and Parkes are representative).
3. North-western Slopes (of which Tamworth and Gunnedah are representative).
4. South-western Plains and Western Riverina (of which Deniliquin and Hillston are representative).
5. Western Plains (of which Nyngan, Trangie, and Condobolin are representative).
6. North-western Plains (of which Coonamble is representative).
7. Southern Tableland (of which the Monaro, Crookwell, and Batlow are representative).
8. Central Tableland (of which Bathurst is representative).
9. Northern Tableland (of which Glen Innes is representative).
10. Murrumbidgee Irrigation Areas.
11. Coastal districts (which are specially subject to rust).

Classes of Soil.

All classes of land are to be found in the wheat-growing country, ranging from fairly heavy clays to light sandy loams. The heavy soils produce good yields in favourable seasons, but the yield is not so satisfactory in dry years. The light sandy loams can generally be depended upon to return profitable crops in almost any season, but, as a rule, lighter yields are obtained than from heavy soils. Most of the land on which wheat is grown is a medium red loam that is easy to work, retains moisture well, and is fairly rich. It is usually of slate, basaltic or granite origin, the granite formation prevailing.

Grey and yellow box, pine, apple-tree, kurrajong, belar and bull-oak are the timbers most commonly met with in those western districts where grain production is largest, and it is these which land-seekers usually look for in selecting their prospective homes. Yet timber alone does not determine the suitability or otherwise of land for wheat-growing, and many other aspects, such as subsoil, rainfall, &c., have to be taken into consideration.

Rainfall.

Wheat is principally grown in districts where the rainfall is comparatively low. It is grown in a few districts where the precipitation is 30 inches or more annually: the best districts have a 24 to 25-inch rainfall, but the greater part of the wheat area has a rainfall in the vicinity of from 15 to 20 inches. For wheat the distribution of rainfall is more important than the amount. If good rains fall in the autumn to facilitate the sowing of the crops and to produce a good germination, and if further rains occur in the spring when the wheat is earing, good crops are assured.

The natural adaptability of wheat and the wonderful work which has been done in the breeding and selection of varieties have produced several different wheats which have the power of giving high yields with remarkably little rainfall. Many instances have been noted of yields ranging between 30 and 40 bushels per acre from crops which have had less than 6 inches of rain between the time of sowing and maturity. Such yields, however, have only been obtained where the soil has been brought into good condition by particularly sound cultural methods.

In the southern, or Riverina, country, the rain falls principally during the autumn, winter, and spring, which is the wheat-growing season, while the summer is comparatively dry. In the central-west the rainfall is fairly evenly distributed throughout the year, while in the north-west wheat country it occurs most commonly in the summer, although, as a rule, fair rains also fall in winter.

The Purposes for Which Wheat is Grown.

The purposes for which wheat is grown differ a good deal in different parts of the State. The moist, humid conditions on the coast preclude the production of grain, except in small areas and in favoured localities, and of the area there devoted to this cereal, over a third is cut for hay, and quite 20 per cent. for green feed, while on the tablelands 12 per cent. of the total area is also at present used for hay. On the Western Slopes and Riverina the vast bulk of the wheat sown is reserved for grain, the proportion of hay rarely reaching one-twelfth in an average season. In the far western districts, represented by Nyngan or Trangie, hay is again the chief consideration. For these different districts and purposes different varieties are

specially adapted, as will be apparent in the following pages, and farmers should be careful to make their selections accordingly. In view of the preponderating importance of the grain crop, it is fitting that its production should receive the greater consideration, although the adaptation of the same general principles to the production of hay and green feed will be found easy, and, indeed, essential to the best results. The rapid increase in the use of motor-cars and tractors has caused a great lessening in the demand for hay, and production during recent years has declined considerably.

The Establishment of the Farm.

Land can be obtained at fairly reasonable prices, and in most cases liberal terms are granted, such as 10 per cent. deposit and the balance spread over eight to ten years, with interest at about 6 per cent. An existing improved farm may be purchased or an area of land acquired which will require more or less improvement before it can be brought into a fully productive state. While quicker returns may be obtained by the purchase of an equipped farm, probably more satisfaction will result when the latter class of land is purchased. The settler has then the advantage of securing clean virgin soil, while he can make improvements in accordance with his own desires. Probably this method of acquisition is ultimately the more economical, as improvements which may not be immediately essential have not to be paid for.

The size of the farm varies with the character of the soil and the average rainfall. In the more favoured districts a good wheat farm consists of from 500 to 600 acres, and in some cases less, while in the drier districts it will range up to 1,000 to 1,200 acres, though in the latter case sheep will be relied upon to produce a considerable amount of the returns.

To engage in wheat-growing a fair amount of capital is required. In a few cases farms are leased, but this form of tenure is comparatively rare, most farmers owning and working their own land, or engaging in share-farming. The price of land varies according to the soil, and particularly according to the climate. In the drier districts it can be obtained at £4 or £5 per acre, while for good soil in safer districts £6 or £7 would have to be paid. These prices are for what would be called "unimproved land." For established farms the prices range from about £6 to £12 per acre, according to improvements, &c. The cost of establishing a farm varies according to the conditions, but for a 600-acre farm should be somewhat as follows:—

	£
Purchase of land (600 acres at £5 per acre)	3,000
Fencing (5 miles at £50 per mile)	250
Clearing	375
Water Supply	200
House	500
Sheds, &c.	100
Working horses	150
Harness	30
Plant, vehicles, &c	500
Sundries	20
Sheep (200 at 30s. each)	300
Total	£5,425

It does not follow that this amount of capital must be immediately available. The land can be obtained on deferred payments, and material assistance can also be obtained through the Government Savings Bank of New South Wales on the security of farm lands, improvements thereon, stock, plant, &c., at bank rates of interest, with easy terms for repayment.

In the case of virgin or half-cleared land, the settler who has a small capital will find little difficulty in getting extended terms for his horses, plant and machinery, which can be increased as his cleared area is increased. Many a man in prosperous circumstances to-day began farming with little more than his team and a good name.

Share-farming.

Share-farming was first introduced into New South Wales about the year 1896, and the favourable results which at once attended it there and that have followed it wherever it has been tried, have led to its general adoption. It is not confined to wheat-growing, but has been extended to dairying and pig-raising, and other branches of farming.

With wheat-growing, the practice is not confined to any particular district, but extends all through the best areas of the State. Indeed, in several centres it is the ordinary method of leasing land, and is a most popular one, the demand for "areas on the shares" continually pressing on the supply.

For a single man the best course to follow is to obtain work as a farm hand in order to gain experience under local conditions. If he is proficient in his calling, and not afraid of work, his qualifications quickly become known to landowners, and little trouble is experienced in obtaining land for share-farming. With a normal run of seasons the share-farmer should, in a few years, be in a position to capitalise a farm of his own. This step has been quickly and surely taken by many farmers in New South Wales.

There are no hard-and-fast rules as to contracts, each landowner making his own terms with his tenants, but there are many ways in which the agreements made between the landlord and the share-farmers are uniform. The following specimen agreement gives the conditions that usually apply under a number of headings and indicates the scope covered.

A SPECIMEN AGREEMENT.

AGREEMENT made the .....day of .....19 .
BETWEEN ..... of .....
in the State of New South Wales.....(hereinafter called the "landlord") of the one part AND ..... of .....in the said State .....(hereinafter called the "farmer") of the other part WHEREBY the farmer agrees with the landlord to work and sow all that piece or parcel of land having an approximate area of ..... acres and being .....AND to reap and harvest the crops so sown by him upon the terms and conditions following:—

1. The term of this agreement shall be from the .....day of..... 19 to the ..... day of ..... 19 .
2. The farmer shall, unless prevented by adverse weather conditions, commence ploughing the said land on or before the .....day of ..... and shall continue such ploughing with his full plant from one working day to another without interruption (except while prevented by adverse weather conditions) until he has ploughed the whole area. Ploughing shall be done in a workmanlike manner to a depth of not less than ..... inches and the farmer shall remove from the ground all roots, wires, and other foreign matter which the plough may unearth.

3. The farmer shall thoroughly harrow the land and drill in the seed at the rate of .....for every acre sown, and shall at the time of such sowing, drill in with such seed at least .....lb. of a brand of superphosphate agreed upon between the parties hereto to every acre sown as aforesaid. All headlands shall be properly ploughed harrowed and sown. No seed shall be sown after the .....day of ..... except by mutual agreement.

4. The farmer shall thereafter keep the ground in proper order and condition by harrowing, cultivating, or rolling as may be necessary.

5. The farmer shall cut a track half a chain wide round the crop, and any tracks which shall be necessary for the proper working of the stripper or harvester. The farmer shall cart and stack the whole of the hay so cut, and thereafter he shall be entitled to receive two-thirds of such hay and the landlord shall receive one-third. As soon as the track aforesaid has been cut round the crop the farmer shall plough the same for a firebreak.

6. If the parties hereto shall mutually agree that it is advisable to cut any portion of the whole of the crop for hay, the farmer shall cut and bind the said crop, and all hay so cut, whether in pursuance of this clause or of clause 5, shall be stacked on the said land in such place as the landlord shall direct, and the stacks shall be thatched by the farmer in a proper and workmanlike manner. Any hay cut in accordance with this clause shall be divided equally between the landlord and the farmer, but the landlord shall pay to the farmer the sum of .....per ton of the landlord's share as remuneration for cutting, stooking, carting, and stacking the same.

7. As soon as the crop is ripe in the opinion of the landlord, the farmer shall commence and continue without interruption (save while prevented by adverse weather, strike, or other unavoidable cause), to harvest the same, and as soon as practicable thereafter shall deliver the wheat to..... All work referred to in this clause shall be done in a proper and workmanlike manner and so that the produce shall be placed in the best marketable condition.

8. The farmer shall for the convenience of loading and branding, make the stacks of wheat in the field as large as possible, but so that they shall contain not less than ..... bags. Such stacks shall be protected against fire by being separated a distance of at least 15 feet from the chaff, and by having a strip of at least 12 feet wide round the said stacks cleared of stubble. All such stacks shall be placed upon timber (the cost of which shall be borne equally by the landlord and the farmer), and the grain shall be protected against exposure to the weather.

9. Provided that the terms of this agreement have been duly observed by the farmer, he shall be entitled to and shall receive ..... of the crop and the landlord shall receive the remainder of the crop; provided that the farmer shall receive as a bonus the surplus over ..... bushels up to ..... bushels, after which the division shall be equal.

10. The farmer shall cart the landlord's share of the wheat to the railway station, and the landlord shall pay him ..... per ton per mile in respect thereof.

11. The landlord shall supply—

(*a*) all necessary seed sufficient to sow the land at the rate hereinbefore provided,

(*b*) a sufficient quantity of approved copper carbonate fungicide or bluestone to treat such seed,

(*c*) half the amount of superphosphate required for manuring the land as hereinbefore provided, and

(*d*) bags and twine for his share of the crop:

and the farmer shall supply—

(*a*) half the amount of superphosphate required as aforesaid,

(*b*) bags and twine for his share of the crop, and

(*c*) except as herein otherwise provided, all machinery, implements, horses, carts, materials, and labour necessary or proper for the carrying out of the terms of this agreement.

12. All horses which the farmer may require in and about the performance of this agreement may be depastured by him in a horse paddock which shall be provided by the landlord, but the farmer shall not be entitled to take on agistment on the said land the horses or other live stock of any other person.

13. The farmer shall keep all stray and strange stock off the said land, and shall prevent any stock having access to the crop.
14. The farmer shall not permit any smoking in the field during harvest, and shall not fire any stubble or chaff heaps unless with the consent of the landlord.
15. The farmer shall not bring any dirty or otherwise objectionable horse feed upon the said land, and he shall cut down and eradicate all noxious weeds on the said land, and shall in all respects comply with the provisions of any laws relating to noxious animals or plants.
16. If the farmer shall fail with all expedition to plough the said land or to harvest the crop, or shall fail to perform anything hereby agreed to be done, the landlord may perform and complete any such thing in such manner as he thinks fit, and the share of the farmer in any crops on the said land shall stand charged with the payment to the landlord of the expense of performing and completing any such thing, and the landlord may retain the whole of the share of the farmer in the said crop, or so much thereof as in his opinion shall be sufficient to recoup him the expense of performing and completing any such thing as aforesaid, with full power to sell and dispose of the same at such time and in such manner as he thinks fit, and out of the proceeds of the sale thereof to pay the expenses of and incidental to such sale or sales and to retain and repay himself the expense of performing and completing any such thing as aforesaid, and the balance (if any) remaining in his hands shall be held by him in trust for the farmer.
17. If the farmer commit any act of bankruptcy, or bring or attempt to bring his estate within the operation of the laws relating to bankruptcy, or make default in the observance or performance of any stipulation or condition on his part herein contained, then the landlord may, by notice in writing, determine this agreement forthwith. Such notice shall be deemed to be sufficiently served if sent by post addressed to the farmer at his usual or last known place of residence in New South Wales.
18. The farmer shall not mortgage, assign, or sublet the contract or his interest therein or in the said crop, without the consent in writing of the landlord first had and obtained.
19. The farmer shall be entitled to occupy the house erected on the said land and the appurtenances thereto free of rent during the term of this agreement, but no license or right of occupation given to the farmer by this agreement in respect of the said land shall be construed to create a tenancy in the farmer.
20. The farmer shall, on the expiration of the term hereof, vacate and leave the said land, and shall remove therefrom all stock, machinery, carts, implements and things which he shall be entitled to remove.
21. If any dispute arise under this agreement, the same shall be referred to the arbitration of.....or such other person as may be agreed upon, and the decision of the said.....or of any such person shall be final and binding on the parties hereto.
22. The farmer agrees to indemnify the landlord against any claim in respect of any accident to any farmhand employed in connection with the work to be carried out under this agreement.

As WITNESS the hands of the parties hereto the day and year first before written.

SIGNED by the said.....) in the presence of.....)

SIGNED by the said .....) in the presence of.....)

Clearing Land for Wheat-growing.

Two methods are employed in clearing wheat land for the plough: First, grubbing out the trees and roots to a depth of 6 to 9 inches; and second, burning off the timber and stumps just 1 or 2 inches below the surface. The latter method is generally referred to as "Yankee grubbing." On land cleared by the former process a set-plough is used; in the latter case a stump-jump plough is necessary.

The cost of Yankee grubbing depends entirely on the length of time the timber has been ringbarked. Thus, a paddock in which the timber has been rung, say, for seven or eight years will cost far less to clear than a paddock in which the timber has only been rung for three or four years.

The usual procedure is to stack small wood and limbs against the ringbarked trees, and then to fire the pile. March is considered the best time for burning off.

Land can be cleared in this way, ready for the stump-jump plough, at from 12s. 6d. to 25s. per acre, according to the length of time the timber has been rung. The cost of clearing land for the set-plough—that is, grubbing stumps and roots to a depth of 6 to 9 inches—will be just double in most cases, while in some instances where the paddock is very thickly timbered it will be considerably more.

Yankee grubbing is the method employed by many wheat-growers. The man who is just making a start frequently cannot afford the extra cost of clearing thoroughly, and as he is anxious to get as much crop in as possible during the first year, he cannot afford the time thoroughly to rid the paddock of all stumps and roots.

The general opinion held by wheat-growers is that the yields from a Yankee-grubbed and from a thoroughly cleared paddock, other conditions being equal, are about the same.

At Glen Innes the method has been adopted of grubbing the roots near the surface and then pulling down the tree with the grubber. In this way it is possible to clear to a depth of 8 inches.

The stump-jump plough works well on the stony land on the Northern Tablelands. It breaks the soil up thoroughly, though not so neatly perhaps as the set plough. The disc plough is used to some extent in that portion of the State.

The cost of ploughing with a stump-jumper does not exceed that of ploughing with a set-plough. The former is certainly a little heavier, but this can hardly be taken into consideration. As to the respective merits of the work performed by the two kinds of ploughs, there is not much to choose; but for obvious reasons a stump-jump plough only is used on Yankee-grubbed land.

The foregoing refers to country carrying grey box, yellow box, stringybark, pine, bull-oak, belah, buddah, and apple-tree. It in no way refers to mallee country, the clearing of which is described on page 296.

If, on the other hand, a paddock is not immediately required for cultivation, and sufficient labour is available to clear it thoroughly, that is, to take out the stumps to a depth of 6 to 9 inches, this method has much to commend it, as it leaves the paddock clear of all stumps for all time, and any kind of plough can be employed in future operations. The methods by which land is cleared for cultivation are more fully dealt with in another portion of this Handbook under the section heading "The Farm Holding." The farmer may safely make it his motto to clear as thoroughly as possible. Well cleared land saves many a breakage.

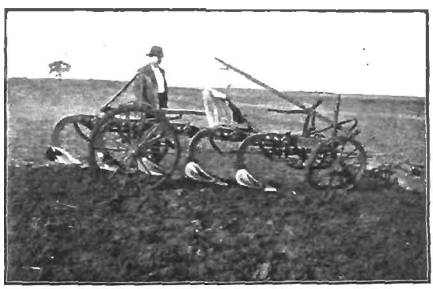
Providing the timber is well dead and the ground dry, stumps that are fired will burn themselves out to a depth of several inches, in fact, in pine and buddah country Yankee-grubbing may then prove as thorough as grubbing out, for the fire does its work well and does not go out until it is done. *The stump-jump plough will then pull out most of the running roots, which* can be carted off and burned inexpensively.

CULTIVATION METHODS.

The Various Implements Used.

Many different kinds of implements are now used for cultivating the soil for wheat-growing, and a brief indication of the utility of the more important is given below.

Ploughs.—The mouldboard plough does neater work than the disc and inverts the furrow slice more thoroughly, and it does not pulverise the soil to the same extent. After being ploughed with a disc, many soils become rather fine, which makes it difficult to maintain the necessary cloddy surface on the fallow. When a disc plough is used the subsequent cultivation is

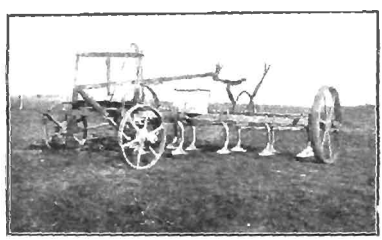


A Five-furrow Stump-jump Mouldboard Plough.
A popular type for the Mallee country.

not quite so heavy, but the fallow will not usually be found to be in such good condition as when fallowed with a mouldboard plough. It has been found that on *some of the heavy clay soils the disc performs* the work at a lower cost, but for the majority of soils the mouldboard should be used in preference to the disc.

Springtooth cultivators are useful on most classes of soil, but are more effective on the light to medium loams. They are excellent implements for the early cultivations of the fallow to bring the clods to the surface, also for stirring the surface to maintain a cloddy mulch, but unfortunately they are not effective in destroying weeds, except while the latter are very young. They also possess the disadvantage of cultivating too deeply where the soil is loose and friable, while, on the other hand, where it is hard and set, these implements, lacking rigidity, cannot penetrate sufficiently deep.

Rigid tine scarifiers.—These are very effective implements on most classes of country. Being rigid, the tines can be set to the desired depth, and very uniform work will result. Different-sized points are available, so that towards the end of the fallowing period, as weeds get larger, the wide points can be used. The notched points are more effective for weed destruction than the plain ones. Knife bars can also be attached for cutting large weeds; in fact, they are frequently necessary to avoid hand-hoeing. Even when the 12-inch points are used on the rigid tine scarifier, large black thistles and paddymelons cannot always be effectively dealt with, the thistles sliding round even the widest points, and so escaping destruction. Instead of cultivating the fallows too deeply in a vain endeavour to kill all black thistles and melons, it is advisable on country free from roots and stumps to attach knife bars to the scarifier. If these are correctly adjusted they will effectively deal with black thistles, paddymelons, and other weeds growing on the fallow, and without going deeper than 2 inches. Some home-made knife bars have been observed, and, although these were only



Rigid Tine Scarifier.
A very popular implement for working the fallow.

made from old "choke-cutter" knives, the "duck foot" points being removed to allow the knife to be attached in their place, very effective work was nevertheless performed. With properly-constructed steel knives attached diagonally to the scarifier, even full-grown black thistles can be destroyed. When the knife bars are adjusted to a uniform depth, say, of 2 inches, the effect is very beneficial to the fallow. The evenness of the depth of the mulch and the consolidation of the subsurface are improved.

The rigid tine scarifier is a handy implement for cultivating stubble land in late summer or autumn or for summer fallowing. Being heavier and more rigid than the springtooth cultivator, it is a better implement for such work. The stump-jump scarifier is slightly heavier, and should be used on mallee country or where roots and stumps occur.

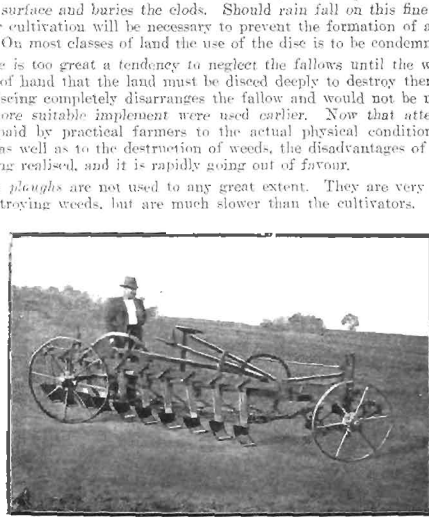
Harrows are now being used to a greater extent than formerly. Where paddymelons are troublesome a knife bar may be attached to a set of rigid harrows. The knife is kept reasonably sharp, and is fastened diagonally. In some classes of soil this will successfully deal with paddymelons, provided it is carefully adjusted, and the paddymelons are not too large. Where the melons are too thick the scarifier with knife bar attached must be used.

The advantage of using the harrows with the knife bar attached is that a much greater area can be handled. With a large set of harrows from 60 to 100 acres may be covered in a day. This is not only cheaper than using the cultivator, but it also enables the work to be completed in one-quarter the time—a wonderful advantage during the summer when the land dries out rapidly and weeds grow so quickly.

Disc cultivators are useful on certain heavy clay soils for breaking up large obstinate clods. They are also good implements for summer-fallowing stubble land, particularly if it is to be followed by a ploughing in the winter. These are the chief instances where the use of the disc cultivator is favoured. They are certainly effective in destroying weeds, but have the disadvantage of throwing the fallow out of condition. Instead of leaving fine soil underneath and clods on the surface, the disc places the fine soil on the surface and buries the clods. Should rain fall on this fine surface, another cultivation will be necessary to prevent the formation of a surface crust. On most classes of land the use of the disc is to be condemned.

There is too great a tendency to neglect the fallows until the weeds get so out of hand that the land must be disced deeply to destroy them. This deep discing completely disarranges the fallow and would not be necessary if a more suitable implement were used earlier. Now that attention is being paid by practical farmers to the actual physical condition of the fallow as well as to the destruction of weeds, the disadvantages of the disc are being realised, and it is rapidly going out of favour.

Skim ploughs are not used to any great extent. They are very effective for destroying weeds, but are much slower than the cultivators. In most



A Skim Plough.

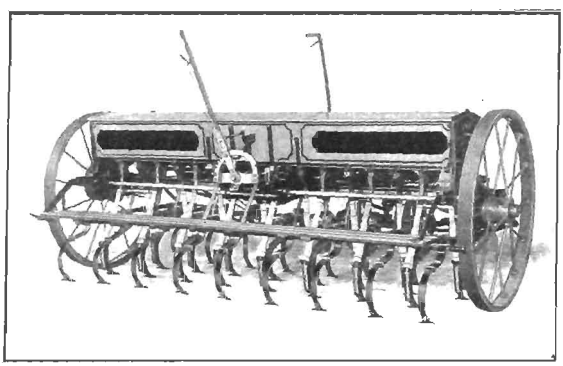
districts the rigid tine scarifier is a more suitable implement, although the skim plough has been found very useful on some of the light soils, particularly light mallee country, where, if used judiciously, it is of great assistance in consolidating the sub-surface soil.

Rollers are not used in many parts, although the importance of sub-surface consolidation has led a few farmers to experiment during recent years with this implement. On some soils when a roller or culti-packer is

used just before sowing and the land then harrowed, great benefit has resulted. More experience with the roller is required before any general recommendation could be made.

It is significant, however, that the spiked roller is in general use in the Corowa and other districts near the Victorian border. The rollers are here used to break down heavy clods, and to assist in the compaction of the sub-surface soil. The farmers in these localities usually exercise good judgment in their use of this implement. It can be taken as a definite rule when using a roller on wheat country never to leave a rolled surface, but always to follow the roller with a harrow or cultivator, so as to leave a loose cloddy mulch.

"Combine" drills.—These machines are a combination of springtooth cultivator with a grain and fertiliser drill. The great advantage is that one man can, at one operation, give a final cultivation to his fallow and



A "Combine" Drill.
This implement combines the grain and fertiliser drill with the springtooth cultivator.

drill in his seed and fertiliser. Apart from the saving of labour, this is a great advantage, as it effects a considerable saving of time at this critical period of the year, and enables the seed to be sown under ideal conditions on a weed-free seed-bed and with a minimum loss of moisture. Without this implement it frequently happens that rain, falling after the final cultivation of a fallow, necessitates an additional cultivation before the seed can be sown. The sowing period is restricted even in favourable years, and an implement which enables the work to be carried out quickly is a big factor in eliminating the element of risk.

In using the combine for sowing, care should be exercised to ensure that the cultivator points do not cultivate too deeply and so spoil the consolidation. They should be adjusted to cultivate to the proper depth of sowing.

The Moisture Required to Produce a Crop.

The determining factor in the cultivation of wheat in New South Wales is the rainfall; not so much the annual rainfall as the amount which falls during the growing period of the crop.

To produce a crop of 15 bushels per acre, 4½ inches of water are required to pass through the crop: for every additional 5 bushels, 1½ inches are required, so that 6 inches of rain must actually pass through a crop in order to produce 20 bushels. This by no means signifies that only 6 inches of rain must fall during the growing period, because out of an actual fall of 6 inches during six months, 3 inches or more may be lost through evaporation or other causes.

The exact amount of rain that is actually needed during the growing period of the crop in order to allow 6 inches to pass through the tissues of the plant is hard to estimate, for much depends upon whether the rain has been distributed over few or many days, the condition of the soil, the temperature, the amount and velocity of prevailing winds, and many other factors; it is sufficient to say that the rainfall during the growing season in most of our wheat districts is not sufficiently large to allow 6 inches, or even 4½ inches, of moisture to pass through the crop during the growing period.

The first impression produced by such a statement is, perhaps, surprise that wheat-growing should have become such an extensive industry as it has. In consequence, however, of the low cost of the methods adopted in earlier times, and of the undoubted fertility of the soil in large areas of the wheat belt, it was possible to raise crops averaging 10 to 12 bushels per acre that left a margin of profit. Cheaper farming methods are necessarily adopted by new settlers, and are usually profitable on new land for the first three or four years; they may even be adopted—and certainly are—over large areas of much older wheat-land. In such cases the land is ploughed as early in the autumn as the conditions will allow, and harrowed or cultivated once or twice before sowing. Crops grown under such conditions are dependent entirely on the rain that falls immediately before sowing and during growth, and are consequently readily affected by an unfavourable season.

The Practice of Fallowing.

Within the last ten to fifteen years, however, there has grown up another system of cultivation which has such a marked effect on the moisture-content of the soil so worked as to increase the average production to over 20 bushels. To this improved method of production is largely due the

extension of wheat-growing into areas once regarded as "too dry" for the purpose, while in the older wheat districts of better rainfall the method has so increased yields and added security as to preserve the area devoted to the crop in the face of increasing costs. The system referred to is known as "fallowing"—a method of dry-farming that peculiarly suits Australian conditions. In the earlier days of the practice in New South Wales it was referred to as "dry-farming," that term having come to us from North America.

Time was when dry spells were the occasion for the failure of the wheat crops over wide areas, but the adoption of fallowing as part of the practice of wheat culture has minimised such losses and imparted considerable security to the business. In brief, fallowing is a method of soil management by which the farmer can conserve in the soil rain that falls before sowing time and hold it there for the benefit of the crop when it requires it. So efficient is the system that, provided it is properly carried out, it is possible to hold moisture in the soil and subsoil for many months with only a small loss by evaporation. It is no uncommon thing for moisture to be retained in the soil for eight, ten, or twelve months, the rain that falls in one winter being carried through the following summer, and being still there when the crop is sown in the ensuing April or May. In this way the crop is grown on the rainfalls of two winters, and the possibility of entire failure is practically wholly eliminated.

Principal Advantages of Fallowing.

The main advantage of fallowing, as will be gathered from the above, is the conservation of moisture—a consideration that in itself is ample justification for the adoption of the method by most farmers in Australia. But other advantages accrue from the practice.

One very important one is that the practice ensures the soil being ready for sowing at the correct time, and it has been proved that seasonably-sown crops give the best average yields in all districts: crops sown too late have about equal chances for success or failure, especially in dry areas. In a dry summer the land becomes so hard that it is sometimes impossible to plough it until the time when the seed should be in the ground. Seasonable sowing is then impossible, and maximum results cannot be expected. Not the least advantage is that, as the result of fallowing, an ideal seed-bed is produced.

The aeration of the soil for a longer period prior to sowing enables bacterial activity to go on for a greater time and results in a larger accumulation of available nitrates. Fallowed land can be kept free from wild oats and other weeds and from fungous diseases; unfallowed land usually produces a big crop of pests.

A fallowed paddock supplies an effective firebreak and often, in a favourable season, provides a place where the ewes and lambs can be kept away from grass seeds in the spring.

Fallowing distributes the work of the farm more evenly over the whole year, keeping men and horses more steadily employed and avoiding a rush of heavy work in February and March. Finally, by sowing a smaller area and getting a bigger return, the harvesting plant can be reduced, and economies in seed, superphosphate, and wages can be effected.

The Department's Influence.

For twenty-five years the Department of Agriculture has urged this system upon the wheat farmers of New South Wales. The response has often been disappointingly small, but there have always been those who—*good season and bad season—have been able to point to the practical results* of the system, and to declare that the bank book furnished the most convincing evidence. To-day there are thousands of farmers who practice fallowing, and in 1926-27 more than half the area sown for grain in this State had been prepared in that way. Thus the Department's propaganda has borne fruit, and the steady improvement in the State acre average, notwithstanding the extension of wheat-growing into drier districts, is undoubtedly due to the change in cultural practice.

By medium of the Farmers' Experiment Plots (trials conducted under Departmental supervision on private farms all over the State) the system has been steadily pressed upon the attention of growers, until the attitude of farmers, from being sceptical and conservative, has been altered into one of appreciation and practical application. The effect of such a notable disturbance in cultural methods has been evident even in other directions. *Having been convinced as to the value of the Department's recommendations* in connection with soil management, a disposition to accept suggestions in other directions has followed, to the great advantage of the whole industry.

Results Obtained by some Farmers.

Records of the yields obtained from individual paddocks over a number of years are not kept by many farmers, but Mr. W. W. Watson, of Woodbine, Tichborne, near Parkes, has been an exception, and he has made available the figures for his farm over a period of twenty-four years.

The farm, which was acquired in 1902, consisted of 1,200 acres, of which 50 acres had been cleared. Fallowing was attempted at once, 30 acres out of the 85 acres planted receiving the lengthy preparation for the 1903 planting. Those were days of small things at Woodbine, for plant and other things were not too plentiful, and with the exception of 70 acres in 1906, no more fallowing was done for four years. As things improved, however, and resources increased, a regular application of the system became possible, and since the year 1908 Mr. Watson has always had a proportion of his wheat under fallow, and year by year the proportion has increased, until latterly the larger part of the area, and in some years the whole, have had that thorough preparation.

The accompanying table, prepared from Mr. Watson's own records, shows the cropping on the farm year by year, the rainfall, and the returns from the fallow and non-fallow areas:—

AREA cropped at "Woodbine," 1903 to 1926, showing wheat sown on fallow and stubble separately.

Year.	Wheat				Rainfall.	
	Grown on Fallow.		Grown on Stubble.			
	Area.	Average Yield.	Area.	Average Yield.	On crop 1 April to 1 Nov.	Total for year.
	acres.	bus.	acres.	bus.	Inches.	Inches.
1903	30	26	55	23	12·50	19·50
1904	...	...	125	8	10·90	16·45
1905	...	...	150	13	12·30	20·30
1906	70	22	180	12	17·35	25·55
1907	...	...	200	5	7·70	18·60
1908	50	12	140	5	6·20	14·16
1909	110	23	130	20	10·20	15·31
1910	120	21	160	10½	8·42	19·18
1911	85	17	90	10	6·66	21·00
1912	210	28	85	23	13·35	15·78
1913	245	15	80	6½	8·28	14·58
1914	210	8½	100	2	5·63	14·68
1915	400	16½	...†	...	10·07	14·12
1916	370*	10	80	12	19·30	28·29
1917	250	21	80	10½	13·42	23·29
1918	200	19	...	...	6·00	14·22
1919	45	10	125‡	3	6·75	15·60
1920	120	36	300	21	12·90	19·02
1921	280	25	330	16	13·00	21·24
1922	130	22	65	13	7·87	12·45
1923	300	18	...	...	9·00	11·46
1924	500	30	...	...	12·84	25·77
1925	500	23	20	18	10·08	18·52
1926	370	27	70	21	9·36	19·27

* 50 acres destroyed owing to excessive rains.
† 40 acres failed owing to drought.
‡ 80 acres failed owing to drought.

In compiling these figures the areas that failed have been included in the averages.

Average yield on *fallow* ... ... 20½ bushels per acre.
" " *stubble* ... ... 12½ " "
Increase of fallow land over stubble ... ... 64 per cent.

The consistent excess of the "fallow" yield over the "stubble" yield is most interesting. The year 1906, for instance, must have been a most instructive one to the farmer himself. The 70 acres of fallow averaged 22

bushels, while the 180 acres on stubble land only gave 12 bushels. Again, in the bad years of 1914 and 1919, the fallow land amply paid the cost of production with 8½ bushels and 10 bushels respectively, whereas the stubble land only gave 2 bushels and 3 bushels respectively. In 1919 practically every non-fallow crop in the district failed. Even in a wet season like 1920, when the stubble land had a rainfall of 12 inches during the growth of the crop, the fallow land still yielded over 70 per cent. more, although in the stubble land are included areas that failed in 1919 and that, being sown again in 1920, had the advantage of a sort of accidental fallow. Only in one year (1916) did the fallow show to disadvantage, and then the growth was so heavy that when 13 inches of rain fell in the four months, September to December, the crop lodged and only portion could be harvested, whereas on the unfallowed land the crop was lighter and could all be saved. It was an experience shared by a good many farmers that year.

The comparative yields obtained by a number of farmers in the Dubbo district on fallowed and stubble land for periods ranging up to ten years were made available by Mr. H. J. Harvey at the Conference of the Agricultural Bureau held at Dubbo in 1926.

On Mr. Harvey's own property, "Kindalin," accurate records have been kept since 1918, when 200 acres of wheat were grown on fallow. The results obtained that year when the annual rainfall was only 1,313 points, of which 572 points fell during the growing period, were so convincing that fallowing has been practised ever since. The following are the results obtained in that and subsequent years:—

Year.	Average from Fallow.	Average from Stubble.	Rainfall.	
			Year.	Growing Period.
	bushels.	bushels.	points.	points.
1918	12	2	1,313	572
1919	*Nil.	3	1,113	582
1920	33	25	2,448	1,518
1921	24	15	2,717	1,305
1922	*Nil.	3	1,415	609
1923	5	2	1,460	960
1924	23	22	2,628	1,253
1925	34	16	2,169	1,099

* Sown dry; fed off.

The average over the whole period was 16.4 bushels for fallow against 11 bushels for stubble. Although the crops sown on fallow in 1919 and 1922 were fed off to save stock, the increase in favour of fallow was 5.4 bushels per acre over the period of eight years. Taking the average price of wheat at 5s. per bushel, that would mean £1 7s. per acre each year, or a total of £10 16s. for the eight years in favour of fallowed land.

From several neighbours who had kept records for the past few years, Mr. Harvey also obtained figures which furnish confirmation of the value of fallow- compared with stubble-sown crops. We present them in the following table:—

Year.	P. H. McInnes, "Warringa," Dubbo.		McCarty Bros., "Lennox Farm," Minore.		J. P. Cullen, "Redbank," Terramungamine.	
	Fallow.	Stubble.	Fallow.	Stubble.	Fallow.	Stubble.
	bushels.	*bushels.*	*bushels.*	*bushels.*	*bushels.*	*bushels.*
1916	25	12	...	...	...	...
1917	21	13	...	...	...	...
1918	18	6	...	...	...	...
1919	Cut for hay.		...	...	...	...
1920	27	27	33	24	36	24
1921	27	18	30	18	18	19
1922	10	4	10	6	15	6
1923	15	9	16	8	18	12
1924	21	15	21	21	22	15
1925	21	15	27	16	20	21

It will be seen that over a period of nine years Mr. MacInnes showed an average of 7.8 bushels per acre per annum in favour of fallowing, while over periods of six years Messrs. McCarty Brothers showed an advantage of 7.4 bushels, and Mr. Cullen 4.9 bushels per acre. In each case these farmers have substantially increased their holdings, and to-day have comfortable properties, the value of which is the greater because their owners know how to work them to the greatest advantage. Such results are practical and undeniable evidence of the soundness of the Department's advice.

How Fallowing Pays.

The foregoing figures afford practical evidence that fallowing is a profitable farm method, but a comparison of the cost of working fallowed with non-fallowed land, together with the average returns in each case, will be found interesting. For the purpose we may take the average yield of the State, which is about 12 bushels per acre, as representing the non-fallowed land (a distinctly favourable basis), and the average yield on the Farmers' Experiment Plots (which according to a large number of plots in all parts of the State spread over several seasons, may be fixed at 21 bushels), as representing fallowed land.

Cost per acre of Wheat-growing on Non-fallowed Land: estimated yield, 12 bushels.

	£	s.	d.
Ploughing once	0	8	6
Harrowing once	0	1	0
Drilling	0	2	6
Seed, 60 lb. at 7s. per bushel	0	7	0
Superphosphate, ½ cwt. at 6s.	0	3	0
Pickling seed	0	0	6
Harvesting with header	0	9	0
Rent, at 8s. per acre	0	8	0
Bags, four at 1s.	0	4	0
Cartage, at 4d. per bushel	0	4	0
	£2	7	6

Allowing an average yield of 12 bushels per acre for non-fallowed land (an estimate really in excess of the actual), the gross proceeds at 5s. per bushels would be £3 per acre. If the cost of production, with rent, averages £2 7s. 6d. per acre, as shown above, the actual profit is 12s. 6d. per acre.

On the other hand, if the land be fallowed, the cost will work out thus:—

Cost per acre of Wheat-growing on Fallowed Land; estimated yield, 21 bushels.

	£	s.	d.
Ploughing once	0	8	6
Harrowing three times	0	3	0
Cultivating twice	0	5	0
Drilling	0	2	6
Seed, 60 lb. at 7s. per bushel	0	7	0
Superphosphate, ¾ cwt. at 6s.	0	4	6
Pickling seed	0	0	6
Harvesting with header	0	9	0
Rent, two years at 8s. per acre	0	16	0
Bags, seven at 1s. each	0	7	0
Cartage, at 4d. per bushel	0	7	0
	£3	10	9

The return in this case would be 21 bushels, which, at 5s. per bushel, represents £5 5s., showing a profit at the rate of £1 15s. per acre over the two years, or at the rate of 17s. 6d. per acre per annum, compared with the 12s. 6d. per acre per annum derived from the non-fallow crop.

The advantage attaching to fallowing as a farm method is obvious.

In addition, in the non-fallow case there is always a possibility of almost *total failure to be reckoned with, while in the case of the fallowed crop there* is always a reasonable certainty of success.

It is evident that, apart from other advantages gained by fallowing, such as the maintenance of fertility, the checking of wild oats, &c., a rigid system of fallowing should commend itself on a simple commercial basis to every wheat-farmer in the southern or western portion of the State.

VARIOUS SYSTEMS OF FALLOWING.

As the essence of fallowing is the storage in the soil of moisture precipitated before the seed is sown, so that it may supplement that which falls *during* the growth of the plant, the time of the year at which the plough should be put in must be governed largely by the incidence of the rainfall.

In southern portions of the wheat belt the greater part of the year's rain falls in the winter, and operations must be directed at carrying the rainfall of one winter through the following summer in order that it may be available in the soil in the autumn.

In western districts the summer rainfall is greater than in the southern districts, *but it is not reliable, and it is therefore safe practice for the* farmer in that portion of the State to commence fallowing so soon as possible after sowing. The farmer who follows that practice will almost always be able to complete the full area he has planned to fallow, while the *farmer who delays commencement of operations frequently finds that the* setting in of dry conditions in the spring renders it impossible for him to fallow a considerable portion of his area.

Three distinct kinds of fallow have been defined by the Department as follows:—

Long Summer Fallow.—Land fallowed for at least twelve months, the initial ploughing or cultivation to be not later than May in the year previous to sowing.

Winter or Ordinary Fallow.—Land fallowed for at least six months, the initial ploughing or cultivation to be not later than October in the year previous to sowing.

Short Summer Fallow.—Land fallowed for at least two months, the initial ploughing or cultivation to be not later than February in the year of sowing.

Long Summer Fallowing.

Long summer fallowing may with advantage be practised on practically all classes of soil, and can profitably be adopted on portion of the land to be fallowed. By long summer fallowing is meant the ploughing or cultivation of the soil as soon as possible after harvest. If the soil is only cultivated in the summer it is generally necessary to plough it in the winter, especially if weed growth is very vigorous, but if weeds are not troublesome it is not always necessary to plough in the winter. It is not advisable, however, to continue to grow crops continuously on fallows that have not been ploughed, except on certain very suitable soils—usually soils that are light in texture. Even on these very light soils it is not advisable to go too long without ploughing the soil, as the thorough aeration of the soil which follows ploughing is very essential to the maintenance of fertility. From winter onward, the long summer fallow is treated in the same way as an ordinary winter fallow.

The chief advantage of long summer fallow is that more moisture is conserved in the subsoil—the soil lying in a receptive condition for fifteen months, instead of the ten months usual when the land is not ploughed till July. It is also an invaluable method of cleaning up dirty lands, for black oats and weeds readily germinate on a summer-worked fallow. A better distribution of the work throughout the year is also obtained by this system.

Short Summer Fallow.

Ordinary fallowing should, of course, be practised whenever possible, but occasions do arise when for various reasons a grower is forced to sow a portion of his land without having given it such thorough preparation, and although the sowing of stubble land is not recommended, it is perhaps advisable to describe how best to prepare the land when this is necessary.

When it is intended to sow a crop on stubble land, the usual practice is to plough not long before sowing, and to work the land down at once; but this is not a satisfactory practice. Better results will be obtained from stubble land if the straw is burned as soon as possible after harvest, and the land either ploughed immediately, or, if it is too dry to plough, cultivated with a springtooth cultivator, scarifier, or disc cultivator. In this way a short fallow is given, and this can then be cultivated two or three times before sowing. If the weed growth is too vigorous, the land can be ploughed shallow before sowing; but this is not necessary if weeds are not allowed to get out of hand, and if the fallow has been well worked.

One point must be again emphasised, viz., that while short summer *fallow may be quite satisfactory in* point of moisture conservation in some districts and certain seasons, it is absolutely essential *that every wheat* paddock should have an occasional winter fallow—possibly once in three years—in order that the control of weeds and diseases may be more complete; maximum yields are possible only in weed- and disease-free soils.

While the short fallow described is useful in most parts of the State under certain conditions, there is one portion where it is of particular utility. *In the north-west, where the rainfall is largely a summer one, ploughing* immediately after harvest will usually conserve much of the rain that falls in January, February, and March, and that otherwise evaporates before seeding time arrives. Farmers in the north-west will find it a sound programme to plough half the following year's wheat area in the winter or spring (say, July and August), and the other half in December or January. This system would enable a man with, say, 300 acres of wheat land to sow 200 acres every year, half of which would receive a full fallow of 8 or 9 months and the other half a short summer fallow.

Burning-off Stubble.

One of the most frequent questions asked is, "Would it not be advisable occasionally to plough in the straw left after harvesting, instead of burning it?" It can be stated that it is usually advisable to burn the stubble when preparing land for wheat. A good stubble burn is one of the best means of destroying fungous spores, and is therefore of great assistance in combating such diseases as flag smut, take-all, wheat blight, and wheat mildew.

The ploughing in of stubble, in addition to encouraging fungous diseases, also has a most objectionable effect on the physical condition of the soil, rendering it extremely difficult, if not impossible, to bring about a good consolidation of the sub-surface soil. The moisture-holding capacity of the soil is also affected temporarily. The results of experiments in most wheat districts throughout New South Wales indicate that wheat yields are reduced when the straw is ploughed in.

PLOUGHING THE FALLOW.

Ploughing should take place when the soil is neither too wet nor too dry—a condition that generally obtains in the winter months, sufficient moisture being then usually present to make the soil crumbly, so that it will not turn over in heavy dry clods. If the soil is too wet ploughing will destroy its physical condition, and it will dry out in hard lumps, from which state it will be very difficult to get it back into good free condition.

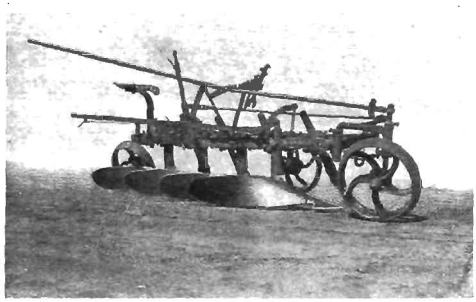
One of the objects of fallowing is the production of a suitable seed-bed, and this must be kept in view throughout the whole of the cultural operations that precede sowing if success in this direction is to be obtained. Even in connection with the first ploughing it must be considered. Though, over the major portion of the wheat-growing area, it is desirable to invert completely the top 4 to 5 inches of soil when ploughing the fallow to bury weed growth and admit air and moisture to the soil, the depth of ploughing should be regulated according to the nature of the soil, the rainfall of the district and the time of ploughing. Turning up of sour subsoil should be avoided. On some types of soil it is very difficult to secure consolidation if

the ploughing is deep because of the impossibility of obtaining compactness except in seasons of ample rainfall, and on these, excellent fallows can be prepared by not ploughing more often than every two or three years. As rains are the most effective agent in compacting the soil, it follows that the less rain that is likely to fall on the fallow the more shallow should be the ploughing; therefore in the case of districts of limited rainfall it is advisable to plough shallow; so, too, when the fallow is not ploughed sufficiently early. Farmers should be careful not to plough too many years at the same depth, as such a procedure is very liable to result in the formation of a hard pan. An occasional variation of, say, half an inch in depth will prevent this.

If the ploughing in one season is from north to south, it is advisable that the following year it should be from east to west, in order that the formation of deep furrows may be prevented. Many farmers, for convenience, plough the paddock round and round, but it is certainly a better method to plough in "lands."

The Type of Plough to Use.

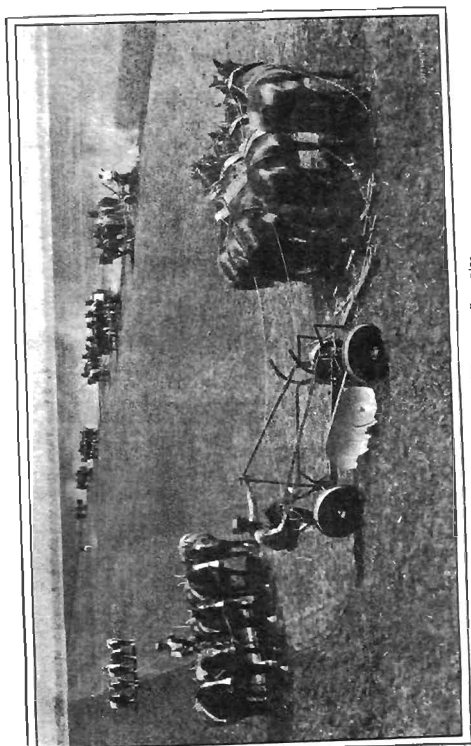
Much controversy exists among farmers as to whether the mouldboard or the disc plough is the better implement for the purpose. No hard-and-fast rule can be laid down, and the farmer must be guided to a large extent by the class of soil he has to handle and the condition it is in when making a choice between the two implements.



A Modern Mouldboard Plough.

The mouldboard plough may be said to do better work in land that is likely to break up too fine, and is certainly superior to the disc on land covered heavily with weeds or other rubbish.

On the other hand, the disc plough on fairly clean land has many advantages, chief of which is that from 400 to 500 acres can be ploughed with the one set of discs without renewing them. However, a great deal less depends upon whether the land has been ploughed with a disc or mouldboard plough than upon the choice of the right time and the thoroughness with which the work is done.



The Disc Plough on a large area at Narromine.

CULTIVATION OF THE FALLOW.

It is well enough known that, while the top 12 or 18 inches of the soil are the most important to plant life, beneath that is also stored water which is conducted by capillary attraction to the surface, where it is lost by evaporation. This capillary movement of the soil moisture if permitted to continue, will carry off the moisture stored below, and the only way to prevent that taking place is to disturb the surface and interrupt the movement of the moisture to the surface.

Experiments at Geelong, Victoria, showed that just before sowing time a worked fallow contained equal to 492 tons of moisture per acre in the top 18 inches of soil, while a neglected fallow could only show 281 tons. The work was continued on a more extensive scale the following summer at Longerenong Experiment Farm, the moisture-content of a worked and a neglected fallow being carefully ascertained at different depths every month. Certain land was ploughed and cultivated in September, one portion receiving no further cultivation, and the other being worked in the same way and time as other fallow land in the vicinity. On 1st November there was already a difference in the moisture-content, and by April the difference was marked, the neglected fallow having in the first 4 feet 27.16 per cent. of moisture, while the cultivated fallow had 32.71 per cent. As February and March were months of good rainfall, the difference in the top 4 feet was not as great as it would have been in a dry summer, but further tests showed that the rains referred to had gone a good deal deeper than 4 feet on the cultivated portion, and remained there to nurture the succeeding crop.

In California, Hilgard and Loughridge made instructive comparisons. They found that while in uncultivated land there was 4·3 per cent. of moisture in the first foot of soil, in cultivated land there was 6·4 per cent., and continuing their experiments at every foot to 6 feet below the surface, they showed that the advantage was the same almost the whole way down. In other words, while the uncultivated land had equal to 86 tons of moisture per acre at the first foot, 88 tons at the second, 100 tons at the fourth, and 90 tons at the sixth, in the cultivated area there was equal to 128 tons at the first foot, 116 tons at the second, 130 tons at the fourth, and 120 tons at the sixth—an advantage, where cultivation was carried out, of 30 to 40 per cent. more moisture the whole way down to 6 feet.

The result of neglecting the fallow, as the above results clearly show, is to allow the moisture which has been caught to escape again into the air. The only way to prevent that is to maintain a loose surface, and thus put a lid on the reservoir.

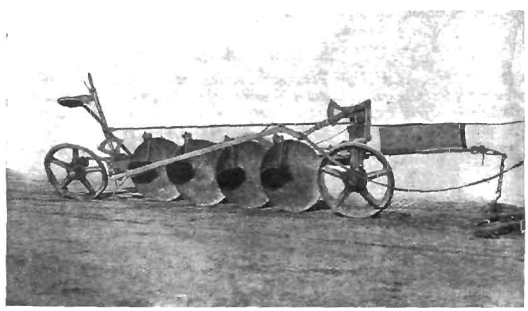
Again, a neglected fallow means a dirty fallow, in which weeds add their part to the loss of moisture and plant-food, and spread their seeds to the detriment of the next crop.

Provided the soil has been ploughed when in good condition, it can with advantage be left some weeks in the rough state as broken by the plough. Recently ploughed land is covered with the most effective mulch possible, and even if the surface becomes somewhat caked, little is gained by working it in the winter. In this rough state, too, it readily absorbs moisture, permitting rain to penetrate into the subsoil, and loss of moisture

by run-off is reduced to a minimum under these conditions. Moreover, a greater surface of soil is exposed to weathering agencies such as frost, air, and sun, which have a mellowing influence in the soil.

As the soil begins to dry up in the early spring, it is necessary to break the surface to renew the mulch and begin the preparation of the seed-bed.

The actual amount of working the fallowed land will require will depend upon the climate and the condition of the soil. If the moisture is to be conserved, the soil must be stirred as soon as the effectiveness of the mulch is destroyed by rain; mulches are only effective when loose and dry. Even a light shower is sufficient, under some conditions, to render a mulch non-effective; and when this is the case the soil is often drier twenty-four hours after the shower than if no rain had fallen. This is due to the increased capillarity of the particles, caused by the wetting and consequent compacting of the soil, resulting in loss of subsoil moisture by evaporation.



A Modern Disc Plough.

The cultivation of the fallow must necessarily fit in with other operations on the farm. A December cultivation, for instance, may be extremely desirable but is not always practicable, the men and horses being busily engaged with the harvest. It may be considered desirable (subject to the conditions already outlined as to the state of the soil) to give a cultivation before hay cutting begins, and a second one after the harvest is over and rain has fallen.

The Object in View.

Two things have to be kept in view in the working of the fallow through the summer; first, the preservation of an effective surface mulch, and second, the preparation of a seed-bed that will afford the most favourable conditions for the germination of the seed and the growth of the crop.

An effective mulch consists of a layer of loose, dry soil, composed of small clods and fine soil particles, distributed evenly over the whole of the fallow to a depth of 2½ to 3 inches. The aim should be to provide a mulch no deeper than 2 inches as the sowing period is approached. A shallower

mulch is not very effective in preventing evaporation; a deep mulch compels the sowing of the seed in a loose seed-bed, with the consequent danger of the grain malting and the liability of fungous attacks, owing to there being probably insufficient moisture present to push the seedling above ground. Such mulches are usually irregular in moisture content, and a patchy germination follows.

A suitable seed-bed is dependent upon mulch and compactness. By compactness is meant the degree of compactness of the soil immediately below the mulch and above the ploughing depth—approximately 2 inches in thickness. This layer of soil in well fallowed land has been "sweetened" during the winter, is well charged with moisture and soluble plant-food, and has been firmed by the action of rains, implements, and stock, until it is in an ideal condition to draw moisture from the subsoil and supply plant-food for the use of the young wheat. When sowing, the seed is placed in the top layers of this compacted soil, and the mulch covers the seed. With an even depth of mulch and a seed-bed nicely compacted, conditions are most favorable for an even and quick germination.

The Early Workings.

The actual manner of the cultivation of the surface, and the implements to be used for the purpose, differ considerably. On the great bulk of the soils in our wheat areas, especially on those that tend to break up readily,

An Ideal Fallow at Corowa.
Note the cloddy condition of the surface.

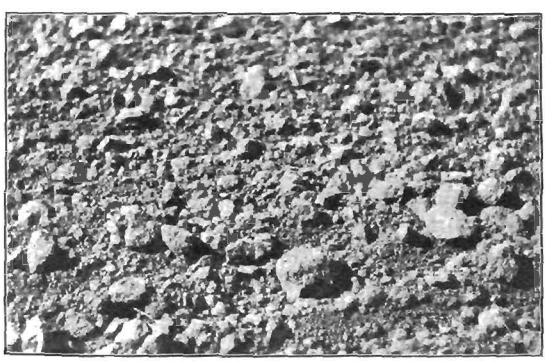
the practice preferred by many farmers is to work the fallow first with the harrows and then with the springtooth cultivator to the full depth of the original ploughing. The effect is to bring the clods in the worked soil to the surface, while the fine soil is sifted to the bottom, forming a layer of a couple of inches of finely-divided soil, which readily becomes united and compacted with the subsoil.

The fallow contains its maximum percentage of moisture in the spring and this is the period when evaporating agencies become active. Any delay therefore, in mulching the surface at this season, even though it be but for a few days, results in a very serious loss of soil moisture. By enabling the cultivation to be completed in a minimum of time, wide stretches o

harrows are very useful for the first cultivation of the fallow in the early spring. They also prepare and pulverise the soil for the subsequent working with the cultivator.

On some of the heavier and cloddier soils harrowing after the first ploughing is sometimes advisable, for if not worked down somewhat during the winter while still moist, the clods are very hard to deal with later; they become dry and hard in the summer, and none of the ordinary implements are capable of breaking them down to smaller sizes. If such soils are harrowed down soon after ploughing, many of the clods will be considerably reduced in size. When the soil is infested with the seeds of the wild oat it is an advantage to harrow after ploughing in order to encourage the early germination of the oat seeds.

On all soils that set after rain and on which it is desired to maintain a cloddy mulch, it is not advisable to harrow after ploughing, as this practice helps to make the surface too fine without improving the condition of the soil below the surface.



An Ideal Mulch.
Showing correct degree of "Cloddiness"

Subsequent Cultivations.

The subsequent cultivations that the fallow should receive also depend upon the soil and on the incidence of the rainfall. They should be about 3 inches deep when performed early in the summer and reduced to 2 inches deep after December, and done with the object of stirring the soil mulch only, keeping it in a loose, dry condition, and weed-free. It is in these workings that wheat-growers chiefly err. Insufficient attention is given to regulating the implements to work uniformly at the correct depth, particularly approaching seeding time, and not infrequently a loose, open seed-bed that rapidly dries out, is the result. Under such conditions normal growth cannot take place, and being in a weakened condition the plants are more susceptible to attack by parasitic fungi, such as take-all, foot-rot, &c.

It is essential that all weeds be destroyed when they are very small by shallow cultivation, preferably with the harrows; neglecting to cultivate the fallow after rain in November or December is sometimes the cause of a dirty fallow. Perhaps the most frequent cause of harm to the fallows is allowing weeds to grow to such a height that the disc cultivator has to be employed to a depth ruinous to the compacted sub-surface soil.

Judgment must be used in deciding when and how to cultivate the fallow. Working the soil during the hot, summer months is, of course, not recommended unless rain has destroyed the mulch, in which case it should be restored. It is not advisable to work a fallow when it becomes too dry, as little benefit, if any, will result; the most suitable time for cultivation is as soon after rain as possible. It can definitely be stated that, other things being equal, a fallow receiving a sufficient number of cultivations will produce a heavier yield than one which did not receive so many. Cultivating the soil definitely increases fertility and makes possible the produc-

The Surface of this Mulch is regarded as too Cloddy.

tion of heavier yields, and, although it is not necessary to cultivate after every fall of rain occurring during the summer, it is advisable to work the land after every fall sufficiently heavy to form a surface crust.

This system of cultivation is carried out until the sowing period approaches. On the medium to heavy textured soil an effort should be made to maintain a cloddy surface so as to prevent evaporation, and also to prevent the surface of the soil setting down hard after heavy rains. However, one must expect a fallow to possess a cloddier surface in October, say, than in April or May, and no great anxiety need be experienced if the surface, on account of frequent cultivations, is getting rather fine towards the sowing season. The surface appearance of a fallow does not tell everything; the condition of the land below the surface is equally important. All the details of what the ideal fallow looks like must be kept in the mind's eye, and every working must be carried out with this definite objective in view. It is, therefore, advisable for the operator to get off his implement occasionally to examine the work being done.

The Implements to Use.

The implements that should be used in working the fallow depend very much on the nature of the soil and the state of the fallow. If the soil is medium to heavy loam and is free from weeds the harrows or springtooth cultivator would serve. If semi-alluvial brown loam, light red loam, or heavy black self-mulching soil, and free from weeds, the harrows would be the most suitable implement. If heavy red loam or clay country, or if weeds are prevalent, the rigid tine scarifier should be used.

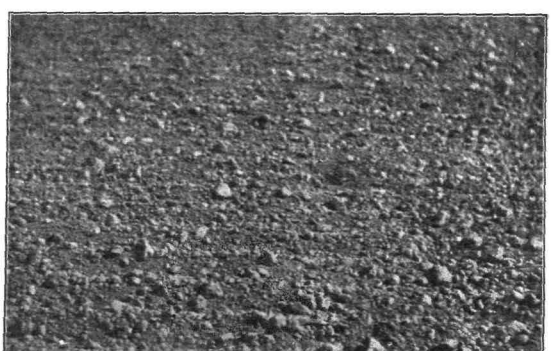
The determining factor, however, is usually the amount of weed growth. It is often possible to deal very effectively with weeds when very young by the use of the harrows, but should weather conditions, &c., delay the working until they are too big, the rigid tine cultivator with suitable

Sowing Experiment Plots at Coolamon.
The correct degree of cloddiness.

points will put the fallows into excellent condition. The rigid tine cultivator or scarifier is the most satisfactory implement for most classes of soil. Compared with the springtooth, because it can be set to the desired depth, it does much more uniform work, makes a more even mulch, and leaves the top of the compacted sub-surface area level, not ridged. This makes for a much more uniform condition of the fallow generally, and results in a more even crop. With the correct points, or fitted with knife bars, it can deal much more effectively with weed growth, particularly thistles and melons; it has not, however, the sifting action of the springtooth, and should not displace it for the early cultivations.

The disc cultivator is without doubt the best implement of all to put the fallow in bad condition. Admitting its value in destroying large weeds, it is evident that they could almost always have been killed while quite small by the use of other implements. Large weeds are a sign of a neglected fallow. Deep discing ruins the compacted sub-surface layer, and delivers the clods to the bottom and fine soil to the surface, where it is easily crusted by the first rain. As discing is usually done in January or February, not only is the whole physical condition of the fallow practically ruined, but rapid evaporation of moisture results, and there is not sufficient time to restore consolidation unless special means are devised, and they very rarely are.

The Surface in this case is Too Fine

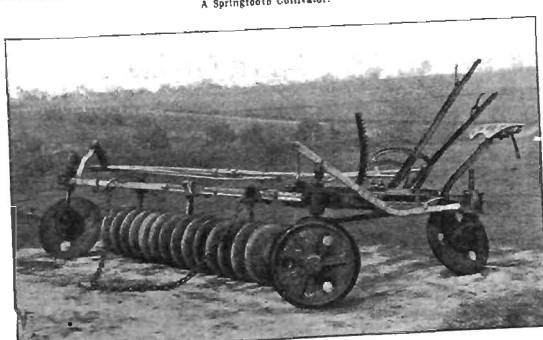


Another Fine Surface.

This illustrates portion of a headland which became too fine as a result of too much working.

A Set of Harrows for Stirring the Surface of Fallowed Land.

A Springtooth Cultivator.



The One-way Disc-cultivator.

Sheep on the Fallows.

The great value of sheep in keeping the weed growth down and reducing the number of cultivations, is now acknowledged by nearly all wheat-growers. The tramping over the fallow helps greatly to compact the sub-surface soil—very necessary to the growth of heavy wheat crops—and by eating black oats, weeds, &c., they often obviate the necessity of cultivating the fallow at busy times, such as in the middle of harvesting. Heavy stocking of the fallow is advisable; in fact some farmers keep a special flock of wethers just for this particular purpose. They find that wethers stand this treatment better than ewes. The fallow is closely grazed till it is bare, and the sheep are then removed to good pasture where they rapidly improve in condition, when they are again ready for heavy grazing on the fallow. These farmers sacrifice the sheep a little in order to improve their wheat yields.

A point worth keeping in mind is that the usual practice of grazing sheep on wheat stubble infected with flag smut and then putting them immediately on to the fallow is likely to increase the amount of flag smut in the succeeding crop. It is advisable to graze the sheep for about seven to ten days on pasture before putting them on to the fallow, so that it will not be infected with flag smut from the stubble.

Rotation on the Wheat Farm.

Many of the problems that confront the wheat-grower may be solved by rotation of crops.

All farm crops require very much the same plant-foods, but different crops require them in different proportions. Hence, the production of the same crop from the same land year after year tends to use up the supply of one or, perhaps, two kinds of plant-food faster than they are made available by the ordinary processes that are going on in the soil, with the result that in a few years the yields become consistently disappointing. The introduction, from time to time, of a crop that uses different elements of plant-food, or uses them in different proportions, allows the renewal of the supply of that particular element upon which the previous crop has made the heaviest demand, and enables the farmer to return to his main crop with an assurance of a greater yield.

The Value of Rotation.

A change of crops, indeed, may sometimes actually result in an increase in the supply of plant-food in the soil. An illustration is afforded by the practice in parts of the tablelands of the State, where oats for hay and potatoes are rotated. The cultivation required by the potatoes is quite different from that required by the oats, and the effect of the different treatments is certainly to hasten the break-up of the chemical compounds in the soil, and thus to render certain elements available that, though present previously, could not be used by the plants. Another illustration may be quoted—that of lucerne and wheat. Farmers know that no wheat-land yields grain like that on which lucerne has been grown, and the reason is that the deep-rooting habit of the lucerne has led to plant-food being brought from the subsoil and made available for the surface-feeding wheat when the lucerne has been broken up and the roots have decayed.

Rotation has an important relation, also, to some of the active enemies of crops—notably weeds, insects, and fungi. It is now widely recognised by farmers that the occurence of wild oats is closely associated with continuous cropping for wheat, and that some change is imperative if a dirty paddock is to be cleaned up. Better illustration of this can hardly be furnished than by the result of the "continuous wheat experiment" at Cowra Experiment Farm. Certain land on that farm was cleared in 1906 and divided into three main parts—one of these being devoted to wheat every year, another to wheat alternated with fallow, and the third to wheat alternated with a fodder crop. That experiment was initiated to prove that wheat could not be grown continuously without a serious loss in the eventual yields. And that was exactly what happened. Seed of the cleanest and best quality was used; cultivation methods were adopted that should have tended to check and destroy any oats that might have been on the land (an old common); but it was to no purpose. Wild oats and Saucy Jack were to be seen by 1910, and by 1912 they had so taken possession that the manager reported that "but little wheat is now taken from the area, and the weeds have become a menace to the cleared adjoining areas." It is a most significant fact that on the sections where wheat was grown alternately with fallow and with fodder crops, the oats were a negligible factor. A valuable experiment had thus to be interrupted and started on a new area, simply because the "wheat-every-year" portion had become infested with wild oats.

Strangely enough, confirmation of this result was furnished in a few years by the new area, for in 1923 the manager of the same farm reported that "the continuous wheat experiment plots are very dirty and practically unfit to carry on." Thus for a second time the same farm provided positive evidence that continuous wheat is not profitable compared with some rotation, even if it be only the fallowing of the land every second or third year.

Change of crop is quite as essential from the point of view of disease control as of weed control. It has been found that take-all, foot-rot, flag smut, and other troubles cannot be held in check unless a rotation with oats, which crop is not subject to these diseases, is adopted.

Limitations of the Position.

The question is, "What crops can be used in connection with wheat under New South Wales conditions?"

It has to be confessed at once that there is no crop that wholly serves the purpose. Wheat is grown on such a large scale and under such extensive cultural conditions in this State that there is no other crop that offers such a certain market at remunerative prices, or that can be grown in such large areas. Barley and oats have not the sure market awaiting them in large quantities, even if they could be relied upon to yield as well in all parts of the State where wheat is profitable; and the same objection applies with even greater force to the various root crops which in nearly all other agricultural countries are considered most desirable as changes from grain.

Rape is a valuable soil renovator and fodder crop, but as a rotation crop on a large scale it is quite out of the question, there being no way of utilising it other than for fodder.

It is essential, as we have said, that any change crop recommended in rotation with wheat should be a profitable one; in other words, it should be such as will not only improve the condition of the soil, but also improve the condition of the banking account.

Fallow as a Rotation.

The rotation practised over the greater portion of the wheat belt of New South Wales is simply wheat and fallow alternately. The period of fallow not only conserves moisture for the benefit of the next crop, but it permits the soil to recuperate and additional plant-food to be made available. The practice has its limitations, however, for it fails to add anything to the soil; in fact, fallowing tends to deplete the humus in the soil, and it is recognised in many quarters that a broader rotation is necessary if fertility is to be maintained. Fortunately the association of sheep-raising with wheat-growing is operating in this direction, for farmers are finding that oats provide excellent grazing for the sheep, and that they are available at the very time when they are required in connection with the raising of fat lambs, while the grain makes such excellent feed that many are erecting small grain silos on their farms to store what they grow. So far is oat-growing becoming associated with wheat and sheep, that areas of 200 acres of oats on wheat farms are not uncommon.

The Value of Oats.

Strangely enough, the presence of sheep on the wheat farm is forcing matters even further, for it is found that better pasturage makes for greater profits, and the introduction of a period under improved pasture into the rotation on the wheat farm is now receiving attention in many districts.

Thus the two-course rotation of wheat and fallow, while many times preferable to wheat continuously, is improved upon by the adoption of a three-course rotation of (1) wheat, (2) oats, and (3) fallow, or of (1) wheat, (2) pasture, and (3) fallow, which permits of more sheep being carried, maintains the fertility and physical condition of the soil, and gives greater returns.

In most of the favoured wheat districts, where the rainfall is reliable, oats grow well after wheat, and the rotation is very satisfactory, and can be recommended. It is likely to eventually become very popular in New South Wales, as in the districts indicated good yields are obtained from oats, and the cost of growing oats on wheat stubble is very low.

Where a difficulty is found in utilising such a large area of oats, it is often overcome by cutting half the oats for hay and using the remainder for grazing or grain. In the larger wheat districts a modification of the system may be adopted. Instead of sowing all the wheat stubble to oats, only half is sown, and the remainder is simply utilised for grazing; *e.g.*, where in a farm 900 acres are available, there could be 300 acres sown to wheat, 150 acres oats, 150 acres grazing, and 300 acres bare fallow.

The actual carrying capacity of a crop of oats varies a good deal, of course, but one experiment area of 15 acres in the Gulgong district provided practically continuous feeding for three months for an average of seventy-five to 100 sheep.

The Mallee Rotation.

At present it seems that the most economical and practical way of increasing the nitrogen and humus content of wheat soils is to make fuller use of the clovers and trefoils which usually grow luxuriantly, if encouraged. They provide a leguminous crop which can be either fed off or ploughed in, and without any expense for seeding.

On heavy soils, trefoil and clover growth is exceptionally vigorous and persistent, and demands very little encouragement. On the lighter country, however, the clovers must be given more consideration. The application of heavy dressings of superphosphate to the wheat crops has been found to have a wonderfully stimulating effect on the growth of clovers, even on light soils, and is often profitable for this reason, notwithstanding that the wheat crop would not perhaps actually require quite so heavy a dressing.

Where vigorous growth occurs naturally or can be induced by heavy manuring it is thought that the most practical way of maintaining, or even increasing the humus content of the soil, and incidentally of increasing wheat yields, is to adopt a rotation of wheat, pasture, and fallow.

This is known as the Mallee rotation, and is useful where, because of the low rainfall (or for other reasons), oats do not grow well. In those districts where oats thrive, the wheat, oats, and bare fallow rotation is preferable. The Mallee rotation is particularly advantageous in the drier parts of the wheat belt. It has the advantage of enabling a small flock of sheep to be kept on a farm that otherwise might be considered too small to carry any sheep at all. For instance, on a farm of 1,000 acres in the drier parts of the State, 100 acres would be reserved for horse paddocks, &c., leaving 900 acres for cultivation: 300 acres of wheat would be grown each year, 300 acres of wheat stubble, self-sown wheat, and grass would be grazed, and 300 acres would be bare fallowed. Superphosphate liberally used on the wheat crop has a residual effect which is noticeable in the subsequent grazing.

It is safe to anticipate that this 300 acres of grazing with the 300 acres of fallow in the dry parts of the southern wheat belt would carry, in normal seasons, from 200 to 400 sheep, according to the nature of the soil.

The "Wimmera" Rotation.

Where the rainfall is fairly reliable and the areas sufficiently large, a rotation consisting of wheat, oats, pasture, and bare fallow is sometimes adopted. This is called the Wimmera rotation, although it is not adopted to any great extent in the Wimmera district. It is a valuable rotation in certain districts, but it has the limitation that only a small area of wheat is grown. Only a quarter of the farm is sown each year with wheat, which is a disadvantage, especially on high-priced land, although this is compensated for to some extent by the greater number of sheep carried. From the point of view of maintaining fertility it is, of course, very satisfactory. This rotation permits of many modifications. Where Wimmera rye grass is grown it should prove more profitable than where the natural feed is depended on for the grazing during the third year. Various fodder crops could be substituted for the oats, *e.g.*, field peas, rape, barley, &c. Lucerne, when it can be grown, increases the stock-carrying capacity of the farm to a greater extent than any other crop. It is therefore likely to be a tremendous factor in ultimately lifting our wheat areas from the ruck of a

pioneering system, where practically the only crop grown is wheat, and placing them in the more permanent and prosperous position of true mixed farming districts, where stock occupy their proper place. The disadvantage of including lucerne in the Wimmera rotation is that it occupies the land for too short a period considering the cost of establishment.

WILD OATS.

One of the factors in wheat-growing that may be said to be associated with the question of rotation is the control of wild oats. As a result of the continuous cropping system and of the indifferent cultivation methods of years gone by, that pest has become widespread in our wheat areas, and in some districts and on some farms is so firmly established that it occasions heavy losses. A better understanding of the whole problem of wheat production, however, has indicated the means by which this formidable weed can be controlled.

The wild oat (*Avena fatua*) belongs to the family of grasses which includes a large number of varieties of cultivated oats. *It matures quickly, and usually sheds the bulk of its seed before the sown crop of wheat or grain is harvested, thus re-sowing its crop for the following and often for succeeding years.*

Weeds we shall probably always have in our fields as long as our fine wheat lands retain their fertility, and the wild oat will probably always find its place; but a consideration of its characteristics will show the proper methods of keeping it within bounds, and of utilising the undoubtedly good forage which it provides when it cannot be entirely suppressed. Once it gets thoroughly established in a cultivation paddock its complete eradication is a matter for hard work for many years, and it requires a study of the plant's history to cope effectively with it.

The prevalence of wild oats may be attributed to two causes—the almost universal use of the combined harvester and the header and the constant cropping of the land. The combined harvester is almost diabolically devised as a disseminator of the seed of the wild oat, and a paddock which is comparatively clean will, in three of four years, be almost unfit to sow with wheat when this means of harvesting is employed. When to this is added constant cropping, until the land becomes too dirty to produce wheat, it can be realised how difficult it is to control the pest.

An additional source of infection is the use of "oaty" feed for working horses. The hairy coating of the seed enables it to survive the digestive operations of the horse and the ox, and the pest can thus be spread to land hitherto clean.

The loss in yield caused by the presence of black or wild oats amongst the wheat crops is yearly increasing, and the pest is the more troublesome because the seed frequently lies in the ground without germinating until the wheat is sown, when favourable temperatures and soil conditions make it sprout and grow with the wheat. In some of the older paddocks the oats come up so thickly that it is impossible to obtain a profitable crop.

The wild oat seed is accused of lying dormant in the ground for years. Some men quote instances of paddocks, which have been thrown out of cultivation and so closely grazed that no oat seeds have been allowed to mature, but which have produced oats as thickly as ever, five, seven, and even ten years later, when ploughed up. Even allowing for seed which may have been produced unobserved, it is certain that the seed does, under certain

conditions, retain its vitality for long periods when buried. Close observation and study lead to the opinion that the persistence of the wild oat is chiefly due to the fact that the seed germinates slowly and requires favourable temperatures. It is evident from the observations of Dr. Darnell-Smith that the short, velvety hairs on the seed form a protective covering, preventing moisture coming in contact with the germ, and so retarding germination. It is probable that this protective covering is effective only for a time, and that when the soil immediately surrounding the seed is kept moist long enough germination does take place.

If young wild oat plants are examined it will be found that in nearly every case the seed has sprouted in the earth about 3 to 4 inches below the surface; and it is here the land remains moist for the longest period. The surface soon dries out, and becomes unfavourable to germination. Experiments showed that when the soil was kept moist only 24 per cent. of the seed germinated after three weeks in February, when the temperature of the soil was comparatively high. Observation in the field indicates that comparatively low temperatures encourage germination, and that the oats come up most thickly in May, June, and July. This has led practical farmers to sow wheat early so that it will start ahead of the oats.

Wild Oat (*Avena fatua*).

If the seed be examined it will be noticed that the hairs are arranged in such a way that the seed moves forward when touched. The tough awn or tail attached to the seed assists in the progressive movement, as with changes in amount of moisture, &c., it alternately twists and straightens, and each time forces the seed in a forward direction. The seed, therefore, works through the soil, and is further distributed by cultivators, harrows, ploughs, &c., until it is ultimately mixed with the soil to at least the depth to which cultivation is carried out.

The clods on the surface harbour many a wild oat seed. It is probable that in a dirty paddock there is more than sufficient in these to re-seed it. Strenuous efforts may be made with the ploughs, harrows, and cultivators to encourage germination; but all the time the clods are harbouring the seed. The smallest of them is big enough to hold a grain. They rarely become moist, and thus the seed is well protected.

Methods of Control.

For combating wild oats "an ounce of prevention is worth a ton of cure," and farmers should make every endeavour to prevent oats gaining a foothold on their land. Where headlands, &c., have produced a crop of oats, it will be found wise to cut these green for silage and plough the headlands, thus at the same time providing an efficient firebreak for the wheat.

Extreme care should be taken that no seeds of wild oats are put through the drill, and only good quality seed harvested from oat-free crops should be used, and only after it has been put through a grader.

Where, however, paddocks have already become infested, cultivation methods must be adopted that aim at the germination of the seed before the sowing of the wheat, and at times when the destruction of the young plants is possible. For this purpose judicious cultivation of the fallow and the use of sheep are the farmer's best weapons, though a good stubble burn will often kill a large number of seeds lying on the surface.

No amount of cultivation is likely to render land badly infested with wild oats clean in one year; it may take several seasons, much depending on the incidence of the rainfall and the judgment exercised in tillage.

Measures to encourage the wild oat seeds to germinate should commence with the cultivation of the infested stubble as soon as possible after harvest to cover the seeds lightly to induce them to start with the first rains. Later on when the land is ploughed for the fallow, all growing oats are turned down; if these oats had not already germinated there is the possibility that this ploughing would have buried them to a depth that would have resulted in them remaining dormant till another season.

After ploughing the fallow in June or July, the land should be thoroughly harrowed. This cultivation helps to make the soil fine, and leaves it in such a condition that it retains the moisture. Ploughing alone is not sufficient—the land is left loose. The farmer must remember that he is dealing with seed, although he has done no sowing, and the same attention must be given as when wheat is sown. The harrow must be used to make the ground fine and firm about the seed. If the ground is dry when ploughed, it is practically useless to harrow; the work should be done when the soil is moist.

The subsequent cultivation given the fallow to preserve the mulch will assist in providing suitable conditions for the germination of the oat seeds and in destroying the young plants, while sheep can be very profitably employed in preventing the oats from seeding; being ruminants, they destroy all the oat seeds they eat, even ripe ones—horses often pass them through without injuring them in any way.

The oats that are most troublesome to the farmer are those that come up just at sowing time, and if possible, a good rain should be awaited to start these prior to the last shallow cultivation before sowing. It is necessary to avoid cultivating deeply at sowing time, owing to the risk of bringing any oat seeds in the soil close to the surface where conditions are favourable for their germination, while the loose seed-bed that would result from a deep cultivation would be unfavourable for the rapid germination of the wheat seed, which would thus be at a disadvantage.

In the sowing of the wheat, measures should be adopted that will enable the wheat crop to dominate any oat plants that may make an appearance; for instance, it is advisable to choose a variety which makes rapid early growth, and to increase the quantities of seed and superphosphate, thus assisting the wheat crop to outstrip the oats and smother them.

One of the best methods for reducing the infestation on badly-infested land is to sow an early-maturing variety of oats as a fodder crop, to be grazed by sheep and then ploughed down before the crop can ripen its grain, or, in a prolific year when the fodder crop may not be required, to be converted into silage while still green.

VARIETIES RECOMMENDED.

A few pages back the statement was made that the production of improved varieties has been one of the important factors in the development of the wheat-growing industry in New South Wales, and that is no exaggeration of the facts. A number of excellent varieties of wheat have been the result of the cross-breeding and selection carried out by officers of the Department, some of them (notably Federation, Waratah and Canberra) adding in a very substantial degree to the average yield of grain, others to that of hay, and yet others to the quantity of green feed that coastal dairy-farmers can grow for the early spring.

Beyond even those conspicuous contributions to potential and real wealth, there are several others (several of them, like Yandilla King and Turvey, not the products of the Department, though recommended by it) that for special seasons, special climatic conditions or special purposes have so far proved their worth as to be well and favourably known among wheat-growers.

Some varieties fulfil a dual purpose, and can be cut for hay or harvested for grain. On the other hand, farmers growing wheat for the chaff market must exercise particular care in choosing special hay varieties. Further, in growing for grain the difference between the yields of a suitable and unsuitable variety may be as much as a third of the crop. In general, the best yielders are those that are able to make use of the full growing period in their respective districts.

Several factors have to be taken into account in selecting the variety or varieties that are to be sown on a farm. They may be briefly presented thus:—

1. *The climatic and other conditions of the district.*—In a cool district the varieties grown may be slow-growing or long-season ones, so that the plant may have every opportunity of making the maximum growth and producing the maximum crop.

2. *The convenience of the farmer at sowing and harvesting times.*—Both operations must be distributed as much as possible in order to avoid too great a pressure of work at one time, and this can be effected by sowing a proportion of slow-growing varieties before the main sowing season, and a proportion of quick-growing ones after the main crop is in. The result of such a method will also be that harvesting work will be extended over some weeks.

3. *The aspect and other conditions of the farm.*—One farmer may find that a certain variety does particularly well with him, though not so well generally throughout the district.

4. *The particular market which the grower wishes to cater for.*—The variety for the early chaff market must be quite different from that intended for grain even in the same district.

5. *Soil conditions.*—It is becoming quite clear that certain varieties do better on certain soils than others. Little information has so far been collected on this point, but recent experiences have indicated that the soil must be studied in relation to the variety.

6. *The moisture requirements of a variety.*—A variety that is economical of soil moisture is valuable, especially in a dry district. In California Briggs and Shantz compared Early Baart (the principal local variety) with Hard Federation, and found the latter to require far less moisture to produce a profitable crop than the former. In dry districts like the western portion of the wheat belt this is an important consideration.

"Early," "Midseason," and "Late" Wheats.

As much depends upon the time that the wheat is sown as upon the variety that is sown. As a general rule, late-maturing varieties (such as Cleveland or Yandilla King) should be sown early in the sowing season, mid-season varieties (such as Federation) in mid-season, and early varieties (such as Canberra and Florence) late. This is more important than may appear at first sight. Individual varieties of wheat have their own characteristics and will not yield their best if sown out of season. The difference in yield according to the time a variety is sown frequently amounts to several bushels; at the present value of wheat, 3 to 4 bushels more or less per acre is the difference between success and failure. Tests in eleven Riverina centres showed that the average increase in favour of seasonable sowing with Federation was 3¾ bushels per acre. Yandilla King or Marshall's No. 3 sown in June almost invariably spell failure; so does Canberra sown early in April.

Heavy losses are occasioned yearly through farmers sowing their wheats at the wrong time. This is due either to the fact that farmers do not know which varieties are early and which are late, or, as is more frequently the case, to a misapprehension of the terms "early" and "late" as applied to varieties of wheat. To the vegetable-grower, as well as to the stud wheat-farmer, the term "early" has always meant a variety that grows quickly, and produces its crop early, and similarly the term "late" has always meant a variety that matures slowly, and produces its crop late. Hence, to sow an "early" wheat at the beginning of the sowing season is literally to make an attempt to produce wheat in the middle of winter, and to sow a "late" wheat at the end of the sowing season is to look for a grain crop in the height of summer. The quick-growing habit of the first kind will bring it into head at a time when, even if other conditions are favourable, frost is almost sure to prevent the maturing of the grain, and the slow-growing habit of the second kind will produce the ear at a time when extreme heat will be just as disastrous.

If it is remembered that "early" wheats are early in maturing, and that "late" wheats are late in maturing, the whole problem is solved, and there is no possibility of mistakes being made in the future.

Sow "late" wheats first, and "early" wheats last.

The early wheats have found a place in all portions of the wheat areas, particularly when late sowings are necessary owing to adverse circumstances, and herein lies the danger of the elimination of the naturally higher-yielding mid-season wheats where the autumn rains are erratic. In these districts there is a tendency to sow according to the conditions of the previous season, but present seasonal conditions and prospects must be considered if the best

returns are to be aimed at. The only practical safeguard to ensure that wheats will be sown in season, is for the farmer to hold sufficient seed wheat of mid-season and early-maturing varieties to meet his plans, plus an additional quantity of seed wheat of an early-maturing variety to take the place of the mid-season wheat if the conditions for germination are unsatisfactory during the seasonable period of the latter.

Such a system would mean that the sowing of the mid-season wheats would not take place until the favourable autumn rains were registered, and in no case in a dry seed-bed, thus largely avoiding the patchy germination that is common to April-sown wheat in the Central-western Slopes, when conditions are warm and rainfall generally light. Failing such rains, sowing would commence in May with Federation or a variety of similar season wheat, followed by the early wheats.

The Introduction of New Varieties.

The popular varieties of wheat change so frequently, one being superseded by another of more recent introduction, that it is perhaps wise to consider whether such changes are in the best interests of the wheat-grower. Of the many factors that contribute to increased production per acre, none appeals more forcibly to the farmer than a new variety which has produced a favourable yield in a similar and adjoining district, even if only over a short period. It should, however, be remembered that in the production of a new variety the plants have necessarily been subjected to rigorous selection over a number of years, such factors as yield and disease-resistance receiving particular attention. These characters have at first been bred into the variety, and then emphasised by selection, and when first removed from the breeding plots the new variety possesses its maximum vitality and producing powers. Recent introductions have thus a decided advantage over old-established wheats which have been continuously grown without selection. The new wheat may be more prolific than the old as tried, but possibly below the standard of selected seed as it originally left the hands of the plant breeder. The natural law of reversion begins its work immediately a wheat is removed from the stud plots, and is accentuated with each successive year of reproduction. A new variety should not therefore be sown extensively on a farm unless it can definitely displace one of the older sorts.

The Great Number of Varieties.

Although opinion is fairly constant as to the best class of wheat for a district, the popular wheats of the class cover a large number of varieties. It is true that some varieties do better than others on particular soils and under certain climatic conditions, but this hardly justifies the growing of so many different sorts. It would not be difficult to name twenty varieties growing on commercial areas within a radius of 10 miles of any centre, each grower believing that the wheats he has chosen are the most suited for his farm. Many growers have six or more varieties—all good sorts, but some better than others. This is a disadvantage, as, besides the direct loss from the lower-yielding sorts, more work is entailed when harvesting, and greater care is needed to maintain a purity standard of seed.

Reduction in numbers of varieties is in the best interests of all concerned in the wheat-growing industry, and such a result is best brought about by each grower (and, further, each group of growers) deciding what wheats are most suited to local conditions.

Varieties for Various Districts and Purposes.*

The following are the latest recommendations of the Department of varieties suited to the various wheat-growing areas of the State. For convenience the recommendations are given from two aspects, viz., the district and the purpose of planting, and in each case the sowing time of the variety is indicated:—

Varieties According to Maturity and Sowing.

In the following statement the recommended varieties are classified according to maturity, though slight differences may be expected in some districts:—

Very Early.—Florence, Clarendon, Firbank.

Early.—Canberra, Waratah, Gresley, Baroota Wonder, Aussie, Hard Federation.

(These should usually be sown late.)

Mid-season.—Federation, Union.

(These should usually be sown in mid-season.)

Late.—Marshall's No. 3, Yandilla King, Turvey, Zealand, Cleveland, Currawa, Cadia, Genoa.

(These should be sown early.)

RECOMMENDATIONS FOR VARIOUS DISTRICTS.

The varieties recommended by the Department for the various districts are as follows:—

Coastal Districts.

(Embracing districts which are specially subject to rust.)

For Hay.—Clarendon, Florence, Firbank, Gresley.

For Green Fodder.—Gresley, Florence, Firbank, Clarendon.

Sowing for hay should be made later than for green fodder.

Northern Tableland.

(Of which Glen Innes is representative.)

For Grain or Hay.—Genoa (early sowing), Florence (mid-season and late sowing), Clarendon (mid-season and late sowing).

For Green Fodder.—Genoa (early sowing), Florence (early, mid-season, and late sowing), Clarendon (early, mid-season, and late sowing).

Central Tableland.

(Of which Bathurst is representative.)

For Grain or Hay.—Cleveland (early and mid-season sowing), Cadia (early and mid-season sowing), Waratah (mid-season and late sowing), Gresley (mid-season and late sowing).

For Grain only.—Federation (mid-season sowing), Canberra (mid-season and late sowing).

* The Department has an extensive system of variety trials at its experiment farms and on experiment areas in co-operation with farmers throughout the wheat-growing areas, and annually compiles a revised list of varieties recommended for each district, which is available free on application.

Southern Tableland.

(Of which the Monaro, Crookwell, and Bathow districts are representative.)

For Grain or Hay.—Cleveland (early sowing), Yandilla King (early sowing), Waratah (mid-season and late sowing).

South-western Slopes and Eastern Riverina.

(Of which Wagga, Temora, Wyalong, and Barellan are representative.)

For Grain or Hay.—Yandilla King (early sowing), Turvey (early sowing), Marshall's No. 3 (early sowing, for more favoured districts), Gresley (mid-season and late sowing), Waratah (mid-season and late sowing).

For Grain only.—Union (early and mid-season sowing), Federation (early and mid-season sowing), Canberra (late sowing).

For Hay only—Zealand (early sowing), Baroota Wonder (early and mid-season sowing).

South-western Plains and Western Riverina.

(Of which Deniliquin, Cargelligo, and Hillston are representative.)

For Grain or Hay.—Waratah (mid-season sowing), Gresley (mid-season sowing).

For Grain only.—Federation (early and mid-season sowing), Union (early and mid-season sowing), Canberra (mid-season and late sowing).

Central-western Slopes.

(Of which Dubbo, Gilgandra, Wellington, Cowra, Grenfell, Forbes, and Parkes are representative.)

For Grain or Hay.—Cleveland (early sowing, especially suitable for the cooler portions of this district, such as Coonabarabran), Yandilla King (early and mid-season sowing), Turvey (early and mid-season sowing), Gresley (mid-season and late sowing), Waratah (mid-season and late sowing).

For Grain only.—Federation (early and mid-season sowing), Union (early and mid-season sowing), Canberra (mid-season and late sowing).

North-western Slopes.

(Of which Tamworth and Gunnedah are representative.)

For Grain or Hay.—Cleveland (early and mid-season sowing, especially suitable for the cooler portions of this district, such as Inverell and Delungra), Currawa (early and mid-season sowing), Yandilla King (early and mid-season sowing), Waratah (early and mid-season sowing), Clarendon (late sowing).

For Grain only.—Canberra (mid-season and late sowing), Aussie (mid-season and late sowing).

North-western Plains.

(Of which *Coonamble is representative.*)

For Grain or Hay.—Canberra (mid-season and late sowing), Florence (mid-season and late sowing), Clarendon (mid-season and late sowing).

Western Plains.

(Of which Nyngan, Trangie, and Condobolin are representative.)

For Grain or Hay.—Hard Federation (early sowing), Waratah (mid-season sowing), Canberra (mid-season sowing), Firbank (mid-season and late sowing).

For Hay only.—Clarendon (early and mid-season sowing).

Murrumbidgee Irrigation Areas.

For Hay on the Irrigation Areas.—Marshall's No. 3 (early sowing), Yandilla King (early sowing), Turvey (early sowing), Firbank (mid-season and late sowing), Gresley (mid-season and late sowing).

For Grain on Dry Areas.—Federation (early and mid-season sowing), Yandilla King (early and mid-season sowing), Union (early and mid-season sowing), Waratah (mid-season and late sowing), Canberra (mid-season and late sowing).

RECOMMENDATIONS FOR VARIOUS PURPOSES.

Dual-purpose Varieties.

Recommended for both Grain and Hay in the districts indicated.

Variety.	Period of Sowing.	District.
Cadia	Early and mid-season ...	Central Tableland.
Canberra ...	Mid-season	Western Plains.
	Mid-season and late	North-western Plains.
Clarendon ...	*Mid-season and late*	*Northern Tableland; North-western Plains.*
	Late	North-western Slopes.
Cleveland ...	Early	Southern Tableland; Central-western Slopes (especially suitable for the cooler portions of this district.)
	Early and mid-season... ...	Central Tableland; North-western *Slopes (especially suitable for the* cooler portions of this district.)
Currawa ...	Early and mid-season... ...	North-western Slopes.
Firbank	Mid-season and late	Western Plains
Florence .	Mid-season and late	Northern Tableland; North-western Plains.
Genoa	Early	Northern Tableland.
Gresley	*Mid-season*	*South-western Plains and Western* Riverina.
	Mid-season and late	Central Tableland; South-western Slopes and Eastern Riverina; Central-western Slopes.
Hard Federation	Early	Western Plains.
Marshall's No. 3	Early	South-western Slopes and Eastern *Riverina (for more favoured dis*tricts).
Turvey	Early	South-western Slopes and Eastern Riverina.
	Early and mid-season... ...	Central-western Slopes.
Waratah ...	Early and mid-season... ...	North-western Slopes.
	Mid-season	South-western Plains and Western *Riverina; Western Plains.*
	Mid-season and late	Central Tableland; Southern Tableland; South-western Slopes and Eastern Riverina; Central-western Slopes.
Yandilla King ...	Early	Southern Tableland; South-western Slopes and Eastern Riverina.
	Early and *mid-season*... ...	Central-western Slopes; North-western Slopes.

Varieties for Grain Only.

Not recommended for Hay in the districts indicated.

Variety.	Period of Sowing.	District.
Aussie	Mid-season and late	North-western Slopes.
Canberra ...	Mid-season and late	Central Tableland; South-western Plains and Western Riverina; Central-western Slopes; North-western Slopes; Murrumbidgee Irrigation Areas.
	Late	South-western Slopes and Eastern Riverina.
Federation ...	Early and mid-season... ...	South-western Slopes and Eastern Riverina; South-western Plains and Western Riverina; Central-western Slopes; Murrumbidgee Irrigation Area.
	Mid-season	Central Tableland.
Union	Early and mid-season... ...	South-western Slopes and Eastern Riverina; South-western Plains and Western Riverina; Central-western Slopes; Murrumbidgee Irrigation Area.
Waratah ...	Mid-season and late	Murrumbidgee Irrigation Area.
Yandilla King ...	Early and mid-season... ...	Murrumbidgee Irrigation Area.

Varieties for Hay Only.

Not recommended for Grain in the districts mentioned.

Variety.	Period of Sowing.	District.
Baroota Wonder	Early and mid-season... ...	Central-western Slopes and Eastern Riverina.
Clarendon ...	Early, mid-season and late ...	Coastal.
	Early and mid-season... ...	Western Plains.
Firbank	Early, mid-season and late ...	Coastal.
	Mid-season and late	Murrumbidgee Irrigation Areas.
Florence ...	Early, mid-season and late ...	Coastal.
Gresley	Early, mid-season and late ...	Coastal.
	Mid-season and late	Murrumbidgee Irrigation Areas.
Marshall's No. 3	Early	Murrumbidgee Irrigation Areas.
Turvey	Early	Murrumbidgee Irrigation Areas.
Yandilla King ...	Early	Murrumbidgee Irrigation Areas.
Zealand	Early	Central-western Slopes and Eastern Riverina.

Varieties for Green Fodder.

Variety.	Period of Sowing.	District.
Clarendon ...	Early, mid-season and late ...	Coastal; Northern Tableland.
Firbank	Early, mid-season and late ...	Coastal
Florence ...	Early, mid-season and late ...	Coastal; Northern Tableland.
Genoa	Early, mid-season and late ...	Northern Tableland.
Gresley	Early, mid-season and late ...	Coastal.

SEED SELECTION.

The complaint is frequently made by farmers that the seed of a variety that they have been using for years has "run out." Similarly, the statement is often heard that Federation or some other variety is not yielding as well as it did, say, ten years ago.

In most cases the statement is perfectly correct—that is, as to the strain that the farmer is using. Inquiry into the facts will usually disclose that the seed has not been changed for years—that year after year a portion of the grain harvested on the farm is kept for next year's sowing, and as probably very little care is taken in the selection of the wheat to be kept, there has been a steady decline in vigour and quality. And can any surprise be entertained that this should be so? Can we expect, if a variety is grown for years without any attempt to maintain the quality and purity of the variety and the vigour and productivity of the strain, that there will be anything else than decline? What would be the result of allowing a hundred stud ewes and a couple of rams to breed indiscriminately for years without the guiding hand of man? No farmer would contemplate such a method. Instead he culls and selects year by year, and actually improves and increases the product of the flock. The same applies, though in a rather different way, to the crops of the farm.

Good as they may be to-day, neglect would allow even such varieties as Yandilla King and Waratah gradually to lose favour.

The system of plant improvement that has been in operation at the experiment farms in the wheat belt consists of the selection for its outstanding qualities of a single plant of the different varieties grown. The seed from this plant is then sown in a single row, which can be inspected and undesirable plants discarded; the grain from that row is again sown by itself until sufficient seed has been produced from the single plant to enable a larger area to be sown on the farm, whence it is distributed to farmers for use in their paddocks and very often in farmers' experiment plots.

Not only is seed of greater purity obtained in this way, but also a strain of greater stamina and productiveness. The farmer garners the good seed with the bad, and does it year after year, but the above system ensures improvement rather than decline.

It is not necessary for the farmer to undertake the selection of a single plant every year and from it to raise seed for future use. Often he has not the necessary knowledge for such work. It is suggested that when a farmer finds his favourite variety is not yielding up to his expectations, he should obtain a few bushels of pedigree seed from the experiment farm nearest him, and from it propagate seed that can be sown on the farm area the following year. Such seed will retain its stamina for several seasons, when it may be time for another recourse to the experiment farm.

Another method is to select from a field crop just prior to harvest, sufficient of the best and most typical plants to give one bushel of seed, and to sow this separately. The product will sow a commercial area with high-quality seed. This method is called "mass selection."

Grade the Seed Wheat.

It is very important that only graded seed be used. Grading not only removes wild oats and other foreign seeds, but also ensures uniformity. If the size of the seed is uneven the sowing will be uneven, inasmuch as the grain will not run evenly through the cups of the drill.

It must not be imagined that because small grains are sown, weak or poor plants will necessarily result. As a matter of fact, if the smallness of the grain is due to adverse weather conditions during growth, no harm is done—indeed, the crop may be a vigorous one. But if the smallness of the grain is due to the parent plant having been weak or diseased, it is obvious that a good strain cannot result.

In order to be on the safe side, therefore, the Department would urge upon farmers thoroughly to grade their seed before sowing.

Various types of graders are on the market, but it will generally be found that the type equipped with the cylinder and perforated screens is the most efficient, and for all practical purposes the single-cylinder machine is the most convenient. For small quantities of up to, say, 250 or 300 bushels, a hand machine will admirably answer the purpose, but for larger quantities of wheat it is advisable to drive the grader with a small power engine.

MANURING THE WHEAT CROP.

Like all other plants, wheat requires the presence in the soil of a number of elements which it assimilates as plant-food, and without any one of which the crop must be a failure in a greater or less degree. Most of these elements are present in the soil in sufficient quantities, but the supply of the three most essential—phosphoric acid, nitrogen, and potash—is often too small for the plant's needs; more often still one or all is present in abundance, but not in a form in which the plant can make use of it. Hence it is that in many countries in which wheat is extensively grown it is necessary to use fertilisers that will supply all three.

Fortunately, in Australia, the supply of nitrogen and potash in the soil appears to be equal to requirements, and it is only necessary to add phosphoric acid, which, luckily for the farmer, is the cheapest of the three. The addition is made in the form of superphosphate, because it dissolves readily in the soil moisture, and the phosphoric acid becomes available for the plant in a very short space of time.

The need for phosphatic manure in the western and southern portions of the State is more apparent than in the northern and north-western portions. In fact, it appears from the results of continuous experiments, that the further south the greater the need for phosphoric acid for wheat-growing. This may be accounted for in two ways—firstly, soils in the northern and north-western districts are naturally better supplied with phosphoric acid than those in the southern wheat-growing area; and, secondly, the southern districts have been cropped for wheat for many years past, whereas the western and north-western districts have only been opened up for wheat-growing during comparatively recent years.

This being so, it is to be expected that the application of phosphatic manures should meet with a more generous response in southern and western than in north-western and northern soils, and the Department's manurial trials bear out this contention. In the north-west it appears that superphosphate is not so much needed as in the south, though in recent years cases have occurred in which definite advantage has resulted from its use. In southern and western districts the average difference between manured and unmanured plots is not less than 5 bushels per acre. It is these extra 5 bushels per acre which means to the wheat-farmer the difference between success and failure.

Quantity of Superphosphate per Acre.

Farmers in the Riverina, South-western Slopes and the Central-western districts should never fail to put about 56 lb. to 70 lb. of superphosphate with the seed. Many farmers are now finding it profitable to use larger quantities, and up to 1 cwt. per acre may often be used to advantage. In tableland districts, 70 lb. of superphosphate is recommended. In the north-west, as mentioned above, superphosphate is not largely used, but wheat-growers should make tests for their own information, applying different quantities of superphosphate to different plots, to ascertain whether the practice is profitable.

Useful as superphosphate is, it must be borne in mind that in order to obtain the maximum benefits from it, the employment of good cultivation methods is essential. Manuring and good cultivation go hand in hand—one is useless without the other—and the farmer will find that it is better in many cases to till the fertility into the soil than to buy it in bagfuls. In other words, the plough, harrow, and cultivator play quite as important parts in the fertility of the soil as artificial manure.

SOWING THE WHEAT.

The ultimate objective of all the attention given the fallow is the best possible seed-bed in which to place the seed, and it is essential if maximum results are to be obtained, that the seed be sown in its correct position, *i.e.*, in the fine, compacted sub-surface soil where it can draw upon the moisture in the subsoil.

Depth of Sowing.

The seed should not be sown deeper than about 2 inches. The young plant has to expend energy in pushing through the soil, and by shallow sowing the plant can emerge through the soil before a dangerous crust is formed. If, at the time of sowing, the soil is hardly moist enough to germinate the grain, deep sowing often causes malting, and this necessitates resowing at considerable expense, whereas with shallow sowing the surface soil soon dries and leaves the seed unharmed and waiting for the advent of rain. The contention of many farmers that deep sowing ensures deep rooting, and therefore greater drought resistance, is based on a misconception. The roots of a grain sown 2 inches deep will penetrate just as far into the soil as those of one sown 4 inches deep. The principal advantage of sowing fairly deep is to make sure that the grain is well covered and thus protected from the attacks of birds. Any greater depth than 3 inches can only be justified if the soil is in such a condition as will ensure immediate germination and enable the young plants to get above the surface before the top soil has had time to set hard. Certainly to put seed more than 3 inches below the surface is, in most instances, to court failure.

In the case of a late sowing—towards the end of June—when a quick germination is desired, it will be found that 1½ inches is ample, provided the drill is in good working order and the soil in such a condition that most of the grains will be uniformly covered.

The condition of the soil is perhaps the most common reason for farmers sowing too deep. Where the soil is lumpy and not in a good state of tilth, the drill has to be set to a considerable depth in order to cover the seed. On a well-prepared paddock the drill can be set to sow ever so much shallower than on a rough, ill-prepared one. With a well-prepared seed-bed the seed can be placed just where the farmer desires.

A Good Cover is Essential.

As already indicated, one of the essentials of good sowing is that the seed should be thoroughly covered. Whether the land has been fallowed or has been under stubble, a final cultivation or harrowing has to be given, and, unimportant as it may appear at first sight, a great deal really depends upon the direction in which it is done. Cultivators leave shallow furrows and ridges in the soil, and if the hoes of the drill get into these furrows and run along them, especially on land that is not quite even, the seed will not be covered to a uniform depth. If, on the other hand, the final cultivation has been carried out at right angles to the direction in which the seed is to be sown, the hoes of the drill will cut through the furrows and ridges, and the seed will be properly covered. In actual practice it may sometimes be difficult to do this, but if the last cultivation has to be in the same direction as the drilling it is a good idea to level the soil by trailing a harrow behind the cultivator. A surface is then obtained by which the seed can be well covered.

Quantity of Seed to Sow per Acre.

The quantity of seed to be sown per acre depends largely upon the variety that is sown, and also upon the time when it is sown. A safe rule to follow is that good stooling varieties, such as Marshall's No. 3 and Yandilla King, should be sown at a lesser rate per acre than such a comparatively poor stooling variety as Canberra. If the wheat is sown early, a smaller quantity can be used than if the seed is sown later on in the season.

Again, the rainfall in the district largely influences the quantity of seed that should be sown per acre. For instance, in a district where the rainfall is, say 22 inches, a larger amount of seed can be sown per acre than in a district where the rainfall is only from 17 to 18 inches per annum.

The size of the seed and the fertility and condition of the soil are other factors that have to be taken into account. A small seed will require a slightly lighter seeding, and the same will apply in the case of a fertile or well conditioned soil.

As a general practice in the true wheat belt, the quantity of seed for early sowings should average 50 lb.; for mid-season sowings 55 to 60 lb.; and for late sowings 65 to 70 lb., the largest figure being chiefly for hay crops that are being sown quite late. On the Black Soil and Western Plains the rate of seeding should be lighter.

Setting the Drill.

An important operation connected with sowing is the proper setting of the drill according to the variety and condition of the seed. A drill set to sow, say, 50 lb. of Federation per acre will often sow as much as 60 lb. of small "shotty" seed. Treating seed with bluestone makes a great difference; seed treated with copper carbonate runs more freely than that treated with bluestone. Atmospheric conditions also influence the flow of seed through the drill.

Many farmers have made mistakes in this way, having taken it for granted that the drill will sow large grains and small grains at the same rate. In reality the larger grains run through the drill distinctly slower than shotty seed, with the result that a farmer who thinks he has put out enough to sow a certain paddock finds he is several bags of seed short. It is safe to reduce the drill to sow about 40 lb. of "shotty" grain as compared with 50 lb. of an average sample of Federation.

Again, a variety will differ with the season. Seed harvested before rain, for instance, is appreciably heavier and more "shotty" than the same variety harvested after the rain, and the drill should be set according to the sample.

The farmer will find it advisable in starting to sow, to weigh the seed used over a known distance, and then it is possible to calculate almost exactly what will be required to sow the paddock, and to set the drill accordingly.

Cleaning Out the Drill.

The cleaning out of the wheat-cups in the drill is another operation that frequently exercises the farmer. If he rightly wishes to keep his paddocks absolutely clean by avoiding the mixing of varieties, he can run out the seed that remains in the drill on to the headlands, but this obviously is not a good method.

If the drill be examined, an opening will be found in the iron plates at the ends of the seed-box, and working just inside the hole is the end of the square iron bar that agitates the feeders in the cups. A key is supplied with most makes of drills to fit through the hole in the plate on to the square end of that iron bar. A few turns of the key will soon empty the cups of any wheat they may contain, and the mixing of varieties is avoided without waste, and with a minimum of trouble.

SHEEP ON THE WHEAT FARM.

Sheep must be regarded as an indispensable factor on the wheat farm. They are valuable as part of the working plant of the farm for the control of weeds, &c., and as an important and reliable source of income. Their indirect value is frequently of greater importance than the cash return. It is essential to the success of the crop that the farmer have on his holding as many sheep as possible, compatible with the most economical use of the land for wheat production.

Sheep are useful and valuable on the following grounds :—

1. They consume and turn to profit the straw left after the harvest.
2. They turn weeds to profit and prevent them from seeding at times when the farmer is unable to deal with them, owing to pressure of other work.
3. Their manure improves the fertility of the land.
4. When the season is so bad that the crops fail to produce grain, sheep turn them to profitable account.
5. The income from the farm is rendered more certain, as the farmer does not then depend entirely upon a crop that may be destroyed by fire or hail.
6. Sheep necessitate the adoption of a rotation, which tends to improve the fertility of the land, and to increase the yields of the crops.
7. They can be used to feed off crops that need such a check.
8. A supply of cheap mutton is made available for the farmer's own household.

To these advantages might be added the pride and pleasure derived by a farmer from the possession of a good flock.

In districts with a distinctly summer rainfall, particularly the north-western portion of the State, it is doubtful whether it is a sound policy for farmers to endeavour to grow wheat as the main source of their income. In the north-west, and in other districts to a lesser extent, rain very frequently falls during the summer months but fails during the wheat-growing season. Where wheat alone is relied upon the year's income is partly or wholly lost in a dry season, but where sheep have a prominent place on the farm a failing crop can be profitably utilised by turning the flock in. The summer rains, on the other hand, produce an abundance of feed, particularly if Sudan grass or a similar crop has been sown.

Some farmers already realise that their income is more assured when sheep take an important place in the farm operations. A very great deal of the wheat land in the north-western districts is not good land for the carrying of sheep in its natural state, but it is immensely improved by cultivation, and after being used for wheat for a few seasons it makes splendid grazing land. Further, Sudan grass and lucerne both thrive well there. The value of the latter is well known, and it needs no recommendation. A number of farmers are now extensively growing Sudan grass solely for the fattening of lambs, and are getting excellent returns.

Fodder Crops Essential.

In the past it has usually been taken for granted—as a result of habits formed during our long pastoral history—that sheep should be turned out into the grass paddocks for their living. Such traditions are, however, now dying, and many practical farmers are producing crops to increase the carrying capacity of their land.

Such crops are valuable in several respects. Sown crops invariably make quicker and greater growth than natural herbage, even under the most favourable conditions. This indicates that some crop should be grown to produce succulent green feed for lambs during the winter. Such feed promotes the rapid development of the lamb by increasing the milk flow of the mother, and results in the early maturity of a first-class lamb.

The growing of fodder crops is of great value, inasmuch as a large quantity of feed is produced on a small acreage. On a good crop of oats, barley, or wheat, from ten to twenty sheep can be carried per acre for a lengthy period in the spring. It is just at this period that the summer grass is coming away. If heavily stocked at that stage, the young grass is eaten off as quickly as it sprouts, and is prevented from making a strong growth. Where a crop is available on which the sheep can be kept at this period, the grass can be protected until it has made a good growth, and a heavy body of feed is thus provided that will carry sheep through the summer. Even on purely grazing properties it is found that the carrying capacity can be largely increased if the sheep can be kept off the grass at this period.

Sheep are particularly valuable in controlling weeds, especially wild oats. It frequently happens during spring that the oats cannot be entirely destroyed by cultivation. Even on the best-worked farms wet weather may prevent their complete destruction. The farmer finds the haymaking at hand, and his only possible means of preventing the oats on his fallow land from seeding is to graze them off with sheep. When the returns from the sheep are being taken into account due credit should be given for these indirect benefits.

Fallowing in Relation to Sheep.

The value of fallowing is now recognised by all capable farmers. Fallowing, however, can only give the best returns when combined with sheep, and it actually provides the opportunities for keeping sheep. Where fallowing is not practised the straw is burnt off and the land is ploughed for the succeeding crop, but under a fallowing system it is not necessary to burn the straw, for the stubble can be grazed with sheep six or seven months after harvest. A great deal of the straw is eaten, and the balance is broken and trampled into the ground, and is generally put into such a state that it can be ploughed under easily without the texture of the land being seriously interfered with.

In the Old World great value is attached to farmyard manure, the basis of which is straw. It is not yet possible, in this country of high labour costs, to adopt reaping and threshing and the production of farmyard manure for the maintenance of soil fertility. The grazing of sheep on the straw and the ploughing under of the residues, however, is a very fair substitute, and has the advantage, which appeals to all of us, of being applicable at no outlay for labour. If, however, the crop was infected with disease such as flag smut, foot-rot, or take-all, then the wisest plan would be to burn the stubble early, cultivate the land and sow an early crop of oats to provide feed.

A very undesirable feature of farming in our wheat districts is its one-crop nature. Such a system tends to deplete the fertility of the land, and to encourage weeds and diseases. Some of these—namely, wild oats among the weeds, and take-all among the diseases—levy heavy toll upon our crops, and the only practicable method of dealing with them is by rotation. In practically all the wheat districts, wheat is the only saleable crop which can be raised; but oats, barley, Sudan grass, and others can be grown as fodder crops and can be turned to account by means of sheep. By the use, therefore, of sheep, we can apply one of the great principles of good farming—rotation of crops.

Perhaps the chief reason that more sheep are not kept by many farmers is that the area under crop must then be restricted. Under our conditions any year may be a winning year—that is, the weather conditions may be so favourable that very heavy yields may be obtained from even the worst prepared land. This reason operated to a very great extent in the early development of wheat-growing, and still prevails in many newly-opened districts, but in the settled districts very many capable farmers have realised the value of adopting sound systems of mixed farming, which give sure and satisfactory returns.

It is very rarely that a crop fails entirely, but it does happen in our worst years, such as 1914 and 1919, that the crop fails for grain. In such years a growth is produced which, by the use of sheep, can be converted into wool and mutton, and made to give a very fair return.

The Number to Carry.

The number of sheep that can be carried on a wheat-farm varies according to the class of soil, climate, and the farming system adopted. If the sheep are regarded purely as an adjunct to wheat-growing, and are kept principally for scavenging, then the number must be strictly limited. If, on the other hand, a farmer regards lamb-raising as an important part of his enterprise, and makes provision for the growing of crops solely for sheep-feed, then the

number may be very considerably increased. Some who adopt the latter practice carry as many as one and a half sheep to the acre, and still grow a considerable quantity of wheat.

In reaching a decision as to the number it will be most profitable to carry, other points should be taken *into consideration—first, the cash return from* the sheep, and second, the indirect return in the shape of heavier crop yields resulting from the greater fertility of the soil that results from grazing with sheep.

In the Riverina and central west, where the conditions are favourable for the production of wheat, the number of sheep carried should at least be sufficient to keep the fallows in clean condition, and to enable the stubble to be turned to good account. A fair amount of feed is available from December to June, but *natural herbage is generally short during the* balance of the year, owing to most of the land being under fallow or in crop. A few acres of oats or barley should be grown to provide feed at this time. Such crops are *particularly valuable for topping off the lambs.*

Even in these favoured wheat districts, however, it is worth while considering the raising of lambs *on more extensive lines.* At present prices fat lambs are very profitable, and when there is fair grazing on the farm which can be supplemented by grown crops, it is probable that it would pay well *to reduce the wheat acreage and carry more breeding ewes. A number* of progressive farmers on the south-western slopes and in the west have already proved this to be the case, and are giving a good deal of attention to the raising of fat lambs.

While in the north and north-west a large part of the annual rainfall occurs during the summer, it is not, except in one or two districts, sufficient for the production of summer crops, such as maize, for sale off the farm, but it is sufficient for Sudan grass and for grazing lucerne. As the wheat crop is risky, it is evident that to stabilise the returns greater attention should be given to sheep, particularly the raising of fat lambs. Where the rainfall is so heavy as in the north-west—about 25 inches per annum—the carrying capacity of the farm *is fairly heavy when fodder crops are grown.* These latter are essential, for, as indicated previously, much of the wheat land is not of good grazing quality in its natural condition, although when allowed to run to grass after cropping it improves very considerably.

Many farmers who have not had experience in raising fat lambs on crops look *askance at suggestions of growing fodder crops, but those who have had* experience and who have a good class of ewe, joining them with good rams, find the returns compare very favourably with those from wheat. It must be remembered that risks are avoided, and that the expenses of sacks and of harvesting are not incurred.

In the *first districts mentioned* (the Riverina and the southern portion of the west), about 150 to 200 ewes can be kept on farms of about 600 acres. These could be carried principally on the stubble and fallows, with a little grass land, but it is necessary to provide some fodder to supplement the small amount of herbage on the fallows in the spring and early summer. For this purpose, a few acres, say, 40 or 50, of early-sown oats, is generally sufficient. In recent years the Department has raised a number of varieties of oats which are earlier than the old sorts, and which make good crops in the dry districts. Amongst these are Mulga and Buddah, which

give good yields in any of the districts where wheat is grown, and which are very palatable and suitable for feeding off. In some places in these districts summer crops cannot be successfully grown; but in some, Sudan grass grows reasonably well, and a small acreage should be sown.

In northern districts the farmer should, on account of the somewhat risky nature of wheat-growing, definitely make lamb-raising an important part of his operations. On a 600-acre farm about 300 or 400 good ewes should be kept and fat lambs raised. This may appear a large number, and it would only be possible to keep so many by growing fairly large areas of fodder crops; but the climate is suitable for the production of these, and in the winter months oats and barley can be provided, while during the summer Sudan grass gives good feed and lucerne will also provide valuable grazing.

On every farm where sheep are kept a good reserve of pit silage should be held. Silage can be made easily and cheaply in the pit, and keeps indefinitely. It should be regarded as a reserve for dry years only, and therefore need not be made every year. Indeed, it would probably be found that the silage would remain in the pit for years, but the possession of it enables a farmer to keep up his carrying capacity, as he is not confronted with the danger of shortage of feed.

The Class of Sheep to Keep.

The lines along which the farmer shall work in the handling of his flock require a little consideration. Three avenues of direct profit from sheep are open to the farmer:—(1) He may confine himself to wool production, or (2) he may produce both wool and mutton, or (3) he may devote special attention to the production of lambs.

With regard to the first of these three, the mixed farmer is at a disadvantage compared with the larger grazier. The latter has cleaner pastures and is able to produce a class of wool that commands more attention in the wool sale-room, for on the farm the dust from the cultivation paddocks and fallows penetrates the wool and opens it on the back, depreciating the value of the fleece. The farmer is, therefore, rather pressed into the second and third ways of earning profits from his sheep. The type of sheep that under most circumstances has proved profitable to the mixed farmer is the crossbred, which principally means the progeny of some longwool English ram and a Merino ewe.

A lot of attention has been devoted by the Department to this phase of the industry, and extensive experiments have been conducted to determine the best breed of ram and the best type of ewe for the purpose. Many English breeds have been tried, but certain ones have gradually been eliminated, until it has narrowed itself down to a contest between the Lincoln and the Border Leicester. Of the two, the latter shows slightly to advantage, although for certain districts the Lincoln is undoubtedly the better. All the Down breeds so far introduced into Australia were also tried, but they failed to "nick" well with the Merino in the first cross. The class of ewe most suitable for mating with these British rams has been found to be a large-framed, plain-bodied, robust and roomy type of Merino ewe. The crossbred thus obtained gives a heavy weight of fleece and is always in ready demand as a mutton animal, whether for local consumption or for export as frozen mutton.

The third line of profit open to the mixed farmer is that of raising fat lambs. This is an industry that commends itself to farmers owing to the quick returns it furnishes, for it involves the marketing of the lambs straight off the mothers at the age of 16 to 20 weeks. The requirements of the trade are an animal that, as a dressed carcase, will run from 35 to 40 lb. and at the same time have the sappy, luscious flesh that belongs to sucker lambs.

For fat lamb production certain things are essential, viz., the farm must be within easy distance of the railway, a supply of feed must be ensured for the ewes, and a combination of breeds must be used in order to ensure that the lambs grow quickly. Extensive experiments have been carried out by the Department in this direction, with the object of finding the best combination of breeds to produce early lambs, and it is here that the Down breeds showed their usefulness. Representatives of practically every Down breed (Southdown, Shropshire, Hampshire, Oxford, &c., and the Dorset Horn) were tried, being mated with first-cross ewes from the long-wool crosses already referred to. At the conclusion of the experiments, the three breeds which showed out ahead of the others were the Dorset Horn, Southdown, and Shropshire, in the order named. The Dorset Horn proved itself pre-eminently suited for the production of early lambs. Working on these lines, the farmer gets approximately 25s. per head for the lambs, and in the vicinity of 10s. each for the ewes' fleeces.

The class of farming thus outlined commends itself to the wheat farmer—firstly, by reason of the quick returns; and secondly, because the sheep can be utilised for cleaning up the fallows and cultivation, and for feeding down crops when necessary. The farmer must ensure a supply of green feed for the ewes during and after lambing, in order that there may be a constant flow of milk for the lambs, which must not suffer any check or set-back from birth to marketing.

An important point in the disposal of the lambs for the export trade is that they must be free from "grass seed." The difference between seedy lambs and lambs free from seed is remarkable, and will represent from 5s. to 8s. per lamb. Care must therefore be exercised in the handling of the flock. It will be found better to sell the lambs a little on the light side rather than to keep them long enough to become seedy.

Handling the Flock.

Reverting to the subject of the ram most suitable for farmers' purposes, it must be remarked that unfortunately many farmers are content to use almost any breed of ram, and in many cases the crossbred has become a nondescript animal. It should always be remembered that a poor type of lamb costs as much to keep and as much to market as a high-class one, while the difference in price will amount to many shillings. Similarly, a poor type of ewe costs as much to keep as a good one, but will breed only a poor lamb and give half the weight of poor quality fleece.

It may cost a little more to buy a good line of ewes or a few good rams, but the extra outlay is amply justified by the return in wool and progeny.

The ewes should not be kept after their mouths begin to break. Old ewes certainly make good mothers, but they give a poor fleece of low weight, and furthermore, do not thrive in dry times, and they generally die early in droughty periods. When they are becoming aged the first opportunity should be taken to fatten and sell them.

Success in lamb raising depends to a great extent on successful mating, and this very largely depends upon arranging the mating at the right time. It is recognised that in some cases this is difficult to secure, but as a rule it should be arranged so that the lambing should commence about that period of the year when green feed is available. In some districts, for instance in the bulk of the Riverina, December and January are good mating months, but in others an October mating will be found best, while in others again it is not advisable to mate before March and April. This question is purely a matter for arrangement so as to meet the most suitable climatic and pastoral conditions of the particular district in which the grower is engaged. The ewes should be in good condition at the mating time, but not too fat. It assists if the ewes can be put on some good green feed about a fortnight before mating.

The rams should be in good, strong, vigorous condition, and to obtain good results one ram should be used to every forty ewes. If they show a disinclination to work, the ewes and rams should be yarded together at night.

Sheep are very fastidious in regard to water, and should always be provided with good fresh water. If dirty, they will only drink with reluctance, and as ample water, particularly when they are on dry feed, is essential, they should drink abundantly. It is, therefore, an advantage to pump water from dams or tanks, and to keep the drinking troughs scrupulously clean.

Feeding-off Growing Wheat.

The feeding-off of growing crops of wheat is frequently practised throughout the wheat belt of New South Wales. It is an operation that is entirely dependent upon the season, and with good rains and mild temperatures in April and May it may become an absolute necessity; but there are many cases where it is not carried out to best advantage as regards the ultimate yield.

Many farmers who combine sheep-raising with wheat-growing sow their crops very early with the specific object of making use of them during the winter months, when the natural pastures are often insufficient for sheep and particularly unsuitable for maintaining the supply of milk in ewes with lambs at foot. Such men are content to regard any loss in the ultimate yield of grain or hay as amply set off by the feed derived by the sheep.

Crops Sown for the Purpose.

Where a crop is being sown with the intention of feeding-off, the sowing should be early in order that the wheat may have a long enough growing season to recover from the effects of the feeding-off, and still yield a satisfactory crop. The slow-maturing varieties are the most suitable, owing to the fact that they are usually vigorous stoolers, and have the added recommendation that they produce the largest quantity of leaf. Hence varieties such as Yandilla King and Marshall's No. 3 are eminently suitable for crops that are intended to provide some green fodder in the winter and a grain crop later in the year. Large areas of Federation are sown a little on the early side with the object of ensuring some feed in midwinter, though Federation hardly produces as much feed as one of the long-season varieties sown, perhaps, two or three weeks earlier. Neither late-sown crops nor quick-growing varieties can be expected to produce anything appreciable in the way of green feed, most of the varieties suitable for June sowings being comparatively poor stoolers and of scanty vegetative habit.

Strongly Rooted Crops.

A crop may usually be said to be ready to be fed off when it is about 6 inches high. It is a common error for farmers to turn sheep on to wheat that is not sufficiently well rooted to stand the pulling about that the sheep will certainly give it. How frequently this happens will be realised if a careful examination is made of a few paddocks after the sheep have been removed, dead plants being everywhere observable if the wheat was not strongly rooted when the stock were turned in. A good firm root-hold is an essential to grazing the crop down.

Feed-off Rapidly.

The length of time the sheep should remain on growing wheat is also of importance. For the sake of the crop it should be as short as possible. It is much better to turn on, say, thirty sheep per acre for one week than, say, ten sheep per acre for three weeks, because in the latter case the soil will be tramped too hard, and tracks are likely to be formed that will remain until the grain is harvested. Tracks are most likely to appear when there is a tank or dam in the paddock, but they are apt to become almost as distinct even in the absence of a dam, if the sheep are allowed to remain too long on the crop.

Heavy stocking for a few days has also the advantage that it ensures more uniform treatment by the sheep. In a crop that is very rank in patches, and that is in danger of developing Rust or Powdery Mildew, there is every likelihood that the sheep will tackle last those patches that the farmer wishes to see eaten back first, and that tendency can only be combated by turning in a large flock for a short time.

Objection will naturally be offered by the farmer who has sown a large area early for the express purpose of ensuring green feed in the winter, and with the definite object of getting a return from his sheep. To him a week or two is quite insufficient to fatten off the lines of stores that he has probably purchased for the purpose, and the only advice that can be offered to such a man is that he must in some measure choose between the wheat crop and the fat sheep—relying on his experience as to which is likely to yield him the greater profit.

When Not to Feed-off.

On some soils, particularly those of a heavy clayey nature, feeding-off has the effect of tramping the ground so hard that the harrows seem to do little good, even when heavily weighted. Obviously feeding-off should be avoided as far as possible in all such cases. Nor can the operation be advocated in respect of paddocks where the seed-bed was not as clean as it might have been. In such cases it often happens that the wheat keeps ahead of the grass and weeds until it is fed-off, and would probably have done so till harvest, but it fails to do so after it has been checked by the sheep. The enemies of the crop seem then to get such a hold as to interfere with its growth and materially to reduce the ultimate yield.

Sheep should never be turned on to the crop when it is too wet, or when the land is in a boggy state, otherwise the soil will be trodden right out of condition. Similarly, if rain falls while the sheep are on the crop, they should be removed as soon as possible.

When to Remove the Sheep.

Considerable differences of opinion exist amongst practical men as to the latest date at which wheat should be fed-off, some holding that the operation should be limited to the early part of the winter, and others contending that it may safely be extended into early spring. The controlling factor is the weather. In a favourable spring, a crop will recover and yield well notwithstanding that feeding-off has been prolonged, but on the other hand it is obvious that if a dry spell ensues upon feeding-down close in July or early August there is practically no hope of a recovery. The question is therefore, what is likely to be the nature of the spring, wet or dry? Were it possible to forecast the weather with any degree of certainty, this and many other problems would be solved. Even the average incidence of the rainfall for particular districts is of little value, but this can be said—in New South Wales dry springs are certainly more common than wet ones, and the farmer who would err on the side of safety will limit feeding-off to early and midwinter, and will make an absolute end of it by the 30th June. The only extensive exception to this rule is the north-west, where the time may with safety be extended to the middle of July. Speaking generally, the earlier the sheep are off the better for the crop.

Effect of Feeding-off.

Does feeding-off affect the yield, and to what extent? There are farmers who turn sheep into their wheat simply because they believe they will get an increased yield, but there is ample evidence of the most reliable kind that a distinct decline in yield is caused, particularly in the case of hay crops. The idea that feeding-off promotes stooling, and thereby a strong rooting habit, is probably well grounded, but that the crop suffers in bulk in the great majority of cases is practically certain. Admittedly there are occasions when wheat crops must be fed-off. It is quite possible for a crop to become so forward that, if the growth is not checked, it will come into ear at a time when weather conditions will be unfavourable for hay-making, and when it will probably be badly frosted if left for grain. Very often this untimely "heading out" of a crop is the result of ignorance of the true nature of the variety, an early or quick-maturing kind of wheat having been sown early in the season instead of late. Such rapid development of a field of wheat under normal conditions is rare, however, and given right varieties, feeding-off under the impression that it will greatly increase the yield cannot be advocated.

Harrowing.

After feeding-off it is advisable to put a heavy set of harrows over the field to loosen the surface. Some farmers think that heavy harrows pull too many wheat plants out of the ground, and while it must be admitted that a few will suffer in this way, no wheat farmer should be concerned about that, for the advantages far outweigh the disadvantages. "The man that harrows should never look behind" runs an old adage, and there is truth in it. The harrows should always be run across the direction in which the seed has been drilled.

HARVESTING WHEAT FOR HAY AND CHAFF.

Many factors enter into the production of wheat for hay and chaff, and the farmer who would secure profitable returns and earn the reputation for the well-grown and well-made article that commands the highest price in the Sydney market must exercise judgment in the selection of the most suitable variety for his conditions, good husbandry in the growth of the crop, skill in the handling of it in the field, and care and close attention to detail in cutting it.

All who contemplate the production of chaff for the Sydney market should make it their business to ascertain exactly what are the requirements of buyers and to act accordingly. It is quite true that many do this, and that in certain districts, particularly in the Riverina, the production of high-class hay and chaff is well understood and practised, but there are other districts where little care is bestowed on this product, and it is regarded only as a convenient method of getting something for that which is worth very little. When it is stated, however, that the proper preparation of chaff may increase its value in the market by almost as much as 20s. per ton—sufficient to pay the cost of cutting—it will be seen that the requirements of the market have an important relation to profits, and are therefore worth catering for.

Crop of Firbank Wheat at Canmain. Yield 3 tons 2 cwt. of Hay per acre.

The preference of Sydney for green chaff is due to the inclination of dry chaff to cause constipation and to necessitate the supply of some other green feed as a laxative. The city carter therefore prefers to purchase a green chaff which will save him the expense of another class of feed, and producers will find it quite worth while to study this feature of the business.

Suitable Varieties.

Chaff-production is rather different to other classes of rural enterprise, for chaff is not always the result of a crop grown intentionally for the purpose. For convenience, producers may be divided into two classes: (1) those who grow for chaff, and (2) those who grow for grain, but who, owing to frosting, dry weather or other causes, have to cut the crop for hay and subsequently convert it into chaff.

The man who is intentionally growing for hay should select varieties which yield straw and flag of good colour and body. Varieties that produce light coloured hay, or that are inclined to be "flaggy," should be avoided, and it is just as well to respect the prejudices against certain varieties (such as *Federation*), even if they be a trifle unreasonable. Varieties that have a brown head do not make the most attractive chaff, for the brown husk shows up and buyers do not like it.

Varieties that carry heavy straw should also have a preference. Some wheats have a very thin, "shelly" straw which gives a light bodied chaff that makes no weight in the bag. Heavier straw cuts better, and produces more weight, and the chaff has more body.

This question of varieties does not receive anything like the amount of attention it should, especially in districts where wheat is not largely grown for hay. There are districts where the value of particular varieties is fully appreciated; but there are others where it has yet to be learned, and where farmers will find it well worth while to consider the subject more than they have done. Farmers will find that it will pay to study the Department's recommendations and, where hay is desired, to grow one or other of the varieties that have proved their suitability for that purpose.

When to Cut.

The crop is at the best stage for hay a few days after it is in flower. This condition is best, because at this stage the plant contains its maximum amount of nutritive qualities, and at the same time the nutriment

Cutting and Stooking.

is evenly distributed throughout the whole plant. This is as it should be for hay-making purposes, for when preserved as hay the whole of the plant is to be eaten, and not only the ears. It is, therefore, better that the whole of the nutriment should be evenly distributed throughout the plant, rather than that one portion should be excessively nutritious and the remainder of little or no value as a food. Though the crop at the flowering stage contains the maximum amount of nutritive qualities, it has not reached the stage when it will produce the greatest weight of hay. The dry matter in the plant increases until it is mature, and because of this

some farmers refrain from cutting the crop until it has passed the flowering stage, in order to get a greater quantity of hay. They gain the extra weight at the expense of the feeding-value and colour.

The position of the farmer who has to cut for hay a crop that he intended for grain, is a different one. He cannot expect to get the quality that the grower will who has grown for hay and cut at the right time. In matters both of variety and of time of cutting the grain grower is at a disadvantage —more especially when he delays cutting as long as possible in the hope that he will get a crop of grain, the straw meantime losing all the colour that would recommend it for hay. In such circumstances the only advice that can be offered is that the farmer should endeavour to cut at the earliest possible moment after he is satisfied that he is not going to get a profitable grain yield.

Cutting the Crop.

Throw the machine in gear as the horses reach the crop, and drive down and round the edges. Cut at least two rounds before attempting to cut the back swath or the piece knocked down by the horses.

By means of the lever, move the knotter to or from the butter-board as required, so that the sheaf will be tied in a position that it will be evenly balanced. When the crop is very tall, and with machines that will allow it to be done, the mechanism operating the packers and supporting the butter-board should be adjusted so as to give as much room as possible on the length of the table.

Raise or lower the reel as the height of the crop requires. If the crop is leaning away from the knife, put the reel forward, so that the beaters will be lifting the crop backwards when the knife reaches it.

In a short, thin crop the beaters should be low and well back over the table, so as to prevent the stuff lodging on the knife or falling in front.

In a very light, thin crop it is advisable to have the beaters right down on the fingers, so as to sweep the greenstuff on to the canvas. It is not possible to do this with the beaters as fitted to the machine, for these are made of wood, and therefore stiff and rigid, and in consequence they cannot be set closer than 3 inches to the fingers, because of the ridge at the back of the knife, which would break the beaters if struck by them when revolving.

The efficiency of the beaters for dealing with light crops can be very greatly increased by tacking or screwing leather on to them, so that the edge of the leather projects about 3 inches beyond the edge of the beater. As the leather is flexible, the reel can be lowered until the edge of the leather touches the fingers; when the reel revolves, the leather, as it strikes the ridge at the back of the knife, will bend and pass over it without injury, and at the same time will sweep the short straws on to the canvas.

For a very light crop the binder may be further improved by inserting a piece of tin, or galvanized iron, under the first roller-holder, and allowing it to project until it meets the clip on top of the fingers.

A light, thin crop can be cut better if rather on the dry side.

It may be thought that a mower will deal with a lighter crop better than a binder, but it may be taken for granted that when a crop is too light for a binder to deal with, though in good working order, it is also too light for a mower to deal with profitably.

When the crop is too short for the mechanism to tie it in sheaves (and it is then so thin that if cut with a mower the rake would miss a great deal), it may be gathered in loose bundles by loosely covering the sheaf-carrier with hessian.

This will carry the loose straws until enough are collected, when the trip can be released and the bundle deposited on the ground.

Laid crops can only be dealt with by cutting them in the opposite direction to which they are lying. This entails working the binder only one way. When the crop is tangled as well as laid, considerable patience and judgment are required to make the most of it. All that can be done is to drive the binder with care, seizing every opportunity to drive it against the direction of the majority of the laid plants.

Curing the Hay Crop.

After cutting at the right time, to secure the maximum food-value the plant is capable of producing, it is essential that it be dried, and so preserved with as little loss as possible of this food-value. Loss takes place as the result of rain washing out the sugar and other soluble food ingredients, and as the result of the heat and sun drying off the essential oils and other volatile compounds. To minimise these losses by protecting the sheaves from the action of the sun and rain, a considerable number are placed together in a stook.

The sheaves should be stooked without delay after they have been cut with the binder. The machine may be allowed to cut a couple of swaths, and then sufficient men should be employed stooking to keep up with the machine.

In a light crop, one man can stook the sheaves as fast as the binder can cut them, but in a 2-ton crop two men are not sufficient to keep pace with it.

The sheaves in long, open stooks dry more rapidly than in round ones, but in the former, more of the crop is exposed to the bleaching action of the sun. Long, open stooks are therefore suitable for moist districts, whilst the practice of making large, round stooks is adapted for the dry ones.

Stooking and Stacking.

Sheaves are allowed to remain in stooks until the hay is so dry that when placed in the stack it will not heat or mould. This stage is determined by drawing a handful of straws from the middle of the stook and examining the knots or joints in the straws. If these are dry the material can be stacked without danger.

In hot, dry districts like the west, the hay dries out sufficiently in fourteen to twenty days in October. Later in the season it will be ready sooner. It requires to be watched by the farmer, however, as the stage at which it is carted in will influence the quality of the produce a good deal. If an examination of the upper joints of the stem shows that these joints have shrunk, it may be taken that the hay is dry enough to stack. Until that shrinkage is apparent the hay will be apt to sweat if stacked, but once the contraction of the upper joints can be seen, the crop should be got in as quickly as possible, as otherwise it gets hard and is then more difficult to make up into good chaff.

Admittedly very fair chaff can be made from poor hay, much then depending on the manner in which the chaffing is done, but the farmer who aspires to "topping the market," or who wishes to get full value for his crop, will regard all the foregoing points as important, and will take care that every one of them receives due attention.

Chaffing Hay.

The man who is pitching off the stack to the cutter should be instructed to throw out all sheaves that have been damaged. A shower at stacking time may cause several sheaves to turn mouldy, or a little rain may have found its way in if the stack has not been well built, and although it is true that a damaged sheaf or two will do little harm to a large sample, there is too much danger that the buyer will hit upon it when he comes to inspect the consignment. If he does the farmer loses a substantial sum by his neglect to throw out in the beginning that which was of little consequence any way.

The Use of the Steamer.

Every farmer who has hay chaffed by contract should insist on the use of the steamer, especially in dry districts. In cooler districts it is perhaps less essential, though frequently the quality of the chaff would be improved were it used. The object being to toughen the hay so that it will cut without breaking, it is particularly necessary in hot districts, but it is also desirable in cool districts where the conditions have been very dry during the curing of the hay, and still are at the time of chaffing.

A certain amount of care and judgment are required in the operation. As the steam is only used to toughen the hay, it will be found that a larger amount of steam is needed for the top of the stack than lower down, the hay at the top having dried much more than in the body of the stack. The best guide is to examine the chaff as it comes to the bags, and to increase or decrease the flow of steam according to the condition of the chaff.

The steam must be high-pressure, dry steam, for there is then no danger of causing mustiness. If wet steam is used, the occurrence of mustiness is probable, especially if the hay is itself somewhat damp. The best results are obtained when a pressure of 90 lb. is maintained. The steam pipe should be placed on the engine in such a position that dry steam is obtained, and to that end the off-take should be from the steam chest. On a Marshall engine at Coonamble the connection was made by inserting a T piece into the pipe leading to the whistle. On no account should steam be taken from the smoke-box end of the boiler.

The hay naturally becomes heated in passing through the steamer, and in the bag the chaff has a hot, damp, or slightly damp feeling, but provided the hay was quite dry before steaming there is no danger of any fermentation in the bag.

Just as in the case of the man who is pitching off the stack, the man who is sewing the bags should be instructed to watch the chaff as it comes through, and if any of the bags are not up to the standard they should be put aside for home use, in order that they may not reduce the value of the whole line.

Cutting.

The first point in connection with the actual cutting is that the "runs" should not be too long. Much depends on the size of the machine, but if the periods are long, the knives get blunt, and towards the end the chaff is broken up badly (instead of being cut), and the sample is rendered uneven. Short runs pay because of the higher quality of chaff.

The knives should be kept sharp, should have a good long bevel on them with a fairly straight set, and they should set close up to the face plate, which must be kept with a good angle. The angle, it will be found, requires renewal after every 300 to 400 tons are cut, for otherwise it gets rounded, and the knives cannot cut cleanly against it. It is also important that the knife wheel should be set firmly, so that when cutting the blades remain close against the face plate.

Sometimes the wheel becomes loose, and when the knives are being set they are apparently right, but when the machine is put in operation the wheel springs away from the face plate. Whether the knife wheel is loose or not, can be ascertained by pushing against the wheel away from the face plate, and if it is found not to be tight, it can be adjusted by means of the set-screws.

One point attaches to the bagging—second-class bags at once make second-class chaff. Good chaff should be presented in a manner that will commend itself to the buyer, and an inferior or dirty bag does not produce a favourable preliminary impression.

Attention to all the above points in cutting will enable a farmer to produce a very fair sample of chaff even from an inferior, "flaggy" hay. The object in dealing with hay of this kind must be to prevent the flag being broken into dust, and to give the chaff a good appearance—and that can only be achieved by care and attention to every detail in the machining.

Feeding Value.

Apart altogether from appearance, however, there is one feature in chaff production that has yet to be appreciated by both grower and buyer—that is, it may vary much in feeding value. It is a quality that cannot be detected in the final product, but it is nevertheless a fact. The feeding value of chaff depends largely on the class of soil on which it is grown, a rich soil generally producing a chaff of high feeding value. At Coonamble Experiment Farm it was observed that chaff from hay grown on the rich, black soil required to have very little grain added to make it a sufficient ration for horses. Chaff produced on good soils has not always such an attractive appearance as that which comes from the lighter soils, but if the feeding qualities were better understood the former would be appreciated more highly. To convince the Sydney market that this is so will take time, no doubt, but meantime the farmer who has a strong soil can console himself that he can feed his horses well with less grain than if he were located on lighter land.

HARVESTING WHEAT FOR GRAIN.

For harvesting grain crops the reaper and binder, the stripper, the combined harvester, and the reaper thresher have been used successively.

In moist districts the reaper and binder is used exclusively, for in such districts the grain in the standing crop is rarely hard and dry enough to be taken off with a stripper.

Over the greater portion of our wheat area, however, the conditions are favourable for harvesting with the combined harvester or some of its later developments.

Considerable controversy has waged about the advantages and disadvantages of harvesting with the respective implements. As cheap and rapid means of garnering the grain, the harvester and reaper-thresher are unexcelled; but advocates of the reaper and binder point to the fact that the straw,

or at least portion of it, is wasted, and that what is saved is of lessened value. This is unquestionably true, but the fact must not be lost sight of that, after all, straw is a very inferior feeding material. The cost of saving it is in most cases greater than its actual value in normal seasons, and it is only by storing it until a very dry time, when inferior materials have an abnormal value, that the farmer is able to recoup himself for the outlay connected with the saving of it. It is claimed that the expenditure necessary for saving the straw, if spent in other directions, would have made more and better provision for times of scarcity.

Nor must it be forgotten that it is not necessary to waste all the straw if the crop has been stripped. If stock be turned on to the stubble it will be put to good account without expense.

The question as to which is the more desirable implement will never be settled by argument. It is a question entirely of profit and loss, and the farmer who finds the harvester more profitable, under his conditions, than the reaper and binder will use the former. This much is certain, that inexpensive methods of harvesting grain have played no mean part in the development of our wheat areas, and that but for them many acres now being profitably cultivated could never have been brought under the plough.

The modern harvester is a wonderfully efficient implement, and Australians may be proud that such an implement was produced and developed in their country. It is particularly adapted for peculiar conditions which necessitate that the individual cultivate a large area to be profitable.

Precautions Against Loss by Fire.

Fire-breaks.—Hay-making affords a splendid opportunity to protect the crops, when ripe, from advancing bush fires, by surrounding them with a bare strip, which will act as a fire-break.

It is a fairly general practice in the grain-raising districts to cut for hay a strip about half a chain wide round the standing crops. Such a practice might be followed by all. In large paddocks the practice might, with advantage, be extended to provide for the cutting of openings, half a chain wide, so as to divide the crop into blocks of approximately 200 acres each.

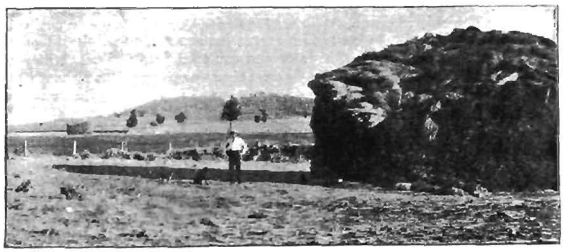
This is a ready and economical way of safeguarding the dry, ripe crop against destruction by fire. The piece of short stubble land provides a suitable place for checking the advance of a fire, which may have broken out in the grass paddocks or other portions of the crop. This is especially the case when a portion of or the whole strip of stubble is ploughed.

Fire-cart.—To assist in controlling or extinguishing a fire, should one break out, a fire-cart, filled with water and equipped with buckets, beaters, and axe, should be stationed, during harvest time, in a convenient place, with harnessed horses for drawing it, close by. On small farms where the number of horses is limited, the most suitable place for such a cart is considered to be at the place where the bags are filled from the harvester and sewn up.

It can be brought daily to this place by some of the horses used in the harvester, and when required for a fire the animals necessary to draw it can be taken from the harvester working close by. There is an additional advantage in having it stationed here, in that a small portion of the water in the tank can be used for giving the harvester horses a drink during the heat of the day. But care must be taken when such a plan is followed that every favourable opportunity is seized to fill the tank, and that the quantity in it never becomes unduly low.

The Advantages of the Sheaf-carrier.

A Large Field of Stooked Wheat.



Effect of a Gale of Wind on Bad Stacking.
Note Hay Sheaves Blown against Fence.

A.—Harvesting with Reaper and Binder for Grain.

The crop is ready for the reaper and binder when the straw under the ears has turned yellow. At this stage the grain is doughy, and the crop may be cut without fear of loss. It is advisable to use the reaper and binder on the heaviest portions of the crop, and also on any portions that may have become laid.

It is probable that in some districts the farmer will find it an advantage to commence his grain harvest with the reaper and binder, and complete it with the harvester.

Building Stacks at Wagga Experiment Farm.

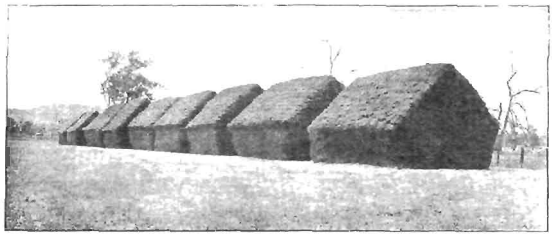
Stacks Placed for Economic Working.
The Threshing Machine or Chaff-cutter can be placed between them.

Stooking Grain Sheaves.

The methods adopted vary with the climatic conditions. In districts where fine-weather conditions during harvest are the rule very little trouble is taken, and twelve or fifteen sheaves are put together in round stooks in such a way as to withstand the winds only.

In districts where wet harvests are common, considerable skill is required in building stooks so as to shed rain, dry quickly, and withstand winds.

Stooking, whenever practicable, should be done in the morning when the straw is tough, to prevent waste in handling. *Ripe wheat should not be handled during the heat of the day, as the grain is then more liable to shed.*



Rectangular Stacks.

In stooking, two sheaves should be handled at once. Each sheaf should be grasped about a foot from the ears and stood firmly on the ground, leaning towards each other at the top, and the short side of the sheaf towards the centre. About three pairs should stand firmly upon their own bases. Two additional pairs at each end should lean towards the central pairs, and a single sheaf should be placed at each end. This would make sixteen sheaves upon the ground. Two sheaves should be used as caps. The butts should be placed in the centre and pressed together to interlock them, and a good handful of straw upon each side of each capping sheaf should be bent down from the bands to prevent the winds from blowing the cap off.

The number of sheaves in such stooks will depend upon the length of the sheaves, as no more should be placed in the base than can be reasonably covered by the two capping sheaves. Such stooks, if properly built, will turn considerable rain and dry readily. As they are only two sheaves wide, they may be blown over. To overcome this, buttresses should be started upon either side at the centre and built as the original stook, and covered by two capping sheaves as before described. A stook in the form of a cross is thus made, which will withstand considerable wind.

The most economical method is to thresh the grain direct from the stooks, but if this is not possible, then the sheaves must be stacked.

Stacking.

The oblong stack is preferred to the round form, as it is easier to top up. A new hand working on a round stack will often find it bulging before he reaches the full height, and he will have some difficulty in keeping a true circle. Those who prefer the round forms and have had experience of the work, will find no difficulty in adapting these notes to that form of stack.

The size of stack which is found the most convenient is 12 yards by 6 yards, built 14 feet to the eaves. The capacity is 45 to 50 tons. Stacks are often required to stand through all weathers for some months, and become compacted to such an extent that the eaves are about 10 feet

from the ground; yet if well built they remain quite perpendicular, and suffer no damage from wind or rain, and the loss of butts on the outside will not be worth mentioning.

After selecting a good site, level and dry, measure off the ground 12 yards by 6 yards, and build a good straddle of straw, sticks, or other suitable material which may be handy.

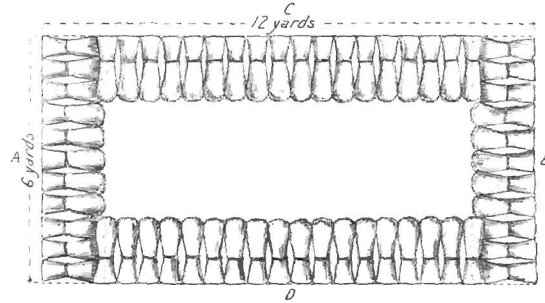


Fig. 1.—Commencing the Stack.

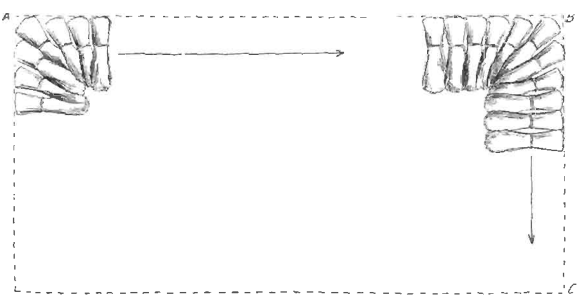


Fig. 2.—Another Method of Commencing the Stack.

The stacking can be started from the centre or from the outside, but it is simpler work to start from the outside, and this is the general practice. Fig. 1 shows the easier method of commencing the stack. First of all place a layer of sheaves on the ends, A and B, butts outwards, and running lengthways with the stack. Then lay sheaves along the sides, C and D, butts outwards, running across the stack and overlapping the heads of the end sheaves. These are the only sheaves which will be placed flat on the ground.

Another method of commencing, which is not quite so simple, is shown in Fig. 2, and provides for binding the corners of the first tier. The first sheaf, A, is placed at an angle, pointing towards the centre of the stack. *The next sheaf overlaps the head of the first, and the third that of the* second, and so on, until the sheaves are lying straight across the stack. As the corner B is approached, the butts are spread and the heads overlapped to *bind the corner. Then the sheaves are straightened again along the end,* B C_2 and so on around the stack.

In filling up the centre of the first tier, always place the butts on the ground. The dotted lines in Fig. 3 show the sheaves first laid. Fill up by placing sheaves heads outwards, overlapping the bands of the first layer. *Continue around the stack, and then commence again in the centre,* always placing the butts on the ground, until the centre is filled.

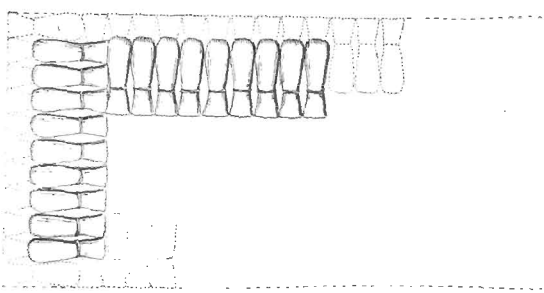


Fig. 3.—Filling up the Centre of the First Tier.

The second, or binding tier, is laid upon the first tier of sheaves exactly as shown in the second method of commencing the stack (Fig. 2). A start may be made at the corner, or in the centre of the end, working to the corner. The usual method is to start at the corner. Place butts outwards to the edge (Fig. 4), and bind the corners by laying the sheaves at an angle. Lay the sheaf flat, and close the head somewhat. In finishing, just go far enough to catch the head of the sheaf first laid.

The centre of the second tier is filled by placing sheaves butts outwards and well up to the bands (Fig. 5). In this portion of the work a good deal of judgment has to be exercised. The aim is to keep the centre of the stack a little, but not too much, above the edges. In a stack of this size the centre should be kept about a foot higher than the edges. This is obtained by placing the centre sheaves farther out or farther in as required. To make the stack faller in the centre the sheaves are placed farther out; to make it more level they are drawn in. As the filling proceeds, the stack always looks as if it were going to have a hollow centre, but the next layer fills it up. It may require a little practice to see exactly how far out to place the sheaves, so as to get the centre the right height.

The following tiers are all put on the same as the second, binding with the butts outwards, and keeping the centre high. If rain beats upon the sides it would have to travel upwards to get into the stack. In the case of a wheat stack, the water would need to travel upwards the full length of the sheaf before it could injure the grain.

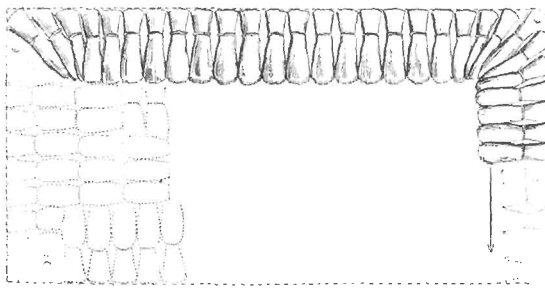


Fig. 4.—The Second, or Binding Tier.

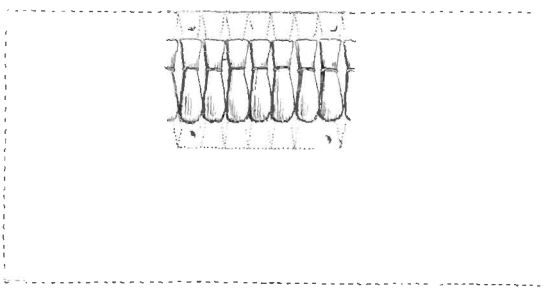


Fig. 5.—Filling up the Centre of the Second Tier.

In commencing the third tier, place the corner sheaf at an angle with the first sheaf of the second tier. Looking at Fig. 4, it will be seen that the corner sheaf slopes towards the bottom side of the stack. *When putting on the corner sheaf of the third tier, slope it towards the right end of the stack,* making an angle with the lower one. This will make the corner secure.

A good stack-builder will always keep the sides of his stack perpendicular. The stack has a tendency to spread as it rises. Do not draw the sheaves in, but use a board about 15 inches x 12 inches, with a handle about 6 feet long (Fig. 6), and beat the edges in with this.

The stack is built 14 feet to the eaves. A light, but strongly constructed platform, which can be readily moved by two men to any required position, is sometimes used for reaching the higher levels.

The second last tier is laid so that the sheaves overhang the sides about 3 inches (Fig. 7). The ends are flush with the other end sheaves. There is no hip to the roof of this stack—it has a straight gable. The heads of the

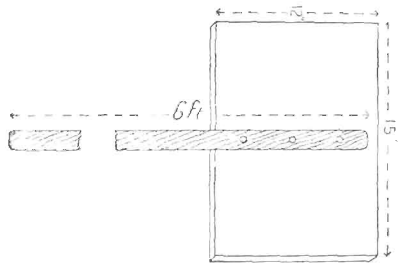


Fig. 6.—Board for Squaring off Edges of Stack.

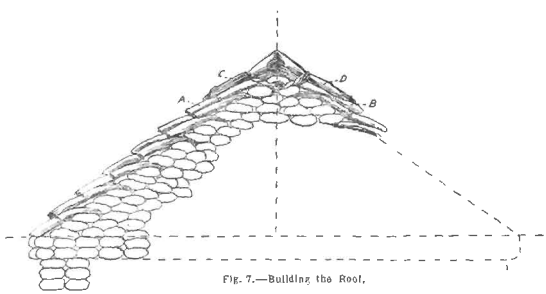


Fig. 7.—Building the Roof.

corner sheaves are bound in so as to support the corner of the roof. The last tier is laid level on the edges with the second last one, binding the corners as explained above. This forms a good eave.

Now we come to the top and roof of the stack. The construction requires a little explanation, but it is hoped that the sketches will enable the reader to grasp the method. The aim is to build a gable roof in such a manner that butts only will be exposed, except at the cap, and the whole made firm and strong.

All the top sheaves are laid lengthways on the stack, butts outwards at the ends. They can be bound in the centre by laying them either way. Start from the edge and work along the stack. It will take about twenty sheaves to run the length of the stack.

Commence the first row about 1 foot in from the eaves. Build all the rows of this layer right across, and then commence the second layer a little farther in. Judgment must be used to give the roof the correct pitch. When about three layers have been built in this way, place the first row of roofing or thatching sheaves in position. They are placed butts downwards on the eaves, the heads resting over the top of the portion of roof already built. If the sheaves are long, four layers of roof may be required before placing on the first thatching sheaves. Lay these thatching sheaves right along the stack on both sides.

Now build three more layers of the roof. Before placing the first row in position, press the heads of the thatching sheaves down upon the stack and bind them in. (See Fig. 7.) When these three layers have been built, put on another row of roofing or thatching sheaves, butts downwards, just covering the bands of the first layer, and resting the heads over the stack as before. Proceed in this way, working both sides together, until the ridge is reached. It will be seen that only the butts of the thatching sheaves are exposed.

Always use well-bound sheaves for covering the stack in this way, as these are the ones which have to stand the weather. It is well to ask the carter for a good load to top the stack.

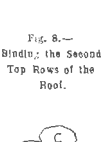


Fig. 8.—Binding the Second Top Rows of the Roof.

The ridge requires binding together, and the method of doing this is shown in Fig. 8. The second top layer will consist of two rows of sheaves lying side by side, as A and B. Take a handful of straws from both sides of the band of sheaf A and stick it into the band of sheaf B. Repeat this right along the top. It keeps the top from spreading. Then the ridge C, the last row of sheaves, is put on, and the stack is capped.

The last two rows of roofing sheaves, coming up the roof one on each side, are placed butts downwards like the rest, so that the heads meet on the top over the ridge. These are shown as A and B in Fig. 9. On top of these place two more sheaves, C and D, butts *upwards*, to act as a cap. Take a handful of straw from each side of the band of each sheaf, *roll them tightly*, and twist the two together, turn the twist underneath, and push it hard into the end of the stack.

Fig. 9.—Capping the Ridge.

Fig. 10.—Binding the Capping Sheaves.

The capping sheaves, butts upwards, are carried along the ridge on both sides. To bind the capping sheaves along the ridge, take a handful from sheaf B (Fig. 10), break it back at the band, and stick it into the band of sheaf A from the top. Continue this along the ridge on both sides; it pulls the sheaves together and makes the cap fast.

As a further precaution to protect the stack from the wind, stick a peg into the second capping sheaf from the end in a direction sloping in towards the stack. Draw a string from this peg over the first sheaf, and tie it to a peg stuck in the end of the stack.

Straw stacks *had* better be thatched. It is possible to build them without thatching by keeping the middle well up, but it is a more difficult job than with hay, and a novice is not advised to attempt it.

A Fair Average Roofing-sheaf, taken from a Stack which had been Standing for Seventeen Months.

These are the most exposed sheaves on the stack.

The same Sheaf after Brushing off the Rotten Trash, which is seen on the Ground.

This is practically the only loss in the whole the stack.

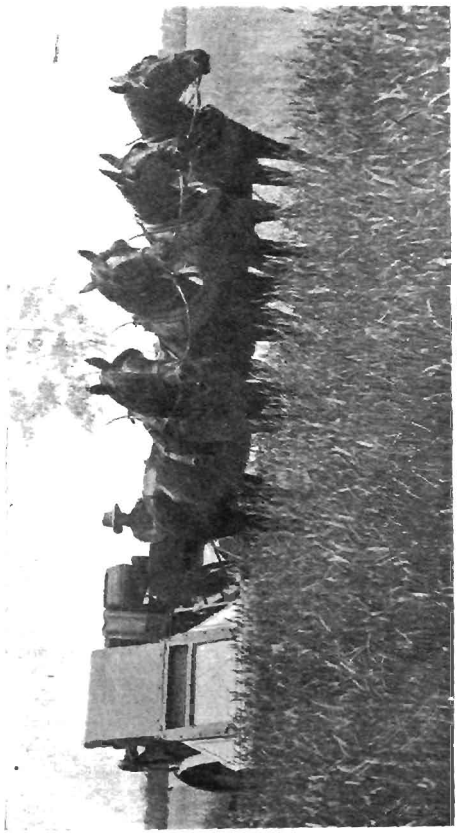
Precautions Against Mice and Fire.

Many devices have come under notice from time to time to cope with the mice pest. *Building the stack upon a raised platform answers the purpose*, if the blocks upon which the platform is built are capped with galvanised-iron guards or inverted petrol tins so as to prevent the mice reaching the platform boards.

Another successful method of keeping them out is to enclose the stack with a fence of galvanised-iron, either plain or corrugated, about 2 feet high. Let the iron into the ground to a depth of 4 inches, and place it in a slanting position, leaning outwards, all round the stack; take care to leave no open space at the corners. To ensure that mice do not enter a stack thus protected, care should be taken that straws, bags, or other articles are not allowed to hang from the iron fence or from the raised platform.

If it should be found that mice are troublesome in the stack, poison with arsenic dissolved in water. Place dishes of the solution all round the stack; if it will not entirely eradicate the pest, this method will help to keep it in check.

Precautions should be taken to protect the stack against fire by ploughing a firebreak all round, and in order to avoid heavy loss by fire the stacks should not be built too close together. They should be covered by insurance.



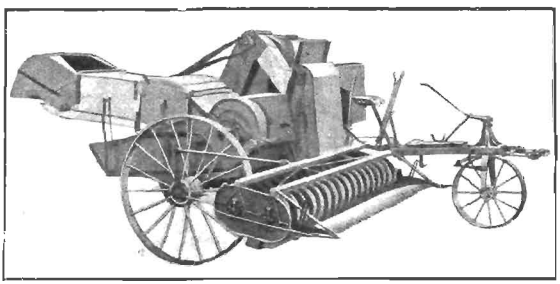
A Combined Harvester in a Crop of Pandilla King.

B.—The Combined Harvester.

For many years the harvesting of wheat crops was performed by the stripper and winnower, but the advent of the combined harvester caused a revolution in the then current methods of harvesting, and the machine quickly superseded the older types. While still entirely satisfactory for the harvesting of a good upstanding crop, its popularity has been considerably reduced by the reaper-threshers. The machine combines the operations of the stripper and the winnower, the grain being harvested, separated from the chaff and bagged, all by means of the horse-power that draws the machine through the crop. The saving in labour so effected has been one of the most important factors in the extension of our wheat areas. Indeed it is hard to see how the area devoted to wheat in this State could have reached even half its present dimensions without the combined harvester.

Manufacturers have perfected the machine with much ingenuity, and at the same time have maintained stability, so that the heaviest crops can be dealt with. During the harvest of 1915, when the work was so heavy that farmers from other lands might easily have supposed the use of some apparently simpler machine was imperative, combined harvesters were employed on probably quite 90 per cent. of our wheat fields. Crops that were as much as 7 feet high, and that yielded up to 40 bushels and more per acre, seemed to present no difficulties, provided the teams were heavy enough.

The crop is fit to strip when the grain is found to be hard, when bitten, and when the heads of those varieties with pendant heads hang down.

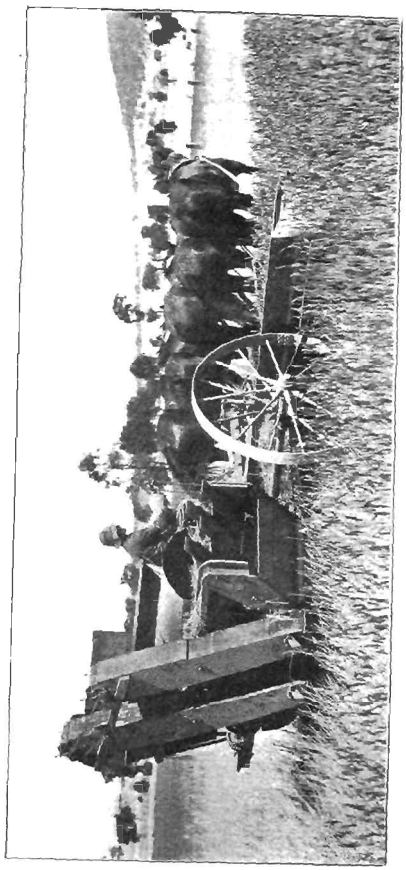


A Modern Wheat Harvesting Machine

The problem of harvesting of wheat in Australia has been solved by the highly ingenious and economical machinery of which the above is an example, the heads being reaped, and the grain threshed and bagged at the same time.

C.—Harvesting with the Reaper-Thresher.

The reaper-thresher, better known perhaps as, and most commonly termed, the "header," is a comparatively new harvesting machine, which prior to the year 1910 was practically unknown in the wheat-growing districts of this State. In that year a number of the machines were distributed throughout the main wheat districts, and although farmers appeared to favour the principle on which the machine worked, the opinion seemed general that many alterations and improvements were necessary. Each year alterations



One Type of Reaper-Thresher.

A Front View of the same Type of Pedal-Thresher.

have been made, and the excellent manner in which the machine handled badly-lodged crops during the 1920-21 harvest firmly established it in farmers' favour, and it has practically superseded the combined harvester.

Perhaps the first main difference between these machines and the harvester is that the heads, instead of being stripped or combed off as with a harvester, are cut off by means of a knife, which is worked at the rear of the comb. This knife is worked on a similar principle to the knife on an ordinary reaper and binder. The straw is drawn through the comb until the heads, assisted by the reel (which revolves at about the same speed as the machine moves through the crop), comes in contact with the knife. The fact of the heads being cut off greatly lessens the draught, as the crop cannot pull heavily upon the comb. Should the ground be soft, or the straw at all weak, the wheat is not pulled up by the roots and choked in the comb. When the crop is dirty with thistles or other weeds, there is not the choking in the comb that takes place when the heads are stripped or combed off.

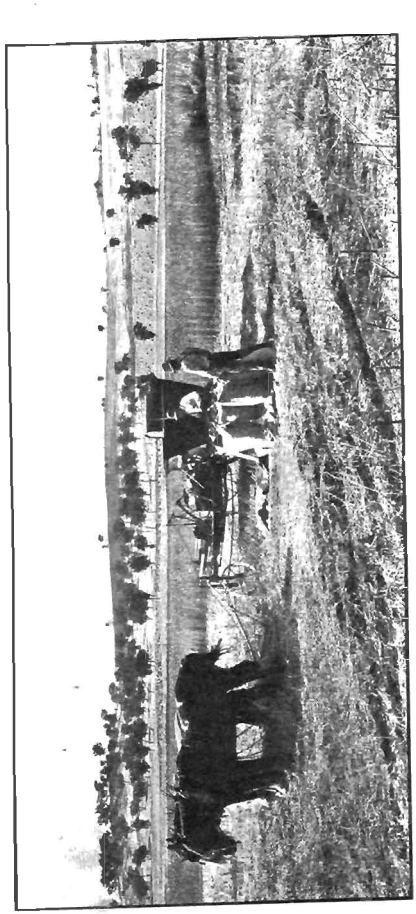
When the heads are cut they are thrown by means of the reel on to the conveyors at the rear of the comb. These conveyors take the heads along to a feeder, where they are evenly forced into the threshing drum. The drum

Another Type of Reaper Thresher.

on the reaper-thresher is very large, and by means of pinions can be altered and made to travel faster or slower to meet varying conditions. A second drum, or really a cavings thresher, is placed at the rear of the machine to re-thresh any broken heads which may have escaped the first threshing.

By means of straw walkers the straw is taken from the threshing drum and thrown out. The grain falls on to a graded pan situated beneath the walkers, where it feeds evenly on to the riddles, and is winnowed. The grain is then carried by means of elevators up into the grain box, which has a capacity of five bags.

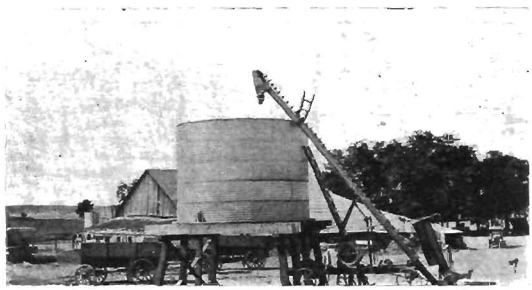
The smaller machines take an 8-feet cut, and with two average teams of, say, five horses each, in a fair crop, from 15 to 20 acres may be harvested in a day. There is very little waste of grain as compared with some other harvesters, and the lightness of draught, and its power to deal with a weedy crop, make it a most valuable addition to the wheat-grower's plant. Larger machines take a 12-feet cut, and the latest development is the "auto-header"; which is a combination of tractor and header, and by the use of which the operation of harvesting is greatly expedited. In actual field work it has harvested as much as 5 acres per hour.



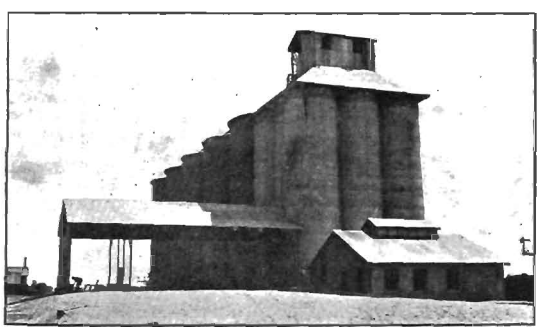
Bagging Wheat from a Reaper-Thresher in the Field.

Harvesting for Bulk Handling.

Some little rearrangement of the New South Wales farmer's method of handling his wheat is necessary in order to enable him to utilise the bulk-handling system to best advantage.



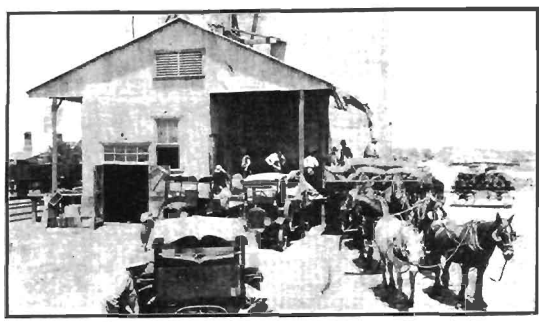
An American Farmer's Granary and Elevator (also showing Grain Wagon).



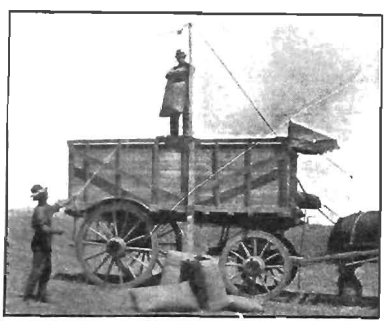
Completed Country Grain Elevator (Working-house Plant).

First of all, if it is necessary for the farmer to complete his harvesting before carting to the elevator, he may purchase sufficient bags for his crop and use them as containers in which to convey his grain to the grain elevator, where he will receive them back again for future use. In this case he will be saved sewing and cost of twine. His bags should be secured at the mouth, either by use of one of the many clips which are now on the

market, or by means of a couple of skewers, which can be made out of No. 8 fencing wire, sharpened at one end and turned over a couple of inches to form a rough loop at the other. Two of these skewers will securely fasten the sack, one being pushed in from either end so as to pin the top together and to overlap about 2 inches in the middle. At the elevator they can be withdrawn quickly and returned to the farmer for future use.



Delivering Wheat at a Country Plant with Temporary Facilities.



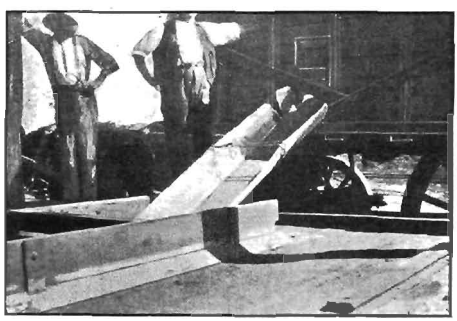
Bulk Wagon being Loaded at the Farm.

If the grower is within a few miles only of the elevator, it may be sufficient for him to purchase, say, only one-third of his usual total requirements in *sacks, and to use these sacks over and over again during the season.* Quite a number of farmers have used their sacks so far for three or more years in succession in taking wheat to the elevators.

Farm Granaries.

A farmer may decide to equip his farm with a granary to hold his wheat while he is finishing harvesting. This granary should be made either of timber, or in the form of a galvanised iron tank, but raised sufficiently from the ground to enable its outlet to discharge by gravity into a box-wagon.

The granary would have to be fitted with a small receiving hopper and elevator leg worked by a small petrol engine or by hand-power. Any skilful farmer would be able to erect what he required in the way of galvanised-iron tanks.



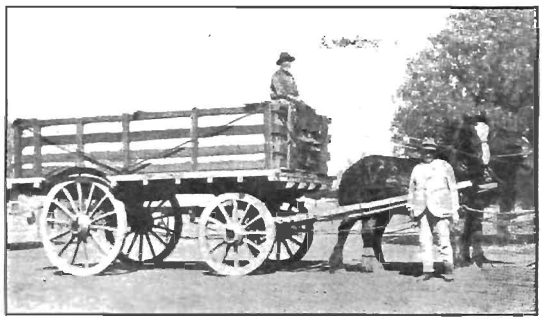
The same Wagon being Unloaded at the Country Elevator (Temporary Plant).

Box Wagons.

A box wagon could be provided out of the usual table-top wagon, on which could be erected a box consisting of galvanised iron of the nature illustrated on page 292. Provided with such a box wagon, the farmer could arrange to convey the wheat to his granary. A box wagon which was used to deliver wheat to the silo at Burrumbuttock is shown in the illustrations on pages 290 and 291; it should be noted that this form is more suited for discharging at one of the temporary plants where a working house has not been provided. By placing the discharge slide at the back, the wagon would be suitable for use at an elevator with a working house, as the wagon could be placed on the dump sticks and tilted so as to discharge the wheat through the door at the back.

A good type of box wagon was used by Mr. L. Marantelli, of Finley. He constructed a box frame on his wagon and lined it with plain galvanised iron; it was capable of carrying about 250 bushels of wheat at each loading. This grower states that in one year it cost him £300 for corn sacks, and the following year, using the box wagon in conjunction with the grain elevator, his outlay in sacks was only £30. The wagon takes about eight minutes to discharge at the elevator.

At working-house plants, wagons drive over the receiving hoppers so that wheat from bulk wagons, if suitably built, can be run into the hoppers very much more quickly than bags can be emptied. In the past bulk wagons



Box Wagon, lined with Galvanised Iron, used at Finley, N.S.W.
[From *The Australasian.*]

The Finley Wagon being Emptied.
[From *The Australasian.*

have generally been built with one central discharge opening in the centre of the floor of the wagon, or with one opening in the back end. With such wagons it is generally necessary to scrape and sweep a considerable amount of wheat which remains in the wagon when no more wheat will run through

the discharge openings. Farmers and carters are strongly recommended to provide several large openings in the bottom of the grain box and the following suggestions may be of use:—

A suitable box to set on the ordinary table top wagon can be made by any handy farmer. This would have a sheet of iron bottom laid on the table-top, and sheet iron sides on a frame of wood. By using a sheet iron bottom for the box tie-bolts across the box are only necessary at the top, thus leaving the floor of the box clear for sweeping or scraping out the last of the wheat.

Three discharge holes should be arranged; one just behind the king-pin; one just in front of the back axle; and one midway between the axles. If so placed, wheat can be run from all discharge openings at once into the hoppers at the silo, and very little wheat will remain to be scraped out through the openings. If it is desired to slope the two ends of the box towards the two end openings, this can be done by making sections of false bottom, but will reduce the capacity of the box.

A Hoppered Bulk Wheat Wagon.

To each of the discharge openings should be fixed a short square spout, about the size of a kerosene tin, long enough to project a few inches through the bottom of the box and the top of the wagon, and these spouts are closed by means of a slide. Simple means can be provided for preventing the slides opening while the wagon is travelling. Such a wagon can be discharged quickly without the use of the tilting dump sticks, at the working-house plants.

Some Farmers' Plants.

The question, what expenditure a farmer would be justified in incurring in equipping himself with bulk-handling appliances could best be decided by himself in working out the cost of those appliances as against the cost of sacks.

Mr. W. Bradshaw, of Coolamon, has given the benefit of his experience. He says:—

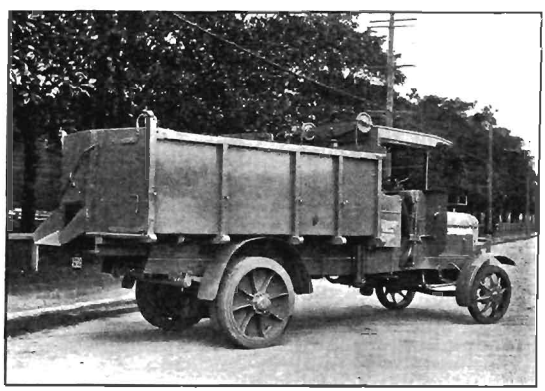
My solution is that farmers need to construct bins on their farms so that there would be no need to purchase bags.

At present, farmers within a couple of miles of the silos can, with the aid of one man and a dray, deliver their wheat to the silos as they strip it, at no

greater cost than bag-sewing and stacking to the farmers further out. The average farmer out from the line is forced to stack his wheat in the paddock at present in bags until he has finished harvesting before he is ready to cart to railway. A system of corrugated iron bins on the farms would be little more expensive than bags at 10s. a dozen, and they would represent economy in labour, and there would be no waste and only a fraction of the depreciation as with the bag system.

Corrugated iron bins are already in use on farms in Victoria, but they are built on stands and perhaps the initial expense would be too great for the average farmer.

The writer's plan for bins is as follows:—21 feet in diameter by 12 feet high, 6 or 8 feet to be under ground level. Any handy farmer could construct such, as they would not need to be soldered, except the roof; and a coating of concrete outside underground would save the iron. That capacity would hold 1,000 bags of wheat, and one man could cart from harvesters over 200 bags a day and tip into bins at as cheap or cheaper cost than at present to sew and stack.



A 5-ton Bulk Grain Lorry, self-tipping.

With the aid of a small oil engine and elevators, one man or boy could daily fill an overhead bin of sufficient capacity for a wagon load. The wagon would draw alongside the overhead bin, and shoots therefrom would convey wheat by gravitation into bags on the wagon. With the aid of patent fasteners the load could be put on with less labour and quicker than by the present bag-loading system. If the bins were emptied, say, in January or February, they could be then filled with chaff for the farmer's winter use, and so save the cost of stack thatching. The above capacity bin would hold about 17 tons of chaff, but they could be made higher for chaff to hold about 30 tons.

A bin of the above wheat capacity would need not more than 1 ton of iron, so that the cost would be little, if any, greater than 1,000 bags at 10s. per dozen, i.e., £42.

At 10s. per dozen the bags needed for a 36,000,000 bushels State yield would cost half a million sterling. If that amount were invested in bins on the farms there would be little need to buy bags. There would be a saving in labour and comparatively no depreciation or waste by pests.

Another progressive farmer, Mr. John Wood, of Ariah Park, states:—

My contention is that no grower need purchase more than one bale of bags for each two 8-feet machines in use. Last year I purchased one bale of bags and put a removable box on my wagon, 12 ft. x 7½ ft. x 8 ft., made of 6 in. x 1 in. Baltic timber, tongued and grooved, at a cost of about £5, which I can put on or take off my wagon in about fifteen minutes. I did away with the bag-sewer and started a man carting in bulk from two 8-feet machines to silos, and we finished harvesting and carting on the same day—2,000 bags—and I still have my bale of bags left for use this season. I intend building an underground concrete silo on the farm, on lines suggested by Mr. Bradshaw, as an emergency to tip my wheat into should there be any hold-up at the railway silo.

WHEAT-GROWING ON MALLEE LAND.

The term mallee is applied to particular types of stunted eucalypts of peculiar habit of growth. The typical mallee consists of stunted trees growing in clumps, four or more stems coming from the one clump of roots. As a rule the smaller the diameter of the trees the greater the number occurring on the same root clump, and in the case of fine whipstick mallee, ten to twenty small trees may be growing out from the one base. The timber generally occurs in these clumps, but interspersed between them may be found single specimens of ironbark, stunted pines and other timber, also porcupine bush, &c.

Mallee country usually presents an infertile drought-stricken appearance, and the trees afford very little shade considering the amount of foliage they possess. In the natural state practically no grass grows in the mallee, and on the lighter types of soils no permanent streams are to be found, due largely to the fact that this country absorbs water very rapidly. The fact that this type of country in the virgin state is almost entirely without water and grass provides sufficient explanation for its avoidance by early settlers, who, of course, greatly preferred the open timbered country, which was more pleasing, more fertile, better grassed and watered, and easier to handle.

With the exception of some of the mallee land around Wyalong, this class of country has been strictly avoided in New South Wales until comparatively recent years. In this respect the opening up of the mallee areas in New South Wales is following similar lines to Victorian development. In that State the mallee was so forbidding that it was not taken seriously in hand until most of the suitable wheat country had been developed, and now this despised unpromising mallee country is producing in the aggregate more wheat than any other part of Victoria. It is now regarded as the granary of the State, and up to the present has produced £50,000,000 worth of wheat.

It is found in New South Wales that the unpromising and even forbidding exterior appearance of the mallee is no true indication of its value for wheat production: in fact, it disguises soil fertility of no mean order; the soil has the power when correctly worked to yield wheat on a lower rainfall than any other class of country. The saying that "One inch of rain on mallee land is as useful as 1½ inches on other wheat country" has some justification in actual fact, as was demonstrated in New South Wales during the dry year of 1927.

Then, again, so far as its physical difficulties are concerned, there are many settlers who choose the mallee in preference to the more attractive looking pine and box country, maintaining that it is much easier to clear

and prepare for cropping than green forest country. It must be said that a new settler can in one season roll a large area of mallee and crop it. Up to 700 acres have been rolled, burnt and sown within twelve months by one settler. This, of course, is not possible on forest country.

Although much can be said for and against mallee it is evident that it possesses wonderful possibilities in the hands of men who understand it. This understanding, however, is essential, and it is considered unwise for a settler to take up mallee country unless he has had previous experience. If he is determined to take mallee he will be well advised to gain his experience by working for others in a mallee district. This advice is given because the mallee presents problems singularly its own, and it yields its harvest only to those who have the knowledge and the heart to demonstrate its productiveness.

Types of Mallee.

Different types of mallee are to be found in New South Wales; each type is usually associated with a certain type of soil, but there is much overlapping of types. As a rule, however, the taller and larger diametered mallee is found on the heavier and more fertile types of soil, while the light and sparse mallee usually grows on lighter soils. The following general types of mallee occur:—

Bull Mallee.—Usually grows in clumps of three or four to good height—sometimes 20 feet or more; the trees are usually 6 inches or more in diameter. It usually occurs on fairly heavy and fertile country, which makes very good wheat land.

Whipstick Mallee.—This variety occurs on a wide range of soils; usually, however, on the lighter soils it will only grow to a height of about 8 to 10 feet and be roughly 1 or 2 inches in diameter, while on the heavier and more fertile soils it will grow taller and stouter. It is generally on good wheat country.

Spar Mallee consists of single trees about 6 or 7 inches or more in diameter and from 12 to 20 feet or more in height. The soil is usually excellent where this is found.

Broombush Mallee consists of a number of fine-stemmed, narrow-leaved bushes coming from the same root clump. It does not grow to any great height, and is usually about 4 or 6 feet high. It occurs on different types of soil, being sometimes found on poor, gravelly ridges, but often on quite good wheat land.

Blue Mallee.—This type grows a little taller than broombush, and is easily recognisable by the distinctive bluish colour of the foliage. It generally occurs scattered through broombush or other mallee, but may occur by itself. It can be found on all classes of soil.

Rolling.

A very different method of clearing is adopted to that used in open forest country. Instead of being cut down the mallee is rolled down with a specially constructed heavy roller. Rolling mallee is an exacting undertaking and requires a certain skill in the driver and steadiness in the horses that only come from experience. When inexperienced men are on the job,

men and horses are easily injured. No definite rules can be laid down to guide a settler under all and every situation; it is desirable, therefore, that only those men should undertake it who have had either some experience of mallee country or who are otherwise good bushmen with reliable judgment.

A metal roller such as an old boiler or a log of suitable size may be used. It is necessary to construct the roller with a superstructure, pole and wheel, so that it can be drawn along with the horses or tractor working in the rolled portion while the roller draws over into the standing mallee. The diameter and length of the roller are best decided by the class of mallee to be rolled. The roller should not as a rule be longer than 10 feet, and a team of eight horses is sufficient to draw it.

A log about 2 feet 6 inches in diameter is often used for mallee-rolling. Such a roller is more effective in rolling out the stumps by the roots, but is troublesome to work, as it is more inclined to get hung up on strong stumps than is a roller of greater diameter; a large iron roller is, therefore, preferable in some classes of mallee. If a log is to be used, a hollow one.

A Tractor-drawn Roller at work on Mallee.

should be selected, and also one that is tough, with the grain twisted so that it will not split. The stouter the mallee the larger should be the diameter of the roller. For big mallee an old boiler 4 feet or so in diameter makes the best roller. For whipstick, broombush or blue mallee the log roller is the better.

One of the secrets of successful mallee-rolling is to have a sufficient number of horses hitched to the roller so that they can walk along freely with only a light pull. For example, if the width of the roller and the class of mallee is such that six horses could do the job, then a team of eight should be put in, so that the animals may have an easy task. If this is done there should be no accidents, and the faster pace will save a considerable amount of time. In this hazardous work horses should never be overloaded, as it is when they are floundering about in heavy going that they get injured.

It is usual to cut a track along the edge of the area to be rolled to provide a clear path for the horses to travel along. It is necessary to have one man working in front of the roller to nick all trees that would be too thick and

tall to roll satisfactorily. If such clumps or large single specimens are not nicked, they break off too high up the stem when the roller strikes them and runs over them, and they have to be cut down level with the ground after the mallee is burnt; as the burning toughens the timber the work is then much harder. Trees to be nicked should be cut as low as possible (right at the ground level), and on the side farthest away from the roller. It is advisable to nick anything over 6 inches in diameter, and sometimes if the mallee is dense and occurring in big clumps it may even be advisable to nick trees of even less than 6 inches diameter. Occasionally scattered ironbark trees or other trees of 1 foot or more in diameter and 30 or more feet high occur in mallee. These are sometimes left untouched so as to provide shade for stock later on, and this is a wise practice, as a few such trees left in a paddock are of great value as shade in this hot country.

The roller is intended to roll down all the standing timber, and although many of the trees are snapped off, if the roller is of a size and weight suited to the class of mallee it is being used on, it should roll in such a manner that many whole clumps of roots are levered out of the ground. This rolling out of the stumps is the desired action of the roller, and if it is simply snapping off the trees without rolling the stumps out it is not doing the work correctly. A fairly short heavy roller of suitable diameter is most effective: such a roller hits a clump fairly close to the ground and with considerable force, and is therefore effective in bumping stumps and roots out. Too large a roller would simply ride freely over many stumps without levering them out.

When to Roll.

Mallee should be rolled at the end of the winter or early spring to get the best results; when the ground is moist the roller has a much greater chance of levering the clumps of stumps and roots out of the ground.

It is found that August and September are the best months; in very dry years, July and August would be preferable, but in any case rolling should be completed before the end of September. The cost of rolling varies, of course, with the class of timber, but at the present time it is in the vicinity of 10s. to 15s. an acre.

Preparation for the First Crop.

After the rolled mallee is burnt in March it is generally advisable to have any stumps which show above ground knocked off with an axe, so that they are level with the ground: if this is not done endless trouble is occasioned by breakages to the farming machinery. This operation costs about 5s. an acre, which may also include picking up the sticks still remaining after the fire. If the burn has not been as successful as desirable it may cost an additional 5s. an acre for picking up the loose sticks, but after a good burn such expense is not necessary.

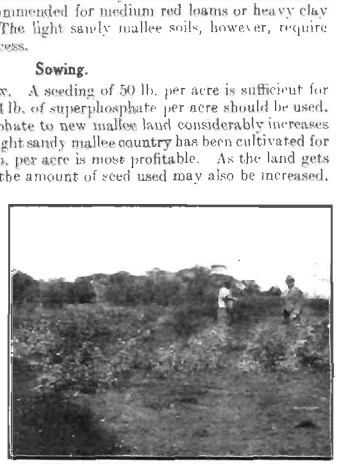
As soon as this is done it is advisable to cultivate the land. On some country it is impossible to plough, but the plough does good work on broombush country. Generally speaking, however, it is best not to plough for the first crop, but just to use the cultivator to work the surface into condition. Whatever implement is used, it should be set to go shallow (no more than 3 inches). There is no necessity to cultivate again unless rain falls. Should this happen a further working with disc or springtooth cultivator is advisable.

Most new mallee land is too loose for wheat-growing and the first aim should be to get the sub-surface compacted as quickly as possible. Much of the mallee soil in New South Wales is inclined to be of uneven surface and inclined to crack badly, but it is found that with cultivation the surface becomes more even and the cracks disappear as the consolidation improves.

The heavier and more fertile mallee soils may be fallowed and cultivated in the same manner as that recommended for medium red loams or heavy clay loams as the case may be. The light sandy mallee soils, however, require special methods to ensure success.

Sowing.

May is a good month to sow. A seeding of 50 lb. per acre is sufficient for the first crop, and 56 lb. to 84 lb. of superphosphate per acre should be used. The application of superphosphate to new mallee land considerably increases the yield. After most of the light sandy mallee country has been cultivated for a few years, a dressing of 132 lb. per acre is most profitable. As the land gets older and in better condition the amount of seed used may also be increased.



Mallee Land just prior to Sowing the Second Crop.
Note the suckers which will have to be slashed after the crop is sown.

On medium-textured mallee soil it is advisable to sow about 1 inch deep or up to 2 inches, but on the very light sandy mallee soils it may be necessary to sow a little deeper for the first crop in order to place the seed on moist soil. On such soil it is preferable not to harrow after sowing, so as to leave the protection of the raised ridges. They prevent excessive blowing of the soil, and also provide a good catchment for rain and materially assist the early growth of the crop. The ridges between the rows of wheat plants reduce the severity of the wind and prevent extreme drying of the root system.

Sowing is carried out with a combine or drill—it is rough work for a combine, and a drill is therefore preferable. It may be necessary to draw light harrows after the drill to cover the seed. If too rough to permit of this, bushes should be dragged instead.

Cropping Systems.

After the crop is sown the suckers may have grown up a little and should be slashed off.

After harvest the stubble is burnt. It is an excellent practice to roll the stubble prior to burning so as to keep the fire near the ground, where it will do most good in burning the young mallee suckers. If the stubble is too light to carry a fire it is advisable to burn it with the assistance of a stubble burner (an implement resembling a hay rake). It is most necessary that as good a stubble fire as possible be obtained in order to check sucker growth.

The aim is to get two or three thick stands of stubble as early as possible on new mallee land so that when the straw is fired a severe check will be given to the still-suckering stumps. There are two schools of thought concerning the best method of achieving this end. One favours sowing a crop every year for the first three or four years before fallowing the land. Those who favour this method claim that in this way a stubble burn is obtained each year which effectively checks the growth of suckers, even if the wheat yields resulting from these crops sown on stubble land without fallow are light. It is found in practice, however, that when three or four consecutive crops are grown in this manner without fallowing the crops get lighter, and actually the stubbles are so thin that they do not burn effectively and are not as potent a factor in killing suckers as anticipated, as the fires are not hot enough. The second method is to sow the first crop without fallowing; then as soon as the stubble is burnt to long summer fallow the land with a mouldboard plough, and continue to sow only on fallowed land for some years.

After observation of both systems in practice over extensive areas in different parts of the State, it is thought that the latter is the more satisfactory.

The stump-jump mouldboard plough is preferred to the disc in mallee country, as it is found that more breakages occur with the disc plough. The mouldboard ploughing given in preparation for the second crop is very effective in severely uprooting some of the live stumps and roots, and it is found that many that would otherwise have suckered prolifically are broken off and killed; thus this method, although it sounds drastic, considerably minimises suckering. The plough certainly loosens the stumps. If the mallee farmer can do this the first year he is a long way on the road towards preventing suckering. Further, as suggested above, the fact that crops are sown on fallowed land ensures a denser and heavier stubble, and consequently a much hotter fire results when it is burnt.

Various modifications of these two systems exist. One successful mallee farmer uses the mouldboard plough to prepare for his first crop, but this is not possible on much of the mallee land in New South Wales. This farmer takes off three crops in succession without fallowing, and boasts that he never has to slash a sucker. He claims that the first ploughing tears the roots and stumps out very effectively and they quickly die. As soon as each crop is stripped he burns the stubble and immediately ploughs the land, thus giving it a short summer fallow.

A method that has much to recommend it is to sow oats for the first two crops on new mallee land. Oats always provide a heavier stubble than wheat on this class of country, and therefore give a more effective burn. The disadvantage is that oats are not such a good cash crop as wheat, and the new settler cannot always afford to grow them.

Just which system a settler should adopt depends on the class of mallee and the nature of the soil, and on his financial position.

Suitable Varieties of Wheat.

On the better class mallee soils, *i.e.*, the medium to heavy loams, varieties such as Yandilla King, Federation and Waratah are very suitable, but on the lighter sandy mallee soils in New South Wales, Currawa has proved to be the heaviest yielding variety, and it can be strongly recommended for such soils. Varieties that grow strongly and produce a good bulk of stubble

for burning should be grown during the first few years in order to assist in killing the mallee suckers. That is why Currawa and Yandilla King are so satisfactory on new country. On older mallee land varieties that have given great satisfaction are Currawa for light sandy soils, Federation, Free Gallipoli, Rajah, Yandilla King and Ranee for the medium to heavy soils. This is as far as our New South Wales experience goes at present. It may be of interest to mention the varieties that do well on the mallee soils in South Australia. On the light sandy soils Sultan, Caliph, Currawa and Canberra do very well. For the new mallee soils Ford is favoured, as it gives a bulky stubble and ensures a good burn.

Sheep on Mallee Farms.

It is advisable to maintain a flock of sheep on a mallee farm as soon as possible. They will be found of tremendous value in grazing the fallows, and assisting to compact the soil, in addition to providing an added source of income. Although in the virgin state mallee lands are quite useless from a grazing point of view, it is found that after clearing they improve in this respect in a really astounding manner.

The cultivation and the superphosphate applied to the wheat crops rapidly improve the grazing qualities of the land, and it is found that quite a satisfactory number of sheep can be maintained on the farm. The fallows and stubble provide very fair grazing for the sheep.

Protection from Wind.

Fortunately the greater portion of the mallee soils in New South Wales is of medium to heavy texture, though areas of light sandy red soil occur, and these are subject to blowing in heavy winds. It is thought that as larger areas of such mallee country are cleared this disadvantage will increase. Settlers in these new areas, especially as they push farther west, should keep this in mind, and wherever possible strips of mallee timber should be left standing as a protection from the winds. In areas where this has not been done it is advisable to plant breakwinds of suitable native trees. The sugar gum is an excellent tree for this purpose.

WHEAT-GROWING IN NEW ENGLAND.

Climatic and economic conditions in New England are somewhat unfavourable to the production of milling wheat, while oats is a more attractive forage crop and one which combines with local practice more completely than wheat can do. Wheat can, however, be successfully grown in New England, and with the usually copious rainfall, high yields can be obtained, although rain is frequently responsible for heavy losses at harvest time.

At Glen Innes Experiment Farm wheat is grown in the ordinary four-year rotation along with oats and maize as follows:—

Wheat or oats—Autumn sown and harvested in December.
Maize—October to June.
Wheat or oats (spring sown)—August to December.
Oats (fodder crop)—March to early summer.

In this practice the spring wheat follows maize (grain), which ordinarily permits of a comparatively short fallow and which frequently subjects the wheat to a check due to the dry weather so often experienced in early spring. Converting the maize stalks into stover is very valuable in making the land available much earlier in the winter than would otherwise be the case, and allowing a longer fallow to counteract the drought conditions of August and September, which are usually accentuated by the heavy frosts of the preceding months.

The annual rainfall at Glen Innes, is approximately 31¼ inches, the bulk of which falls during the summer and autumn months, thus rendering a long fallow period unnecessary and undesirable. Under ordinary seasonal conditions ample moisture can be conserved for the main crop by a short (summer) fallow, the initial ploughing being done reasonably early in the year, and the fallow kept in shape by springtooth and harrow and also by grazing with sheep whenever the surface is dry enough.

Owing mainly to the somewhat stony and uneven nature of the land, the stump-jump mould-board plough (three- or four-furrow) is in general use, and the common depth of ploughing is from about 4½ to 5 inches. On land free of stones the three-furrow disc plough is found useful in effectively dealing with the heavy weed growth and large amount of debris which frequently occurs.

The wheat-sowing season in New England is very long—extending from mid-autumn to late winter, and the wheats which are grown group themselves into winter and spring varieties. Rust-resistance is a most important attribute in local wheats as quite commonly the spring weather is favourable to the development of this disease; hence all recommended wheat varieties are either rust-resistant or at least rust-escaping. The other prominent wheat diseases are of minor importance, bunt being readily controlled by seed treatment, while climatic conditions and crop rotations are sufficient to check the other fungous diseases.

The varieties of wheat recommended for growth in New England are:—

For early sowing (autumn-winter).—Genoa.

For late sowing (spring).—Florence and Clarendon.

Genoa is a fairly tall, white-strawed wheat with a yellowish-white, tapering, erect head. It has been unsuccessful in practically all other parts of the State, but in New England it will outyield any other late or mid-season variety for either hay or grain. It holds its grain well and is an ideal wheat for this district.

Clarendon and *Florence* are early-maturing varieties, the former being more suited for grain production and the latter for hay. Clarendon holds its grain well, whereas Florence is much inclined to shell when ripe.

The amounts of seed required range from 60 to 90 lb. per acre, according to time of planting. The relatively heavy seeding is necessary with New England wheats, largely because of the probability of the grain having been subjected to weather injury at harvest and light seeding is very apt to produce thin stands.

In experiments conducted at Glen Innes Experiment Farm superphosphate at the rate of 40 lb. per acre gave an increase of upwards of 4 cwt. of hay and 3½ bushels of grain per acre, while heavier dressings of superphosphate and other mixed fertilizers failed to return profitable increases.

Until quite recently, grain wheat was harvested by the reaper and binder and threshed. By this process the best quality grain that circumstances would allow was produced, but costs of production were excessive, and during the last few years the use of the header has become more general. It has been found that even in these altitudes the crop will "strip" as early as 8 a.m., and that in spite of delays caused by wet and the cold easterly weather which is always a feature of the New England summer, an extraordinary saving of time and expense is effected, though at the cost of a slightly lower quality grain. The relatively uneven ripening of the crop was raised as an objection to the use of the header, but it has been found that by giving greater attention to the preparation of the seed-bed, by the use of better seed and the application of superphosphate, a more even growth is made, resulting in greater uniformity of ripening.

COST AS A FACTOR IN WHEAT PRODUCTION.

The question of the cost of producing a crop of wheat has always been of supreme importance to the wheat grower, but perhaps never in the history of New South Wales has it been of greater interest than now. Discussion has been frequent and prolonged, the result being the disclosure of greater diversity of opinion than about almost any subject touching farm practice. Individual variations in methods of farm management and work are so great that, while hundreds of farmers can agree about the quantity of seed or manure that should be used per acre, or about the preparation of the land, few can agree as to the actual cost of production.

Wheat for Grain.

Estimates of the cost of producing wheat for grain (fallow and non-fallow compared) appeared on page 226, but it may be convenient to repeat the figures for fallowed land here. These estimates, be it further remarked, are in respect of operations in the commonly recognised wheat belt of this State. Production on the tablelands, especially in New England, is another matter.

The item "rent" will vary with the value of the land, but for convenience the capital value is assumed to be £6 per acre, but as the wheat will be grown on the best portion of the farm, the rental is charged at 8s. per acre. It should not be understood, however, that the farmer can make nothing out of the land while it is under stubble or after it has been ploughed for the fallow. As pointed out a few pages earlier, profitable pickings are available for sheep on such cultivation land at different times in the year, but, as the present concern is the cost of producing a crop of wheat for grain, that aspect of the subject may be set aside, and the rent for the whole of the two years must be charged against the grain crop. In the case of unfallowed land, of course, only one year's rent would be so charged.

Cartage to the railway is another item that is hard to estimate, as very much depends on the distance and the nature of the country, but for an average distance of 6 or 7 miles it works out at very close to 4d. per bushel.

Cost of producing an acre of wheat for grain. Estimated yield, 21 bushels.

	£	s.	d.
Ploughing once	0	8	6
Harrowing three times	0	3	0
Cultivating twice	0	5	0
Drilling	0	2	6
Seed, 60 lb. at 7s. per bushel	0	7	0
Superphosphate, ¾ cwt. at 6s. per cwt.	0	4	6
Pickling seed	0	0	6
Harvesting with harvester	0	9	0
Bags, seven at 12s. per doz.	0	7	0
Rent, two years at 8s. per annum	0	16	0
Cartage to rail, at 4d. per bushel	0	7	0
Total	£3	10	0

Wheat for Hay and Chaff.

Whether it is more profitable in an average season to harvest for grain or for hay is ever an interesting subject for discussion. In the main, of course, everything depends on the market prices of the two lines, but the respective costs of growing, harvesting, and carting are also important, and it may therefore be of interest to consider the average outlay per acre of cutting with the reaper and binder and subsequently chaffing.

As the preceding estimate is on the basis of a yield of 21 bushels of grain, it is convenient to assume that the equivalent yield in hay will be 2 tons.

The estimate is again formed on the assumption that the land is fallowed, and the rent for two years is added as before.

Taking 1s. 6d. per ton per mile as the basis of the item "cartage to rail," the cost for a distance of, say, 6 miles can be set down at 9s per ton.

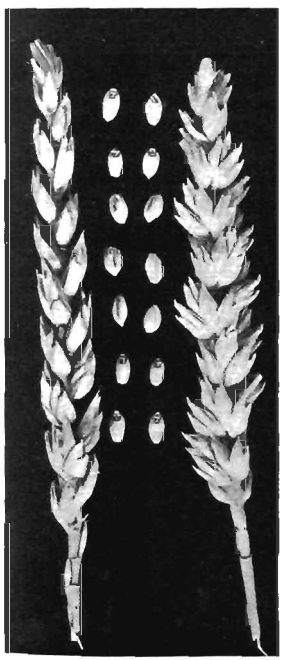
Cost of producing an acre of wheat for chaff. Estimated yield, 2 tons.

	£	s.	d.
Ploughing once	0	8	6
Harrowing three times	0	3	0
Cultivating twice	0	5	0
Drilling	0	2	6
Seed, 70 lb. at 7s. per bushel	0	8	2
Superphosphate, 1 cwt. at 6s. per cwt.	0	4	6
Pickling seed	0	0	6
Cutting with binder	0	5	6
Twine	0	3	6
Stooking	0	2	6
Carting, stacking, and thatching	0	15	0
Cutting for chaff, 2 tons at 17s. per ton	1	14	0
Bags, say 24 per ton, at 8s. per dozen	1	12	0
Rent, two years at 8s. per annum	0	16	0
Cartage to rail, at 9s. per ton	0	18	0
Total	£7	18	8

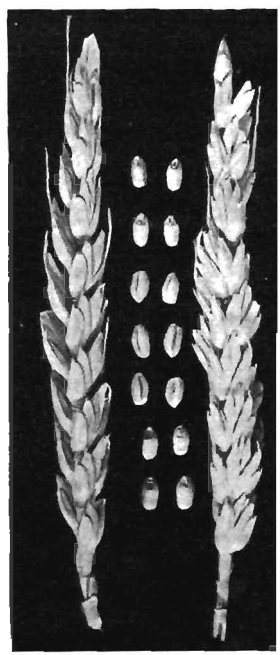
DESCRIPTIONS OF RECOMMENDED VARIETIES.

Aussie.

Aussie is an awnless variety with tapering white ears, and somewhat short and slender straw, which is not purple, and tends to be semi-solid. It has been successful in the north-west, and ripens with Gluyas, being a departmental crossbred between the latter variety and Federation. The grain is yellow, easy to thresh, and in the soft white class. The variety is more suited for grain than for hay.



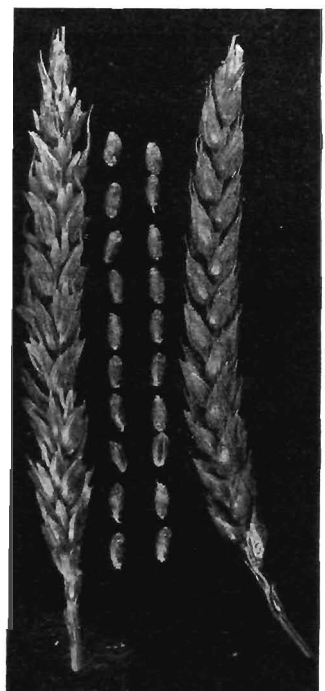
Ausala.



Baroota Wonder.

Baroota Wonder.

A farmer's selection from South Australia, Baroota Wonder is an early variety with the same season as Comeback. In parts of Riverina it is preferred for hay to Zealand and Firbank. The white, tapering, tip-awned ears are carried on fairly tall straw of good quality. The yellow grain is of average size, not hard to thresh, and is in the soft white class.



Cadia.

Cadia.

This variety grows rather tall, though the white straw is not coarse. It has a free-stooling habit with dark green, medium abundant foliage, and may be called a general purpose wheat. Cadia is adapted to the cooler districts of good rainfall, though it stands drought fairly well. Ripening about the same time as Yandilla King, it should be sown early. Its white, tip-awned, uniform heads are in some seasons inclined to shatter, like the old Purple Straw varieties, but it yields heavily, and (taking one year with another) there is very little loss. The bright yellow, flinty grain is medium hard in character, though of a mottled appearance in a wet year. Cadia is the result of a cross made at Lambrigg, the pedigree being as follows:—

Cleveland x Talavera (LAT) Jumbuck x 9 (F)

Unnamed Unnamed

Cadia

The 9 (F) in the above pedigree is a crossbred of mainly Purple Straw breeding.

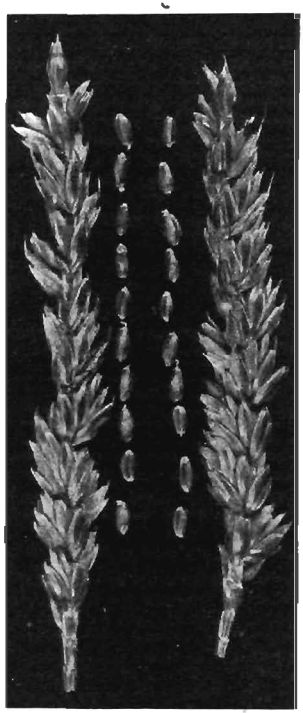
Canberra.

The young growth is rather erect, the leaves medium dark green, somewhat glaucous, and medium broad. The straw is of medium height, hollow, white, and rather slender. It stools fairly, with a moderate quantity of erect leaves. The ears are smooth, light brown, half erect, slightly awned at the tip, of medium length, open and uniform with an acute tip. The spikelets are irregular and medium to widely spreading with medium sharp-pointed glumes, which are not firmly attached. The grain is of medium size, slightly elongated, yellow, opaque, with a medium deep crease.

The variety is the result of an attempt made at Wagga Experiment Farm to produce a hybrid between Federation (the dam) and Volga barley, a two-rowed sort obtained as an impurity in a sample of wheat received from Russia. That the attempt was successful has always been a matter of doubt, however, for while it behaved from the start like the progeny of a violent union (say, of two widely diverse races of wheat), no barley characteristics have ever been seen in it. Probably the variety is the result of accidental cross pollination with another wheat. It has been suggested that a Durum wheat may have been the male parent, but no Durum varieties in the same paddock came into flower until two days after the cross was made. It was named in 1914, and has since become a highly popular variety in a large portion of the wheat belt.

It ripens not quite as early as Bunyip which it supplanted, but is very useful as a quick maturing variety for late sowing for grain throughout

the wheat belt. It is somewhat weak in the straw, but it is such a heavy yielder of grain that it deserves the attention it receives from growers, notwithstanding its liability to lodge under growthy conditions.



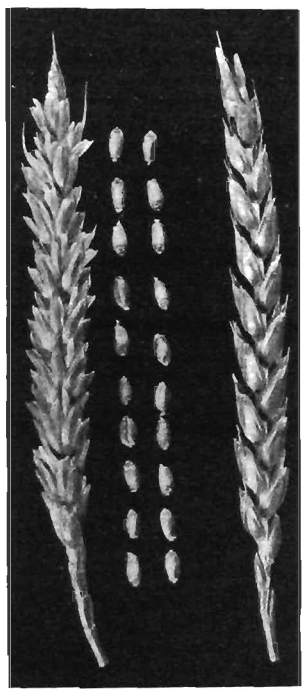
Canberra.

It is important that Canberra should not be sown until the latter portion of the sowing season, otherwise there is a tendency for it to lodge. It is liable to infection by flag-smut and loose smut, which diseases sometimes take an appreciable toll of the yield.

It yields a high percentage of flour, which is of excellent colour and belongs to the "Medium Strong" class.

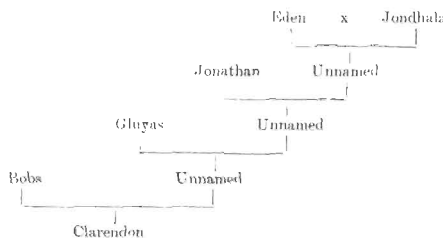
Clarendon.

The chief value of this wheat lies in its comparative freedom from rust and its early maturity. Adapted for the north-western and western plains and coastal districts, where moderate yields are preferable to crop failures (more or less) from drought or rust, Clarendon is an erect grower, and



Clarendon.

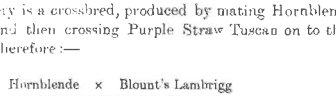
rather sparse stooler with somewhat scanty foliage. The white, tapering ears are slightly tip-awned, and the chaff stands rather open, allowing bleaching of the grain. It occasionally shatters, but not nearly so much as Florence. The straw is white, of medium height, and not coarse. The grain is white and medium hard. Clarendon ripens with Canberra, but is more suitable for fodder and hay than for grain production. It is one of Farrer's crosses, the pedigree being as follows:—



Cleveland.

Cleveland is a vigorous, rather tall-growing variety. It stools abundantly, and in its young state has rather a spreading habit. The foliage is fairly abundant, and of a good dark green colour; the leaves are narrow and erect. The straw is white, and on the stout side. The ears are of medium size, and slightly tapering, with white, smooth chaff. The grain is of medium size, white, plump, and sometimes of a mottled appearance, half soft and half flinty.

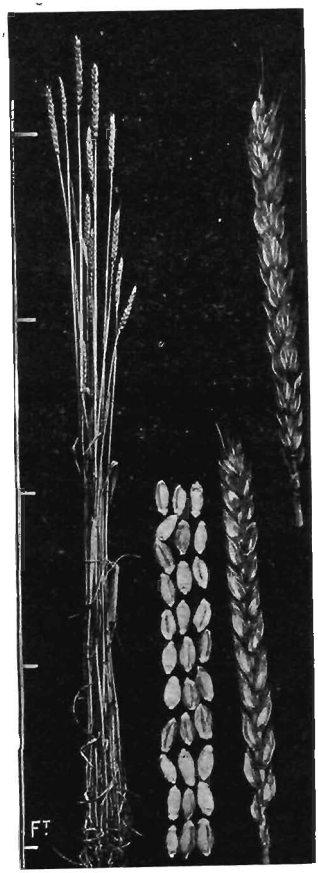
This variety is a crossbred, produced by mating Hornblende with Blount's Lambrigg, and then crossing Purple Straw Tuscan on to the progeny. Its pedigree is therefore:—



Cleveland is a late variety, and for this reason is more particularly suitable for planting early rather than late in the season. It is a good general-purpose variety, being equally suited for hay as for grain. It prefers a cool climate. At Bathurst Experiment Farm it has proved one of the best varieties.

It is rather a good rust-resister, and is not very susceptible to bunt.

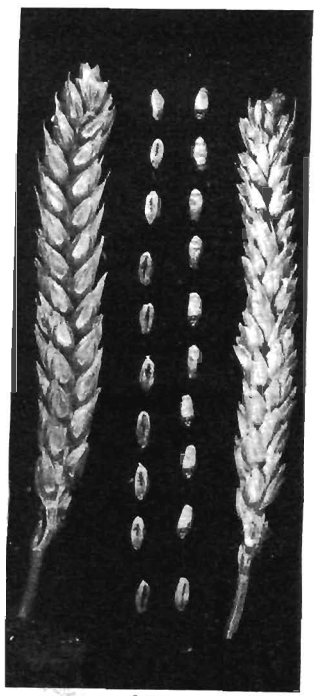
As a milling variety it is in the "Medium Strong" class.



Cleveland.

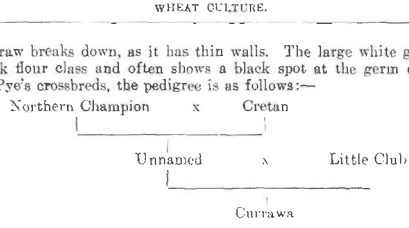
Currawa.

This is a late-maturing variety which was bred at Dookie Agricultural College, Victoria. It is somewhat resistant to both drought and rust; it is grown in the north-west, and is also very suitable for light mallee soils in the south-west. Its clubbed tip-awned white ear holds its grain satisfactorily. Currawa strips and yields well, though in some seasons the short,



Currawa.

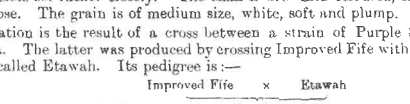
stout straw breaks down, as it has thin walls. The large white grain is in the weak flour class and often shows a black spot at the germ end. One of Mr. Pye's crossbreds, the pedigree is as follows:—



Federation.

Federation is a short, strong, erect-growing variety, which stools well. The foliage of the young plant is of good colour, with broad, stiff leaves, while the straw of the ripe plant is yellowish-white, stout and short. The ears are bald, of medium to large size, full tipped, uniform and compact, with the spikelets set rather closely. The chaff is brownish coloured, smooth and fairly close. The grain is of medium size, white, soft and plump.

Federation is the result of a cross between a strain of Purple Straw and Yandilla. The latter was produced by crossing Improved Fife with an Indian variety called Etawah. Its pedigree is:—



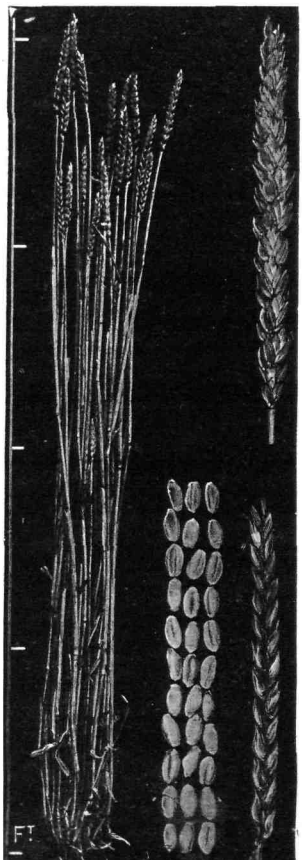
This is a very popular farmers' variety in New South Wales. It has reached this position because of its remarkable ability to yield well and consistently throughout most of the wheat areas of New South Wales, Victoria, and South Australia.

The production of Federation was the result of a deliberate attempt on the part of Mr Farrer to produce a variety with short straw, specially suitable for the Australian methods of harvesting with the stripper. The remarkable popularity of this variety, as the result of its behaviour in the field, affords abundant evidence that he was singularly successful.

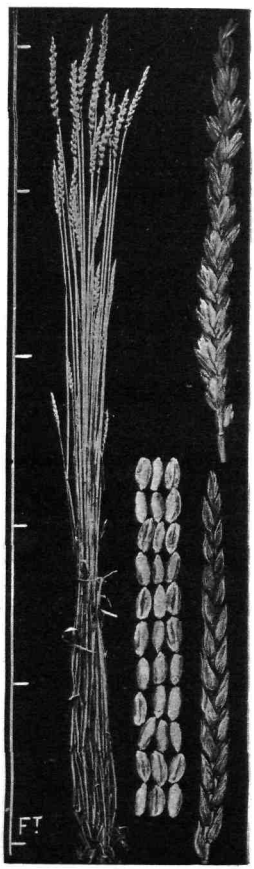
On account of its short straw and erect growth, it is not an attractive variety in the field, and did not appeal to the farmer who had been accustomed to the luxuriant growth and pleasing appearance of Purple Straw and White Lammas. If it had been judged by appearances, Federation would never have become popular. As Federation, despite its unattractive appearance, is able to produce the necessary bags, it has become, and remains, the most popular variety of the present time.

It produces the maximum amount of grain for the minimum amount of straw. Its upright head enables the operation of stripping to be done easily. It holds its grain tightly enough to prevent shattering, yet strips without difficulty. It is not easily damaged by storms, and because of this some farmers have called it "storm proof." The shortness of the glumes, or chaff, and the erect carriage of the head allow the rain to enter the ear, so that the grain becomes bleached as the result of showers more readily than most varieties, which makes it less acceptable in the north-west.

As a milling wheat, it is in the "Soft Flour" class, and it is a slight improvement upon varieties of the old Purple Straw type.



Federation.



Firbank.

Federation is liable to rust, flag-smut and bunt. It also seems specially susceptible, *chiefly in the cooler and moister districts*, to attacks of *powdery* mildew (*Erysiphe graminis*), which, however, does not seem to greatly affect the yield.

Because of its short, stiff straw and brown colour, it is not a hay variety, and cannot be recommended for that purpose, especially if the hay is intended for market. Farmers use it for their own stock with very satisfactory results, and the stock are said to eat it readily and with relish. The yield is also very much greater than appearances would indicate, 2 tons per acre being quite common; even heavier yields are frequently obtained.

Firbank.

Firbank is a tall, erect-growing variety, which stools rather scantily. The young plant carries a moderate amount of foliage of good colour. The leaves are broad, long and limp. The ripe straw is fairly stout, and white in colour and hollow. The ears are long, open and tapering, and are slightly tip-bearded. The chaff is white, smooth, and inclined to be close. The grain is large, white, *and rather plump, and as hay the crop is particularly palatable to stock.*

Firbank is a half-sister to Bunyip, both varieties having the same sire. It was produced by mating Zealand with Maffra. Its pedigree is:—

Blount's Lambrigg × Hornblende

Unnamed × King's Jubilee

Zealand × Maffra

Firbank

This variety is very early, being a few days later than Bunyip. It is specially suitable for hay, the straw being sweet, soft, and of excellent quality. It is green right to the base, with little or no dry flag.

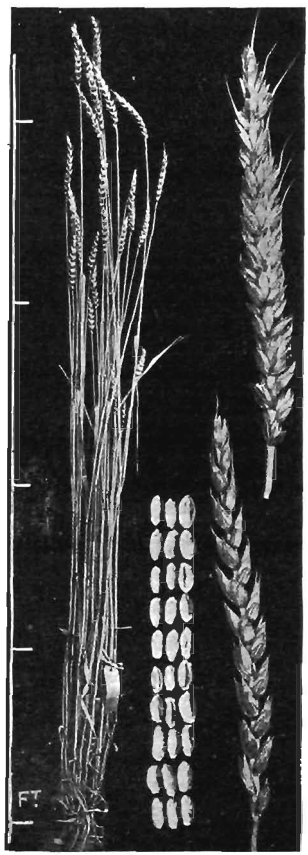
It should be sown about mid-season or late. Early-sown crops are subject to frosting and become ready for cutting before the weather is hot enough to cure the fodder properly. But if sown early the crop will be ready to cut for silage or hay before the black oats fall, and if utilised in this way it will prove a very valuable aid in profitably ridding dirty paddocks of that pest. Its earliness and sparsely stooling habit enable it to thrive in dry soils, and for this reason it is a valuable wheat for the Western Plains. As a hay wheat for sowing headlands and tracks it may be recommended on account of its early maturity.

After it is fit to cut for hay the straw becomes brittle, and should rough weather be experienced at harvest time a good deal of loss may occur.

As a milling wheat it is placed in the "Soft" class. It is, however, a good flour yielder and easy to mill.

Florence.

Florence is a very early variety, of medium height. It stools fairly well. The young growth is of a good, dark colour, vigorous, erect, and compact. The foliage is of medium quantity, with rather stiff, narrow leaves. When ripe the straw is white and rather slender. The ears are slightly tip-bearded, of medium size and tapering. *The spikelets are not set very closely together.* The chaff is white, smooth, and rather open. The grain is good, rather horny, of average size, and inclined to be plump.



Florence.

Florence is a bunt-resisting crossbred, produced as the result of an effort made for that purpose; it is also very resistant to flag smut, and is rust-escaping. The cross was made in 1901, and introduced into larger plots for trial in 1907. The pedigree is as follows:—

White Naples × Improved Fife

Unnamed × White Naples Improved Fife × Eden

Unnamed × Unnamed

Florence

Florence is suitable for hay or grain, particularly in the north-western districts. It is somewhat apt to shell, and being very early it should be fed off if sown before mid-season, otherwise there is danger of frost damage.

As a milling variety the grain is of satisfactory quality; in fact, it is one of the strongest in the "Medium Strong" class.

Genoa.

The young growth is spreading, the leaves dark green, glaucous, and rather narrow. *The straw is fairly tall, hollow, white, and medium stout, the plants* stooling rather freely, with fairly abundant, rather erect flag. The ears are of medium size, yellowish-white, rather open, slightly tapering, smooth, slightly awned at the tip, and rather erect, with regular, medium, widely-spreading spikelets. The glumes are blunt-pointed, slightly incurved at the tip, and fairly strongly attached. The grain is of medium size, regular, yellowish-white, rather horny, with crease of medium depth. Its pedigree is:—

White Naples × Improved Fife

Unnamed × White Naples Improved Fife × Eden

Unnamed × Unnamed

Genoa

This variety is a sister to Florence, but ripens much later; it is a good *bunt-resister, and not susceptible to rust, but a moderate yielder in most* districts. At Glen Innes, however, it thrives well; although its stooling capacity is much less than that of Haynes' Blue-stem, its better grain-holding qualities have brought it into favour for that district.

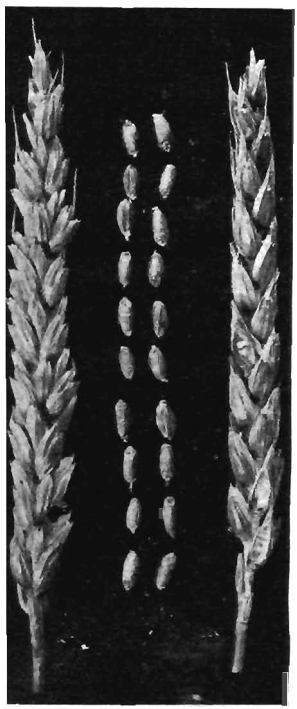
Gresley.

Gresley is not an abundant stooler, but yields heavily for hay and is a good grain variety, ripening with Hard Federation. The long white tip-awned ears are tapering and not dense. Gresley does not shatter, and the long, large, yellow grain is rather soft, with good flour colour. It is taking the place of Firbank, except in the very dry districts, and also does well on the coast. The result of a cross between Federation and Huguenot, made in 1909 by Mr. Charles Harper, of Western Australia, Gresley was introduced by Mr. Grasby, of the *Westralian* newspaper, and it has gained a footing in this State as a general purpose variety. It is only moderately susceptible to rust, and is fairly resistant to flag-smut.

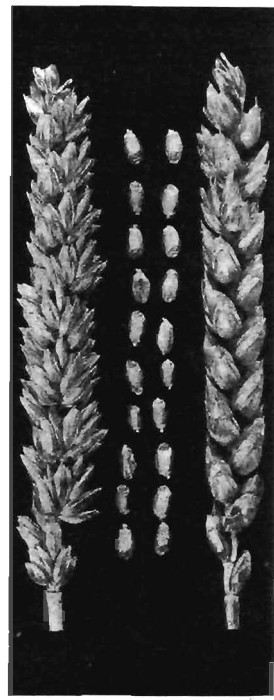
Hard Federation.

This was a selection from Federation made at Cowra—in all probability the result of a natural cross between that variety and Comeback. It was first selected in the stud plots of Federation in 1907 or 1908, when a single

plant had threshed grain of remarkably hard and flinty appearance. The plant had the distinctive brown head and general appearance of Federation in the field, but the grain was of a class that had never been seen in Federation before. The seed of this head was propagated, and during the early years of its growth at Cowra it produced quite a proportion of white heads; this character was gradually eliminated by selection, however, and the quality of the grain created a demand for the strain, which was not named till 1914.



Gresley



Hard Federation.

The ear resembles Federation, but is bolder and more lax; the grain is more rounded, being rather flinty or translucent. Hard Federation ripens about a week earlier, and the straw is a little taller than Federation. It is a very vigorous grower, and does better in a loamy soil with moderate rainfall, while Federation prefers a stiffer soil with more moisture. Harvest results have shown it to be a satisfactory yielder of grain, especially in the western and north-western portions of the wheat belt, but as a rule it does not give quite as good yields as the ordinary Federation in the southern districts and Riverina. Although the glumes leave the grain to some extent exposed, bleaching is not serious with this variety, and shattering does not occur. Hard Federation grain is in the "Medium Strong" class, and is very useful to millers for blending purposes. It is not disease-resistant, and does not differ in this respect from the old Federation.

Marshall's No. 3.

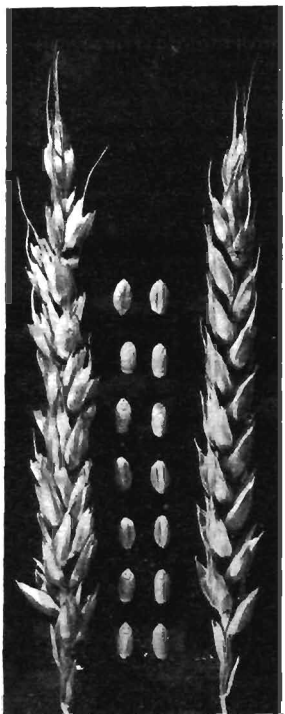
Marshall's No. 3.

Marshall's No. 3 is a late variety, which is usually of medium height, but which occasionally grows tall. It stools freely; the young growth is fairly vigorous, and creeping rather than erect. The foliage consists of an abundance of broad, rather limp leaves of fairly good colour. The ripe straw is purple, stiff, hollow, and stout. The yellowish-white ears are of medium size, slightly pointed and slightly tip-bearded. The spikelets are set moderately close together; the chaff is white, smooth, and open. The grain is of good size, but not very plump, except under good conditions.

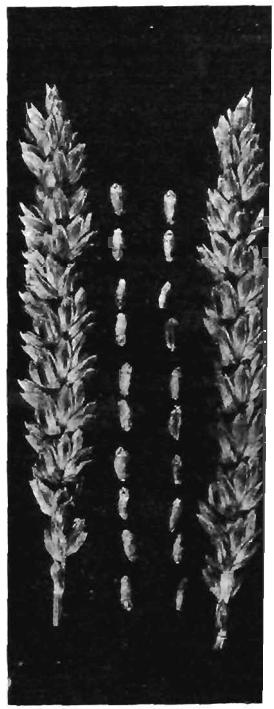
This variety is a crossbred which was produced by Mr. R. Marshall, of South Australia. It is fairly rust-resistant—a quality which it derives from one of its parents (Ward's Prolific).

As a milling variety it belongs to the "Medium Strong" class.

It is as valuable as a late May wheat as it is as a grain yielder. It should usually be sown early, and it can be recommended for the Central Tableland and the more favoured areas of the North-western and South-western Slopes and Riverina.



Turvey.



Union.

Turvey.

A late wheat, ripening with Zealand, Turvey is used for both hay and grain. It is one of the Purple Straw family, originating as a selection by Mr. Turvey, of Rochester, Victoria. The nodding, white, tip-awned, tapering ears on tall, purple-tinted, not coarse straw make a very showy crop. If stormy weather occurs near harvest time the variety becomes lodged and tangled, so that it is to be preferred for hay rather than grain. The white, rather large, grain is in the soft class. It is susceptible to flag smut, loose smut, and rust.

Union.

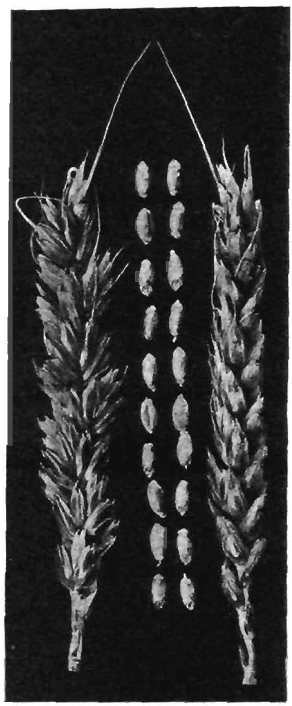
Union has an awnless, uniform, brownish ear, with spikelets denser towards the tip than the base. It stools moderately, the foliage is not abundant, and the straw is short and not coarse. Union stands drought well, but succeeds best in the Riverina where there is an assured winter rainfall. It ripens at the same time as Bena, stripping particularly well, *and does not shatter or lodge. It is an ideal grain wheat, but not tall* enough as a rule for hay. Its white, medium-sized grain borders on the "Medium Strong" class. Union sprang from a cross made at Cowra between Federation and a crossbred with a long pedigree, having Fife-Indian and Purple Straw predominating. It appears to be less exacting in its requirements than its Federation parent, succeeding in drier and lighter soils.

Waratah.

Waratah is very adaptable, being suitable for most parts of the wheat belt, and is now one of the most extensively grown varieties in the State. It has a medium to small head, brown in colour, with strong tip-awns. The straw is inclined to be tall and slender, semi-solid, and not purple. Waratah weighs well for chaff, giving a high yield of hay, besides being very productive of grain. The stooling is not abundant, and the crop ripens a little later than Canberra, to which it is a serious rival. The grain is dark yellow, soft, slightly elongated, easy to strip, and rather inclined to shatter. The cross was made by Mr. Hurst at Wagga, and the pedigree is Hudson's Early Purple Straw x Gluyas. It is fairly susceptible to flag smut, but possesses a degree of resistance to rust.

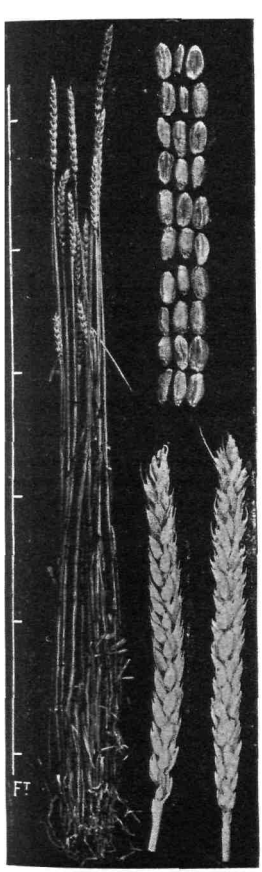
Yandilla King.

Yandilla King is a free-stooling, late variety of medium height. The young growth is inclined to be prostrate rather than erect. The leaves are a good dark colour, limp, and not very broad. When ripe the straw is white, not very long, and rather stout and strong. The ears are slightly tip-bearded, fairly long, the spikelets set rather closely together. The chaff is white, smooth, and fairly closely attached to the grain. The grain is white, large, and fairly plump, and the yield good.

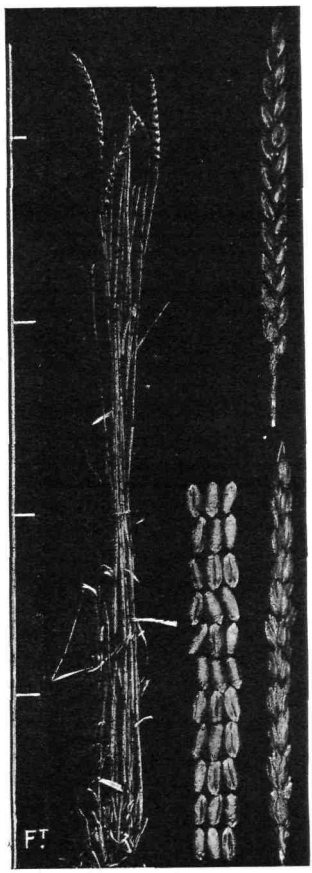


Waratah.

Yandilla King is the result of a cross made by Mr. R. Marshall, of Parkside, South Australia, between Yandilla and Silver King (the latter being also known as Marshall's No. 3 White Straw). It is interesting to note that Yandilla King is a half-sister to Federation, both varieties being the progeny of the common parent Yandilla. Yandilla is a crossbred produced by Mr. Farrer, as the result of mating Improved Fife (a "Manitoba" variety) with an Indian variety called Etawah.



Yandilla King.



Zealand.

For the best results it requires to be sown early on well-fallowed land. It does not shatter, and in the moister districts it is rather tough to strip. It is not very liable to flag smut.

It mills a "Medium Strong" flour of excellent colour, and is recommended for use on the Central Tableland, western slopes from north to south, and Riverina.

Zealand.

Zealand is a tall-growing, free-stooling, late variety, of attractive appearance. The young growth is fairly vigorous, and its foliage colour *dark; the leaves are broad, limp and abundant. When ripe the straw* is long, hollow, rather strong and stout, and yellowish in colour. The ears are beardless, long and tapering, with the spikelets rather open. The *chaff is smooth and white.* The grain is large, plump, *soft, dull white*, and in the "Weak Flour" class.

Zealand is an old-established variety, and is regarded as one of the very best grown in this State for hay, but for best results it must be sown early.

As a grain yielder, it can only be classed as poor, and it is recommended essentially as a hay wheat for the farmer who specialises in the production of hay.

Where there is much grain to be harvested this variety is altogether too late. There is not sufficient time to deal with it before stripping is begun.

MILLING VALUES OF WHEATS.

In the table on page 325, are given the average bushel-weight, flour-yield, and flour-strength of a number of different varieties of wheat. By the term flour-strength should be understood the amount of water, in quarts, required by the 200-lb. sack of flour to make a dough of the proper *constituency for baking. The figures, therefore, give actually the water-*absorbing power of the flour, which is the most ready and reliable means of determining what is understood by the baker under the term "flour-strength." The classification is that adopted in the entries competing for prizes at the Royal Agricultural Society's Show, and includes the four principal classes under which wheat are entered for competition. The "Australian Strong White" class comprises several of Mr. Farrer's crosses made with the specific object of providing a hard, strong-flour, white grain, as distinguished *from the ordinary hard wheats, which are usually red in* colour.

It is to the introduction of this class that the greatly improved milling quality of local wheat is due. Australian, and particularly New South Wales wheat, now enjoys a high reputation for milling excellence on the English market, and possesses pre-eminently the valuable characteristic of being suitable for milling without previous blending with other kinds. It is always of excellent colour, and is a strong favourite with English millers on this account.

It must be understood that the figures given represent averages taken over a number of years. These figures will vary considerably in different samples and also in different seasons.

TABLE showing milling values of wheats.

Variety.	Weight per bushel.	Percentage of Flour.	Flour-strength.	Percentage of Dry Gluten.
	lb.			
Australian Strong White Wheats—				
Pusa No. 4	66½	72·3	54·5	12·2
Comeback	66½	74·0	52·6	12·6
Bobs	66½	74·0	50·0	12·7
Strong Red Wheats—				
Cedar	67	73·0	52·4	12·7
Medium Strong Wheats—				
Hard Federation	67½	73·3	49·1	11·7
Florence	65½	73·2	48·0	14·7
Quality	66½	75·0	46·5	12·5
Canberra	66½	73·1	45·0	11·7
Clarendon	65½	75·9	45·0	14·9
Union	64	73·4	44·6	10·3
Cleveland	64	73·6	44·4	12·6
Gresley	67½	72·6	44·4	8·6
Bena	65	72·3	44·2	10·0
Weak Flour Wheats—				
Waratah	65¾	72·8	44·0	10·6
Federation	65½	71·3	44·0	9·5
Major	65	73·9	43·6	9·2
Potatz Surprise	67¾	73·2	43·2	10·0
Turvey	64½	72·4	43·2	9·5
Purple Straw	65½	72·0	42·4	7·3

The following table may also be of interest in showing the variations in quality of the "Strong White" and "Soft White" classes at the Royal Agricultural Society's Show for the past twenty years.

It will be noticed that the bushel-weights, especially in the strong-white class, have increased.

TABLE showing average bushel-weights, gluten content, and water-absorbing power of Wheats ("Strong White" and "Soft White") milled at the Royal Agricultural Society's Shows, from 1908-1927.

Year.	Weight per bushel.		Gluten.		Flour-strength. (Water-absorption, quarts per 200-lb. sack.)	
	Strong White.	Soft White.	Strong White.	Soft White.	Strong White.	Soft White.
	lb.	lb.	per cent.	per cent.		
1908	64½	65	12·2	10·2	52·5	46·4
1909	64¾	65½	11·9	8·6	53·5	49·2
1910	64½	64	13·8	12·1	50·0	47·5
1911	64½	63⅝	12·5	11·0	53·4	47·0
1912	65	64	13·4	10·6	52·7	45·2
1913	67	65⅛	15·2	11·7	53·1	46·9
1914	67⅛	67	12·8	10·6	52·3	45·0
1915	67½	66½	13·1	12·4	53·8	45·7
1916	67¼	67⅛	13·0	12·3	53·3	47·5
1917	66	67½	12·4	8·6	54·6	43·0
1918	67	65¾	*	10·2	*	44·5
1919	67½	66⅜	10·5	8·9	52·7	43·6
1920	67	65½	13·6	11·5	51·3	44·7
1921	66	64⅜	13·0	11·0	52·6	45·1
1922	66	66	12·7	10·0	54·0	44·3
1923	66	63½	13·2	12·2	52·5	45·5
1924	66½	67	14·7	11·6	53·4	43·6
1925	67	65½	13·2	7·8	54·0	43·4
1926	66½	66½	12·6	9·2	52·8	43·9
1927	66½	65⅞	11·2	10·7	53·5	43·8

* There were only two entries in the Strong White class in 1918, and these were readily differentiated by the judges without subjecting them to a milling test. The figures for gluten and flour strength are therefore not available.

For many years the northern wheats enjoyed an unenviable reputation among millers and wheat-buyers, on account of their alleged softness, their containing too much moisture, and their proneness to develop weevil. These characteristics, especially the last, are particularly objectionable from the point of view of the exporter, though it does not seem to affect their value to the same extent when used as wheats for local milling.

On this account many Sydney wheat-buyers and shippers were averse to purchasing northern wheat, and some have gone so far as to object, in previous years, to its inclusion in the f.a.q. sample.

In order to test the matter, samples were obtained through the courtesy of Messrs. Gillespie Bros. of their bulk of northern, southern, and western wheats, cleaned and graded, and ready for blending. These bulk samples were made up of wheats from a number of different districts and from representative samples of the grain obtained from the north, south, and west respectively. The results of the separate milling of these samples are given in the table on page 327. It will be seen that the northern mixture

Comparison of Miller's Mixtures.

Variety of Grain.	1 *Northern Mixture.*	2 Southern Mixture.	3 Western Mixture.
Appearance of Grain	Light amber, medium size, plump, soft.	Light amber, medium size, plump, soft.	Light amber, medium size, plump, soft.
Weight (lb. per bushel)	65·9	65·9	64·2
Ease of Milling	Easy to mill	Easy to mill	Easy to mill.
Percentage of mill products. — Flour	71·2	72·5	69·8
Pollard	14·5	14·4	17·1
Bran	14·3	13·1	13·1
Nature of Flour. — Colour of Flour	Excellent	Excellent, shade lighter than Western Mixture.	Excellent.
Strength of flour (in quarts per sack of 200 lb.)	46·0	45·6	46·0
Percentage of dry gluten	14·4	12·0	14·3
Character of wet gluten	Yellow, elastic, coherent, soft	Yellow, elastic, coherent, soft	Yellow, elastic, coherent, soft.
Notes	Both bran and pollard clean; semolina faint yellow and soft.	Both bran and pollard clean; semolina faint yellow and soft.	Bran clean, medium size; pollard fairly clean; semolina faint yellow and soft.

is in no respect inferior to the others. There is, as a matter of fact, very little to choose between them. The northern is a heavy wheat, being equal to the southern, and heavier than the western. It stands midway between the two in flour yield. In colour of flour there is little to choose between it and western wheat, the southern wheat being somewhat whiter. The same remarks apply to strength and gluten-content. In both these points the northern and western are almost identical and slightly superior to the southern.

The question of the liability of the northern wheat to contract weevil, a property which affects its keeping quality and its value as an article for export, is a separate one. It seems to be the universal opinion that the northern wheat is more liable to become weevily. The reason for this probably does not lie with the wheat itself, but with the conditions under which it is harvested. All new wheats when bagged have a tendency to heat, and this tendency would be much greater in wheats bagged in the northern wheat-fields, where comparatively humid conditions prevail, than in those bagged in the drier atmosphere of the south and west.

This heating furnishes a more favourable temperature for the earlier hatching out of the eggs.

When stored for any length of time without precautions against the hatching out of weevil, all wheats will develop them in the course of time. This refers to the hardest macaroni wheats equally with the soft wheats. The fact seems to be that the weevily condition becomes sooner apparent in the northern wheats because these are bagged under conditions favourable to a rapid development. This is a serious objection to the miller, since he prefers a wheat with keeping qualities in order to keep a stock for blending purposes, so that he can ensure a uniform flour all the year round.

To sum up, it would appear that the northern and north-western wheats are in all respects quite as good milling wheats as the southern and western wheats, but that the more humid conditions under which they are bagged render them liable to develop weevil more readily than those bagged in the drier districts, and consequently affect their keeping qualities.

FACTORS WHICH LOWER QUALITY.

Whilst it may be argued, and correctly so, that so necessary a commodity as wheat must always find a purchaser at a price, there can be no doubt that it is the highest quality article that gives the greatest return. This being the case, growers should endeavour to avoid, as far as possible, producing samples which are defective from the miller's point of view. The chief defects in grain intended for the flour mill, and methods by which their occurrence may be avoided, are as follows:—

Smut.

Smut, as it is commonly called, or bunt, is a fungous disease, having a very serious residual effect on wheat from a milling point of view, and one which causes considerable losses by reducing the value. It is impossible to determine a definite figure for smut loss, but every grower is aware of its seriousness, either through personal experience, or from that of a neighbour. Smutty wheat is treated harshly by millers, as it is very difficult to handle, although certain "smutting" machines will make a fair sample of infected

grain, but at a considerable cost. There is no excuse now for smutty wheat, however, as practically complete control is secured by treatment of the seed by dry copper carbonate powder, at the rate of 2 oz. to the bushel of seed.

Damaged Grains.

The presence of these in a sample of wheat reduces the milling value very considerably; they have serious effects on the quality of the flour, causing a bad colour, imparting an objectionable taint, and reducing its keeping qualities. Furthermore, these damaged grains cannot be removed. The most serious are those that have been heat damaged, but fortunately they are not common under Australian bagged conditions. They are mostly caused by harvesting the wheat while it is unripe, but the majority of growers are sufficiently alive to the necessity of harvesting when the grain is matured, thus largely obviating the danger of this objectionable condition. This trouble is frequently caused by standing bags of wheat in the paddock without placing sufficient logs (and in some cases none at all) for a foundation. If the ground is damp, or if rain should fall, the bottoms of the bags become wet and the wheat is spoilt.

Damaged Patches.

These are viewed seriously, and to remove them it frequently occurs that a section of the bag is cut away with the bad grain adhering. This causes the bag to be valueless and is productive of much waste of grain. It is a source of considerable expense, whereas a little care would have saved to the grower the full original value of the wheat.

Bleached, Sprung, and Shot Wheat.

These defects are all caused by excessive external moisture conditions when the grain is just ripening or ripe, and they might be described as three stages of the one complaint—each causing a reduction in value according to the severity of the damage. Such weathering is difficult to control, being largely dependent on climatic condition. An alleviation may be secured by close attention to the sowing of suitable varieties at the right time, by harvesting as expeditiously as possible when the grain is ready, and by sowing fine type varieties free from grain of a different maturing period, so that all ripens at the one time.

Bleached wheat is recognised by its loss of colour, for it has a pale, anaemic, and lifeless appearance, with an attendant considerable loss in weight.

Sprung wheat is distinguishable by the above symptoms, together with a bloated appearance of the germ, whilst shot wheat is similar, but with the germs sprouted. Each of the three defects is disliked by millers, the wheat being difficult to store for any length of time, and the flour being much reduced in strength.

Admixtures.

The most serious of these in New South Wales are saffron thistle and black oats. The thistle has such a hold on some areas that its eradication on cultivation is difficult, but together with black oats it must, and can, be controlled. For saffron thistle control, early fallowing and prior cultivations are desirable. By this is meant disc, springtooth, or rigid tine cultivation of the stubble paddock in March or April, then the regular fallow

ploughing in June or July, with the necessary subsequent cultivations for control. At wheat-sowing time it is advisable to wait until after rain, permitting a cultivation, and, if necessary, to sow a quick-maturing variety. Saffron thistle is serious from a milling viewpoint, because the seed, if without its "whiskers," is difficult to remove, and if ground with the wheat causes a discolouration of the flour.

Black oats are not so detrimental, because they can be removed by efficient separators, but in quantity constitute a strong objection, and thereby reduce the value of the wheat. Black oats may be controlled by efficient fallowing methods, by early cultivation prior to fallowing, and by the continual use of sheep on the fallows. (See page 240.)

In some parts of New South Wales taint is imparted to wheat by "hexham scent," which has a most penetrating odour, and has very small seeds.

Mallee leaves are found occasionally in crops grown in that class of country, and to the pioneer of mallee lands they present some difficulty. When the roller is used and the crop sown for the first time, it is not possible to avoid altogether the harvesting of some leaves with the grain. Drake and barley are also found in some parts of the State. Both can be controlled by the use of clean graded seed, together with care in cultivation.

Chaff, whitecheads, straws, thistle heads, and broken grain are objectionable, and are present as the result of faulty setting or operating of the harvesting machinery. With a header, a minimum of straw should be taken, otherwise it is likely that the sieves will become blocked. It is essential that the sieves, beaters, and peg drums be correctly adjusted, and, as far as possible, the machine should be kept moving at a regular speed. These admixtures cause a lot of unnecessary loss and additional work. In the first place the wheat will show a considerably lighter chondrometer weight, bringing the value of the wheat down immediately; then the bulk of stuff causes a wastage of bags, undue handling, a loss of freight, as the material is practically worthless, and finally it causes additional work and expense at the mill for separating and cleaning.

Diseases.

Rust has a very serious indirect effect, as by its action the plant is prevented from supplying the grain with the requisite food material, causing it to be thin and pinched. Such grain, as in other cases of light grain, is relatively low in value. Growers will recollect that in 1916-1917 the f.a.q. weight was 56¾ lb. through this cause.

Foot-rot, take-all, flag and loose smut, &c., do not themselves directly affect the grain, although whatever grain may form on plants so affected will be found to be pinched and damaged and of little value.

Red Wheat.

As mentioned previously, Australian wheat is prized partly on account of its colour, and is in demand for blending purposes. European buyers have taken exception to the presence of red grain. In view of this, it was decided that red wheat should be eliminated from the f.a.q. standard for purposes of export. Consequently it is of utmost importance that growers should keep red wheat out of their consignments.

DISEASES OF WHEAT.

Among the common troubles that the wheat-grower has to fight are Stinking Smut or Bunt, Take-all, Foot Rot, Flag Smut, and Rust. All are caused by parasitic fungi, and from time to time are responsible for considerable losses. Rust, fortunately, is somewhat intermittent in its attacks—several years sometimes elapsing between serious outbreaks in the grain districts—but most of the other common diseases are present each year, and tend to cause increased losses unless special measures are adopted to combat them. Efforts have been made to produce varieties resistant to these fungi, and some success has already been achieved. Early-maturing, rust-escaping varieties have been developed, and extensive experiments are in progress in building up varieties which are naturally resistant to Rust, Flag Smut, and other diseases. It is difficult, however, to produce disease-resistant varieties which have also all the other desirable agricultural qualities; generally speaking most of these types are not prolific enough for cultivation on an extensive scale.

Bunt or Stinking Smut (*Tilletia tritici* and *T. lævis*).

Two wheat diseases are usually known as smut—Bunt, Ball Smut, or Stinking Smut, and Loose or Flying Smut. When, however, the farmer talks about "smut," he almost without exception refers to Bunt or Stinking Smut, which is caused by one or other of two closely-related fungi whose scientific names are given above. Stinking Smut is so called from the objectionable smell which is quite noticeable even if only a little be present in a large quantity of grain.

There are considerable differences between Stinking Smut and Loose Smut; but, from the wheat-grower's standpoint, the chief one is that Stinking Smut (Bunt) can be readily prevented by treating the seed wheat before it is sown, whilst Loose Smut requires special treatment of the seed for its prevention in the resulting crop.

The minute black particles which are found adhering to a wheat grain, and which are commonly called "smut," but which would be better called "bunt," are the seeds or spores of a plant (a fungus), just as the grains of wheat are the seeds of another plant. Fig. 3 illustrates a part of the brush of a grain of wheat, and shows how very minute the spores are. They germinate in the soil when the grain is sown, and under suitable conditions they enter the young plant, grow with it, living on its tissues, and finally cause the "bunted" wheat ear.

The spores do not escape from the wheat ears in a powder, but are enclosed in the ovaries and glumes, and although at first somewhat greasy, they soon become dry and hard. The mass of spores in an ovary is known as a "bunt ball"; hence it is frequently spoken of as "ball smut," and sometimes, on account of its hardness, as "stone smut."

Fig. 5 shows the various stages during which a developing plant may be attacked.

The fungus growing in the plant reaches the developing ear, and produces its spores, forming the dark grain-like bodies (bunt balls) which take the place of the normal grain (Figs. 1 and 2). These spores are produced in enormous numbers. It has been calculated that in a single bunt ball—no larger than a grain of wheat—there are about 4,000,000 spores, each of

Fig. 1.—Ears of Wheat with Bunt. (From McAlpine's "Smuts of Australia."

A. Ears showing spikes standing out from axis, and somewhat separated.
B. Ear with glumes removed to show the bunt balls and grains.

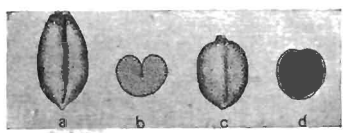


Fig. 2.—Healthy and Bunted Wheat Grains. (From Purdue Univ. Circ. 22.)

a. Normal grain, showing the longitudinal furrow.
b. Cross section of (a) showing furrow.
c. Bunted grain, showing absence of furrow.
d. Cross section of (c), showing absence of furrow and the black spore mass which has replaced the normal contents.

which is capable of causing one wheat-plant to be smutted. In a bushel of wheat there are 600,000 to 1,000,000 grains. There are, therefore, in a single bunt ball enough spores, if regularly and evenly distributed, to provide each grain in a bushel of wheat with from four to six spores.

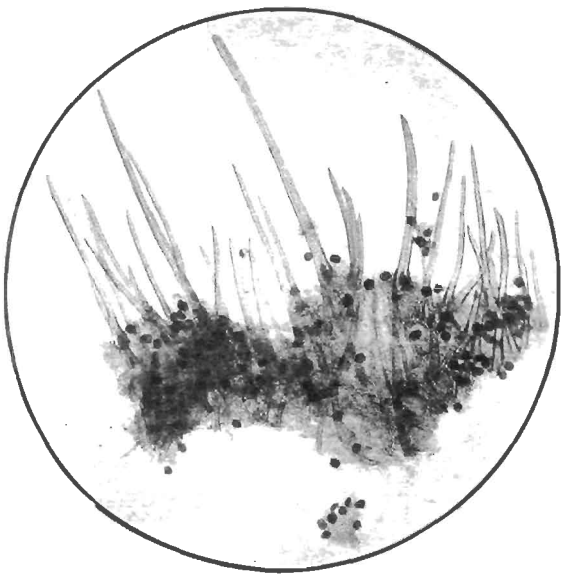


Fig. 3. Part of "Brush" of Wheat Grain.

This illustration shows spores caught by the hairs of the brush, and affords a comparison of the size of the spores and hairs.

The plant may also become affected with Smut as result of infection from soil which has previously grown smutty crops. This, however, is relatively rare. The chief cause of Smut is the sowing of seed which has healthy spores adhering to it. It follows, therefore, that if the vitality of these spores can be destroyed, or if the fungous plants resulting from the germination of the spores are destroyed, the grain crop will be "clean." Methods have been introduced for successfully destroying the vitality of the spores. Occasionally, as in the case of self-sown crops, there is sufficient moisture in the soil to cause the spores of the fungus to germinate, and there is insufficient moisture to germinate the grain. The smut fungus plants are, in these circumstances, generally killed off before the grain germinates,

and a "clean" crop may result from untreated smutted seed; but to depend upon this chance method of obtaining clean crops is very unwise and likely to lead to disappointment. It is far wiser and more businesslike to destroy the vitality of the spores, and thus prevent them growing.

Fig. 4.—Bunt Balls.

The wet "pickle" has no effect on the spores contained in the unbroken balls.

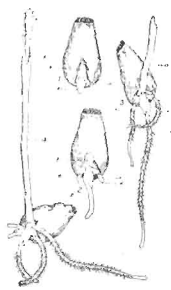


Fig. 5.—Various Stages of Germination of Wheat during which Infection by Bunt Spores may take place.

(*a*) Primary rootlet, (*b*) stem, (*c*) secondary rootlets, (*d*) protective sheath, (*e*) point where first green leaf pushes through the sheath, after which stage no infection occurs. (Ottawa Bul 78.) Drawings from diagrams in Kensington Museum.

Control Measures.

Stinking Smut can be controlled satisfactorily by seed treatment prior to sowing. Two distinct methods are available, viz., dry-dusting with copper carbonate dust (2 oz. per bushel) and the wet bluestone pickle. The dry treatment has many advantages over the wet pickle, and it is now coming into favour generally throughout the wheat-growing regions of the world.

Varieties of wheat resistant to Bunt have been developed both in Australia and in other parts of the world. Florence and Genoa are examples of this type in Australia. However, since seed treatment is so effective, a much wider choice in ordinary commercial varieties becomes possible.

The Dry Copper Carbonate Treatment provides completely satisfactory control of the Stinking Smut disease. Earlier, more uniform and better germination of the grain is ensured, and as it does not depress the germinating power of the seed, the treatment can be carried out a considerable time before sowing, or the seed may be sown in dry ground without fear of damage.

Should bunt-balls be present the greater number of them will be removed by grading, but there is the possibility of them being present in the graded sample; the dry copper carbonate treatment is particularly valuable under

these conditions, since the bunt spores are not killed when the dry copper carbonate is dusted upon each grain, but only after the wheat is sown and comes in contact with soil moisture. That being so, the fact that a few bunt-balls may burst and infect the grain a little more is immaterial. If the copper carbonate killed the spores when applied and subsequently became inoperative, the presence of bunt-balls would mean reinfection.

The treatment of seed wheat with dry copper carbonate results in an increased yield, even when no bunt is present. This is explained by the *fungicidal action of the copper compounds in preventing injury from the* ordinary soil fungi or those carried on the grain, the beneficial effect being counteracted in the case of the copper sulphate treatment by the injury to the embryo of the seed.

To prevent the irritating effects caused by the exposure of the operator to the copper carbonate dust, to ensure that every grain is sufficiently coated with dust, and for greater convenience in treating a quantity of wheat, something in the nature of a dusting contrivance is necessary. This may be of a quite simple design, however, and its construction should not be beyond the power of any farmer. An ordinary cask, fitted with slats inside to agitate the wheat, and mounted so that it can be easily revolved is really all that is necessary, and will provide a quite effective farm-made duster.

The method of dusting is simply to pour a convenient measured quantity of the seed into the cask, add the copper carbonate at the rate of 2 ounces to each bushel of wheat, and rotate the cask for two or three minutes.

Copper carbonate is a poison, and care should therefore be exercised in handling it. Several proprietary mixtures of copper carbonate, which contain about 50 per cent. of copper, are now on the market, at a price of about 1s. 9d. per pound. These preparations are quite satisfactory, and are being used by the Department for the treatment of seed wheat.

Wet Treatments.—Seed injury is likely to result when grain is treated with bluestone or formalin, and this injury is most pronounced when soil conditions do not favour rapid germination of the grain. Destruction of ungerminated and partly germinated grain by common mould fungi may result in a very much reduced stand. There is also a danger that seed treated by the wet methods may become re-infected with Smut before sowing, *e.g.*, if placed in old untreated bags, contaminated seed boxes of the drill, &c.

Although the wet methods for treatment of grain are not recommended by the Department, the details of these processes are outlined for those who still desire to use them.

The Bluestone Treatment.—To secure satisfactory results from the bluestone treatment, good bluestone must be used, and the directions carefully followed. The solution recommended as a general treatment is 1½ lb. bluestone to 10 gallons of water, but a 1 per cent. solution, *i.e.*, 1 lb. bluestone to 10 gallons of water, is strong enough when the seed is apparently clean, and does less damage to the grain. The wheat is immersed for three minutes and then removed and drained.

The bluestone is best dissolved by tying it in a small hessian bag and suspending it in the water. In this way the bluestone will dissolve in a short time, whereas if thrown into the vessel containing the water it will take a considerable time to dissolve completely. Cold water serves the

purpose well, and it is not essential to use boiling water. On no account should the vessel holding the solution be of a metal other than copper; the most useful vessel is a wooden cask.

Seed wheat can be economically pickled in butts of about 1 bushel when the wheat is free from bunt-balls; but when these are present, some method must be adopted which will enable their removal to be effected. If they are not taken out the wheat will probably become reinfected before or during sowing; it is failure to remove bunt-balls which frequently causes wheat that has been treated to produce a smutty crop. Pickling outfits which have a copper vessel for the treatment of the wheat are very handy, but if one is not available, the wheat can satisfactorily be freed from bunt-balls (and incidentally other rubbish) with the aid of a piece of hessian. This is used as a sort of loose lining for the cask, with its edges overlapping the rim. The wheat is poured gently in, and bunt-balls and other rubbish which is so troublesome when drilling will float on the surface, and can be skimmed off.

After the seed has been dipped for the three minutes, it should be removed and drained. Planks, hollowed logs or a sheet of bark should be used for the draining platform; galvanised iron is very unsuitable. The solution can be allowed to run back into the cask, and immediately it ceases to trickle from the grain the butt should be hung up on poles or straddles for a day to dry before sowing.

The process of pickling kills the tiny spores or seeds of the bunt which adhere to the outside of the grain; but bluestone also has the power to impair the vitality of the grain, and even to kill the germ.

The Formalin Treatment.—Formalin, at the rate of 1 lb. to 40 or 45 gallons of water, is very effective in killing bunt spores, but it has not been found a satisfactory treatment under our conditions. It gives good results when the seed is sown at once (within twenty-four hours); but, as in many cases, germination may be delayed for weeks, it is not advisable to adopt the method, as under these circumstances the vitality of the seed is destroyed or seriously impaired.

The seed wheat should be immersed in the solution for a period of three minutes and then allowed to drain.

Loose Smut (*Ustilago tritici*).

Wheat affected with this smut usually has the stalks somewhat stunted. The smut is produced in the ovaries, and destroys the various parts of the flower (Fig. 6). The spores produced form a blackish powder, which is easily blown about, and infected wheat ears are sometimes spoken of as "smutty ears." The looseness of the spores serves at once to distinguish the disease from Bunt, in which case the spores remain compacted inside the wheat grains. Loose Smut has no objectionable odour.

Infection cannot result from spores on the outer surface of the grain or from spores in the soil, but can only be produced by spores which are blown on to the flower just after heading. If all conditions are favourable for germination and growth of the fungus, infection of the grain will result. Fungous threads are produced and these lie dormant in the germ or embryo of the apparently normal grain. These threads grow up with the plant when such infected grain is sown, and produce the disease once more. The treatment recommended for Bunt has, therefore, no appreciable effect on this disease.

Fig. 6.—Loose Smut of Wheat showing the various stages in the development of a smutted head. Heads emerging from boot (sheath), completely smutted mature heads, and bare stalk after spores blown off.

(U.S. Bureau Plant Industry. Bul. 152.)

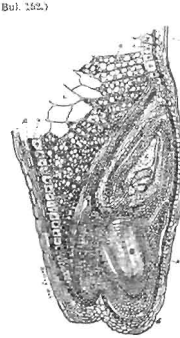


Fig. 7.—Longitudinal Section of a Fife Wheat Grain. through the embryo and deepest part of the groove.

The section shows the location of the embryo with reference to the bran layers. In an infected grain the mycelium of the Loose Smut fungus (*Ustilago tritici*) lives in the tissues of the embryo.

(a) Outer bran layer, (*b*) inner bran layer, G the first root of the embryo, *l*, the first leaf (plumule), *g* sheath covering bud end of the embryo, (*) feeding organ (Scutellum).

(*After Bolley.*)

Control Measures.

As Loose Smut requires special treatment of the seed grain for its prevention, the most practical way of getting rid of it after it has made its appearance on a farm is to use for seed only grain which, as the result of an examination of the growing crop at the proper time, is known to be entirely free from this disease. *To determine whether Loose Smut is present in a crop the examination should be made from flowering time onwards.*

Fig. 8.—Cross-section of a small piece of Wheat Leaf.

Showing masses of Flag Smut spores, which occupy large cavities extending longitudinally in the tissues. These appear in the form of long black streaks and on rupturing allow the spores to escape.

Hot water treatment of the seed is recommended in America, but the treatment is tedious and is rarely employed by the farmer, and, of course, does not prevent infection of the flowers in the field by wind-borne spores. The Jensen (modified) hot water treatment requires pre-soaking of the seed for from five to seven hours at ordinary room temperature. The seed is then put into hot water. For wheat the time of immersion is ten minutes at 54 degrees Cent. (129 degrees Fah.). It is important to maintain the temperature carefully. If the temperature increases, the time of immersion must be shortened, while if the temperature decreases it must be lengthened. The successful margin of safety is very slight.

Flag Smut (*Urocystis tritici*).

Flag Smut is a disease at times responsible for serious losses in our wheat crops. It may sometimes seriously affect the yield—reducing it from 10 to 15 per cent. Reduction of the yield by 50 per cent. and even more occasionally has been recorded. The disease only attacks wheat. It does not affect any other crop, and it does not occur on wild or cultivated grasses.

It is a disease that is difficult to detect in the early stages, but as growth advances it is noticeable that affected plants in the crop have a leaden or sometimes faintly bluish colour in the leaves or flag, instead of the normal greenish colour. As the crop heads out these plants frequently fail to mature heads, and on drying out, the flag, now curled and abnormally grey, gives rise when crushed to a fine, sooty, black dust. This dust consists of the spores of the Flag Smut fungus (*Urocystis tritici*).

During the harvesting operations these diseased plants are knocked about, and the fine sooty dust is distributed through the soil, often, too, adhering to

Fig. 9.—Wheat plant curled at the top by Flag Smut, thus preventing the formation of an ear.
(From McAlpine's "Smuts of Australia.")

otherwise healthy grain. If the young wheat plant at the time of germination be in contact with spores of the Flag Smut which may be lying in the soil, it is liable to become diseased. If, as sometimes happens, the land is otherwise free from disease and the spores happen to be adhering to the grain, infection is again probable.

Fig. 10.—Wheat plants malformed as a result of Flag Smut (Slightly magnified to show smutted masses (spores of Flag Smut) within the tissues.

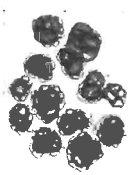


Fig 11—Spores of Flag Smut.

Note the bladder-like cells surrounding the spores. These help the spores to resist unfavourable conditions.

Control Measures.

The control of this disease on the farm is difficult. The greatest danger lies in allowing the soil to become thoroughly infested with the spores of the smut. The following measures are known to be of value in minimising the losses from this disease:—

I.—Dusting with copper carbonate (2 oz. per bushel), or pickling the seed in bluestone, as recommended for prevention of Bunt or Stinking Smut, will result in killing off any spores that may be present on the grain. It will thus also help to prevent initial infection of new land. This treatment, however, has little effect, if any, on the spores which are present in the soil and which are the primary cause of most of the losses incurred.

II.—Rotation of crops is very desirable, as this parasite is not known to affect other hosts. This treatment, therefore, helps to starve the fungus out of the soil. It is suggested that when practicable oats or any crop other than wheat be sown on badly-infested land, either for feeding off or for general cropping purposes, to be followed by a bare fallow before the land is again sown to wheat.

III.—Early preparation of the seed-bed is recommended, because it assists in the conservation of moisture, and in the germination of Flag Smut spores prior to the sowing of the wheat. The opinion that Flag Smut is worse with a dry sowing is very generally held, and there is a good deal of experimental evidence to support this idea. Under these conditions the grain and the Flag Smut spores germinate together, and infection results.

If wheat must follow wheat, then the land should be ploughed as early as possible after the harvest, and thoroughly worked after rain during the fallow period to conserve moisture that will germinate the spores before the grain is sown. The most useful soil workings are those which can be arranged after rain during the cooler months of the year, as it is under these conditions that the Flag Smut spores will germinate most readily, and be killed off before the next sowing period.

IV.—It is desirable that short-season early-maturing varieties should be sown on land that is known to be infested with Flag Smut. Florence and Bunyip, for example, rarely show more than a trace of infection, and this is generally true of those varieties in which the early growth stages are characterised by the rapidity of their development. Generally speaking, late-sown wheats are less affected than those which are sown early. In addition, the varieties Nabawa, Wandilla, and to a certain extent Yandilla King appear to possess certain qualities of resistance to Flag Smut and are thus useful in the control scheme for this disease.

V.—Shallow sowing will also help the young plants to escape infection.

VI.—It is desirable that the stubble of a crop which is badly affected with the disease be burned, as this will destroy many spores which might cause infection in the next wheat crop.

VII.—It has been proved that the spores of this smut can pass uninjured through animals; hence diseased hay or straw should not be fed on the farm, as this may result in infection of fallows or of otherwise clean paddocks. It is preferable, therefore, to use oaten hay and chaff rather than heavily smutted wheaten hay.

Stem and Leaf Rusts of Wheat and Oats.

There are several distinct kinds of rust fungi which attack cereals and grasses, but the most important of these in Australia are those which cause the "stem" and "leaf" rusts of wheat and oats.

Stem Rusts.

Stem Rust of wheat is caused by the fungus *Puccinia graminis tritici*, and Stem Rust of oats by the fungus *Puccinia graminis avenæ*.

Stem Rust appears later in the season than Leaf Rust, and usually is not observed until the commencement of summer. It attacks all parts of the plant, but is most destructive when the stems are attacked. The first signs of infection are pale yellow spots on the leaves, which are especially evident when the leaves are held up to the light. Some days later, large reddish orange patches develop, round the edges of which the ruptured epidermis or leaf covering is to be seen. This rupturing of the epidermis (Fig. 13), is a feature which distinguishes Stem Rust from Leaf Rust.

Numerous one-celled spores, known as uredospores or summer spores, are produced on these reddish patches throughout the season. They are very small and light, are easily distributed by the wind, and under favourable conditions start new centres of infection in neighbouring plants (Fig. 12). In a badly rusted crop it is common to see the ground reddened with the spore dust from affected plants. As summer advances and the plants mature, the red patches change to black, owing to the production of the black resting spores of the rust fungus (*teleutospores*) (Fig. 14).

Straw from an infected crop has not the desirable golden shining colour, but is usually greyish or greyish brown, and is often brittle, although when chaffed and fed to horses and cattle it is often greatly relished. The yield from a rusted crop is much reduced, and the grain is generally small and shrivelled. In severe attacks, no grain is produced, and the flag and stem become worthless for hay, becoming quite brittle and paper-like.

Fig. 12.—A small part of a Section through a Wheat Leaf.

Showing a uredospore (*b*) of *Puccinia graminis* resting on the surface, germinating, and sending its branching filament (*d*) into the leaf through the breathing pore or stomata (*a*). (*After Bolley and Pritchard.*)

The black teleutospores (Fig. 14) are incapable of infecting wheat or oats directly; they are able to continue the life cycle only in the presence of the barberry plant. While the "barberry stage" of the fungus can be produced by the Australian Stem Rust under certain conditions, it is considered that the teleutospore stage serves no useful purpose in the life cycle of Stem Rust in Australia, since barberry bushes are practically unknown here. In addition, the teleutospores in most sections of the wheat belt appear to have lost their powers of germination by the end of the summer. All sources of rust infections can be traced directly to the red spores or uredospores.

The severity of a rust attack depends on many factors. Warm weather, with frequent showers and heavy dews, favours the development of rust. Certain varieties of wheat and oats may be resistant or moderately resistant to rust by reason of inherent qualities. On the other hand, some varieties are "rust-escaping." Early-maturing varieties may ripen so early that the grain is fully formed before infection becomes general.

Some fertilisers affect the final degree of rustiness of plants by hastening or delaying the ripening process, and by affecting the stand. A few days between the dates of ripening of two fields of wheat may have a marked influence on the amount of rust which develops. Superphosphate usually hastens maturity, and thus aids a crop to escape rust, while nitrogenous fertilisers may predispose plants to rust by increasing succulence, density of stand, and lodging, and by delaying maturity.

The Stem Rust on wheat will not attack oats, nor will that on oats attack wheat. Barley, however, is susceptible to Stem Rust of wheat. The Stem Rust of wheat in Australia consists of at least two distinct strains or physiologic forms. Some wheats are susceptible to both strains, while others are resistant to one and susceptible to the other. Owing to the distribution of the strains of Stem Rust it is clear that certain varieties may be susceptible in one locality and resistant in another. The solution of the rust problem is

Fig. 13.—Stem Rust on Oats.

Note the elongated rust pustules and ruptured epidermis of the stems.

a local one, and is to be sought mainly along the lines of breeding for resistance to the strains of rust which exist here. In this connection the Department is conducting extensive experiments with the object of developing varieties which are of commercial value, and which are at the same time rust resistant. In view of results obtained in other countries, there is every probability that the solution of the rust problem by breeding methods will ultimately be found.

Leaf Rusts.

The Leaf Rust of wheat is caused by the fungus *Puccinia triticina*, and the Leaf Rust of oats by the fungus *Puccinia coronata*. These fungi are distinct from one another and are entirely distinct from the fungi causing the stem rusts. The damage occasioned by these rusts, while far less than that caused by the stem rusts, is often of some importance in crops on the coast. They occur in the spring and are almost entirely restricted to the leaves, upon the upper surface of which they cause light yellowish-red scattered rust spots which do not rupture the epidermis. Later in the

season a black spore (teleutospore) stage is produced, which again serves no useful purpose in the life cycle in Australia. As in Stem Rust, the red spore or uredospore stage is responsible for propagating the fungus, and for carrying it over from season to season.

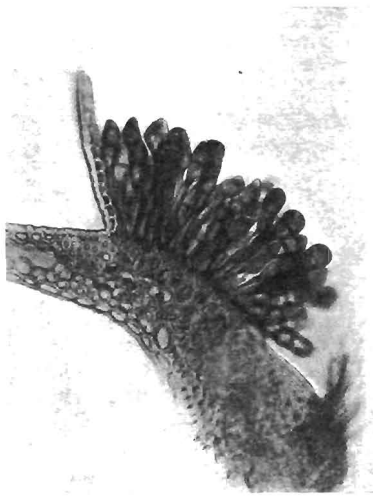


Fig. 14.—A single sorus or group of teleutospores of *Puccinia graminis*.

Note the two-celled spores, and on the left, the epidermis which has been ruptured by the development of the spores.

Leaf Rust on wheat will not infect oats, nor will that on oats infect wheat None of the other cereals are susceptible to attack by either of these leaf rust fungi. Leaf Rust of barley (*Puccinia anomala*) and Leaf Rust of rye (*Puccinia dispersa*) occur to some extent in Australia, but they are of minor importance.

The following control measures are recommended :—

1. Use resistant varieties or varieties which are "rust escaping." The varieties recommended by the Department for particular districts should be adopted.

2. Use superphosphate, which gives the plants a good start and hastens maturity, and will thus sometimes help a variety to escape serious damage following rust infection.

3. Fallowing may help in dry districts by giving the crop a good start, and thus enabling it to mature early. It also assists in destroying self-sown wheats which carry over the rust.

4. On irrigation areas water should not be applied to the growing crop.

5. In moist climates, as in the coastal areas, drainage may help, since rust is generally worst in moist hollows.

Powdery Mildew.

This disease is prevalent in damp seasons. It is caused by a parasitic fungus (*Erysiphe graminis*), and is known in some localities as "flag fungus."

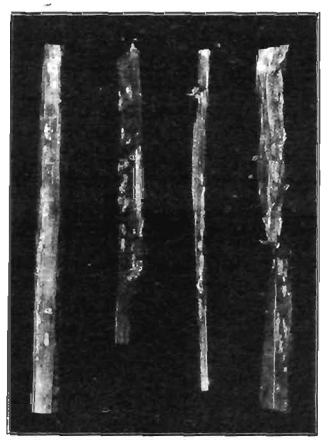


Fig. 15.—Wheat affected with Powdery Mildew.

It grows for the most part on the surface of the first leaves produced in spring, forming white or pink patches, more or less extended and of varying thickness (Fig. 15). Some of the fungous threads grow outwards, and become constricted into a number of small cells like a string of beads (Fig. 16A). The outermost of these cells or spores are being continually set free as a fine white powder; these spores germinate readily and serve to spread the disease. The fungus is often reddish-grey in appearance, and is then sometimes mistaken for Rust.

If the weather be favourable the fungus changes as summer approaches into a greyish-white thick felt, embedded in which can be seen with the naked eye numerous minute black or brown spore cases (Fig. 16B). Soon after these spore cases have begun to appear the leaves that were covered by the mildew felt die, and at length the felt drops off. Each spore case contains a number of small sacs, each of which holds eight spores (Fig. 16c). These small spores inside the black spore cases carry the infection forward from year to year.

Crops attacked by mildew usually recover on the advent of summer, but occasionally the disease has proved very malignant, and it distinctly reduces the yield in such cases.

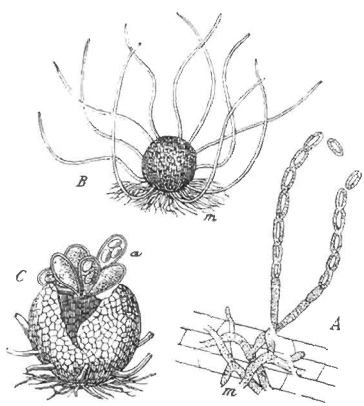


Fig. 16.—Wheat Mildew (*Erysiphe graminis*).

A. Oidium stage, showing the production of conidia.
B. Perithecium with appendages.
C. Perithecium (more magnified) showing asci and ascospores. (*After Frank.*

Control Measures.

The disease is usually most prevalent where the growth has been particularly vigorous, and feeding off in June and July will, therefore, be effective in reducing leaf growth, and admitting sun and wind, in the presence of which the fungus will die. The burning of stubble is likely in a large measure to prevent the continuance of the disease.

Take-all (*Ophiobolus graminis*).

This disease is to be distinguished from Foot Rot disease (*Helminthosporium*), an account of which appears on page 348.

Take-all is caused by a fungus which exists in the soil, and attacks the roots of the wheat plant. The disease makes its appearance in patches, which are usually round, but which may be large or small, according to the severity of attack. Not infrequently the yield on large areas is seriously diminished—even by 50 per cent.

When the wheat is checked before it is out in ear, the disease is usually referred to by farmers as take-all. Sometimes affected plants give rise to ears which are white, and possess no grain; only in rare cases do the ears contain pinched grain. This condition is referred to as "whiteheads."

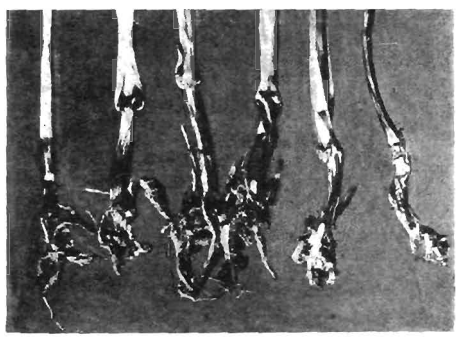


Fig. 17.—Take-all on Wheat.

Bases of young wheat plants killed by Take-all fungus (*Ophiobolus graminis*)
Note the characteristic blackened areas on the lower parts of the stems ("Black feet").

If the straws of such plants are examined at the base or butt they will be found to be discoloured and usually blackened from the ground level upwards for as much as two inches in bad cases. The roots, especially in later stages of the disease, show an abnormal development of root hairs, giving them a "fuzzy" and woolly appearance. The roots become brittle and break off readily if the plants are pulled up. Sometimes an excessive development of secondary roots is noticed. The butts of the plants at the ground levels are, in late stages, usually rotted through, which gives rise to the signs of mal-nutrition in the ears referred to above. When examined microscopically, a felt-like mycelium (fungous threads) or plate of a black to brown colour is noticed encrusting the stems and leaf sheaths of the plants at the base. These fungous threads are ramifying in the basal leaf sheaths and in the straw, and result in the early death of many of the cells. In very advanced stages there may be noticed on the blackened straw of the dead plants a development of the fungous spore cases. These shed their spores into the soil.

Infection takes place from the soil, the young and growing wheat plant being attacked by the fungus, the threads of which enter the plant near the ground level, establish themselves in the root-system and in the lower portions of the stems, and live parasitically at the expense of the wheat plant.

Various grasses are also affected with, and can convey the disease, *e.g.*, Brome grass (*Bromus sterilis*), barley grass (*Hordeum murinum*), and *Agropyrum* sp. The occurrence on oats is rare in Australia, though not entirely unknown. Barley is attacked.

Crops which are fed off are often more severely affected with Take-all than those which are not fed off.

Control Measures.

1. Stubble from a diseased crop should be burnt off. This method of control is not completely satisfactory, as the fungus in the soil and on the base of the plant may escape destruction.
2. Crop rotations in which a resistant crop, such as oats, is included help to starve the fungus in the soil. Barley should not immediately follow wheat nor should wheat follow barley, where the disease has been in evidence.

   Rotations which have been suggested to follow a wheat crop badly attacked by Take-all, are:—

   1. Early and well prepared fallow.
   2. Oats.
   3. Early fallow.
   4. Wheat.

   Or modified as follows:—

   1. Early fallow.
   2. Oats (grazed).
   3. Oats (sown on stubble land for reaping).
   4. Fallow.
   5. Wheat.
3. Bare fallowing also helps to starve out the fungus. Best results are obtained when the fallows are kept clean of all grasses which are susceptible to attack.
4. Avoid ploughing through Take-all patches when the land is in a very dry and dusty state, as this apparently helps to disseminate the fungus more widely. Some authorities consider that late fallowing is worse than not fallowing at all. The reason apparently is that late fallowing only serves to distribute the spores of the fungus which are present on the stubble and on the grasses of stubble land, and does not provide an adequate programme for starving out the fungus. Early fallowing, however, is regarded as particularly beneficial.
5. Sow varieties at correct periods as determined by their seasonal characteristics. Early maturing varieties should be sown late. Feeding off is undesirable and should be avoided whenever possible.

Foot Rot.

This disease is generally first observed in an affected crop shortly after the flowering period. Isolated heads throughout the crop appear to be ripening-off prematurely, and either fail to set grain or produce grain which finally becomes shrivelled and practically worthless.

Although most frequently observed in scattered plants, the disease may also occur in *definite areas*. In this it resembles somewhat one of the characters of the Take-all disease. Occasionally also, plants are observed to be affected with both the Take-all and Foot Rot diseases.

Foot Rot is caused by a parasitic fungus which attacks the plant just below the surface of the ground. This fungus is most frequently a form known as *Helminthosporium sativum*, but during the past few years other fungous species have also been found in association with the condition, *e.g.*, *Wojnowicia graminis*.

Fig. 18.—Plants that have Died of Foot Rot in Various Stages of Development.

Plants affected with Foot Rot may sometimes be killed in the seedling stages and the disease is a common cause of poor stands in some seasons. In more mature plants, the stooling is generally very poor. Sometimes only a few straws produce heads, the others remaining undeveloped, having been stunted by the fungous parasite. The heads are usually checked in their development, and frequently the lower flowers are not formed.

The root-system is also affected, and as in Take-all, there is an abnormal development of root hairs, which give the affected roots a fuzzy appearance. When diseased plants are pulled up, the roots break easily.

A close examination of such plants at and below the ground level shows a most characteristic brownish marking of the leaf sheaths and straw. Sometimes the marking is in the form of brownish tobacco-coloured streaks or spots, and sometimes there is a uniform discoloration of both sheath and straw. When the plant is dead, the color at the base is ashen-grey, and the destruction of tissue is observed to extend into the straw.

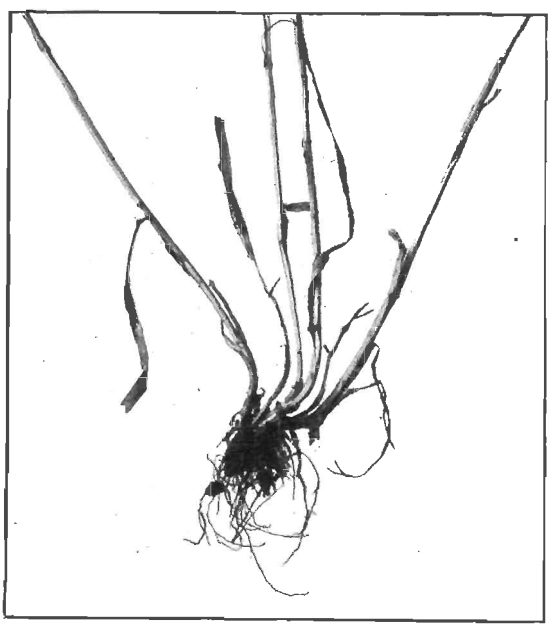


Fig. 19.—Hard Federation Wheat, affected by Foot Rot.

Note the poor stooling, the tendency to form secondary roots, and the diseased straws.

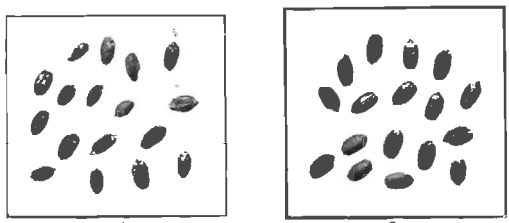
Take-all plants, on the other hand, generally show a charred or blackened appearance at the base of the straw. However, it is not always easy to differentiate between these conditions in the field, especially since one of the Foot Rot organisms (*Wojnowicia*) results in a blackened discoloration at the base, which is very like that caused by the Take-all fungus, although generally it is not so extensive.

Infection takes place from the soil. Stubble and refuse from a diseased crop harbour the disease and enable it to live over in the soil from year to year.

The disease is not carried over in the seed as a general rule, although the disease may be sometimes introduced by means of the seed. It does not necessarily follow that diseased grain will be produced by a crop affected with Foot Rot.

However, in some seasons the *Helminthosporium* fungus may also attack the grain, and result in a brownish-black discoloration at the germ end. This condition is known as "black point," and although other harmless fungi may also cause this condition, it is not desirable that such grain should be used for seed since it may result in the introduction of the Foot Rot fungus into clean land.

It has been observed that "feeding-off" may increase the amount of damage caused by Foot Rot and Take-all. The check which the crop receives under these circumstances apparently enables the causal fungous parasites to bring about more serious injury than would otherwise be the case.



A B

Fig 20.—The Effects of Foot Rot.

A.—Pinched grain from diseased plants. B.—Plump grain for comparison

The Foot Rot fungi may attack barley, and have also been found on certain native grasses, *e.g.*, Barley Grass (*Hordeum murinum*), the Spear grasses (*Stipa* spp.), and the Brome grasses (*Bromus* spp.).

Oats are not affected.

Control Measures.

The following control measures are known to be of value in minimising losses from the disease:—

1. Burning the stubble will kill much of the fungous material which is present on the surface of the soil.
2. Bare fallowing will help to starve the fungus in the soil. The best results are obtained when the susceptible grasses (Barley grass and Spear grass, &c.) are kept down.
3. A crop rotation system which introduces a non-susceptible crop, such as oats, will also help to starve the fungus.

4. Early preparation of the seed-bed results in hastening the decay of old stubble on which the fungus can live, and also assists germination and destruction of the spores before the grain is sown.

Fig. 21.—Two heads from plants affected with Foot Rot and two healthy heads.

5. Only sound and plump graded seed should be used. A sample with pinched seed or "black-pointed" seed should be rejected.

6. When wheat is sown primarily for production of grain, all possible provision should be made to avoid the necessity for feeding-off.

Speckled Leaf Blotch.

This disease is sometimes also known as Leaf Blight, and is caused by the action of a parasitic fungus *Septoria tritici*.

The disease often makes its appearance during a cold and backward season, and during the winter and spring may cause extensive destruction of the leaves of the young wheat plants. The trouble first develops in the form of more or less oval blotches on the leaves. The centres of the blotches are somewhat lighter in colour, and eventually may become yellowish, and in the final stages are light brown. As the diseased areas spread the whole leaf may become yellow in colour, and in severe cases may die prematurely. A close

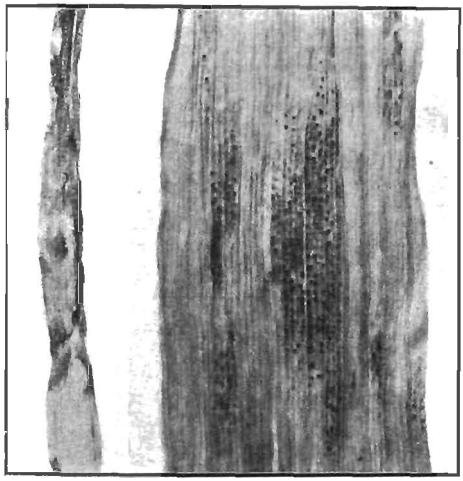


Fig. 22.

Left—Wheat Leaf affected with Speckled Leaf Blotch. Right—Portion of Wheat Leaf affected with Speckled Leaf Blotch. (Magnified.)

examination of the diseased areas on the leaf will reveal the presence of numerous small brown or black specks which are just visible to the naked eye. Each speck represents a small spore case, which contains large numbers of the spores which serve to propagate the disease.

The fungus which causes this disease may attack rye and certain types of grasses, chiefly species of *Poa*. Different fungi cause somewhat similar conditions on oats and barley. Although Speckled Leaf Blotch is most commonly found on the very young seedlings, seasonal conditions may favour its further development until after heading time. In such cases extensive destruction of the flag is responsible for the production of pinched grain and

reduced yields. *Septoria tritici* and a somewhat similar form (*Septoria nodorum*) are sometimes found attacking the chaff of the developing wheat heads. The discoloured areas in this region are somewhat similar to those occurring on the leaf, and the condition is known as "Glume Blotch."

CONTROL MEASURES.

Special precautions are rarely necessary to control this disease, but the measures which are adopted to combat several other important wheat diseases will also be of value in this connection. Of these measures, the following two will be found most useful:—(1) Burning the stubble; (2) rotation with oats.

Downy Mildew (*Sclerospora macrospora*).

This disease is not considered a serious one, but it has been observed to develop in moist seasons and in low-lying areas which occasionally are subjected to waterlogged conditions.

Fig. 23.—A Plant of Turvey Variety severely affected with Downy Mildew.

The first symptoms of the disease appear on the leaves, which, instead of remaining dark green in colour, develop white or yellow longitudinal streaks. Sometimes the whole leaf becomes yellow. Infected leaves are usually thicker than normal, and tend to remain upright. An excessive number of shoots may develop and such plants resemble tussocks of grass.

In severe cases the plant dies prematurely, and the leaves rapidly wither and become brown. In other cases, the plants survive for a longer period, but are quite definitely stunted, and develop extraordinary types of malformations in place of normal heads. The upper leaves, particularly, become stiff and fleshy, and tend to remain upright instead of curling down in the normal manner. In some cases the diseased heads are larger and longer than normal heads, the rachis is elongated and somewhat thickened, and the individual spikelets are several times the length of the normal structures. The glumes and other necessary fruiting parts are considerably thicker than is the case in the normal plant. In other cases the spikelets are almost

Fig. 24.—Heads of Turvey Wheat.
(*a*) Affected with Downy Mildew; (*b*) Healthy.

entirely suppressed, and are represented only by small rudimentary structures. In others, the tissues which should have developed into normal heads are transformed into a branched, curled, and twisted series of stalk and leaf-like outgrowths, in which all resemblance to a normal head has entirely disappeared.

If a diseased leaf is held up to the light and examined with a small magnifying glass, it will be noticed that there are large numbers of clear spots somewhat smaller than a pin's head situated in and between the veins of the leaf.

These spots are, in effect, the oospores or resting bodies formed by the fungus, and which serve to carry the disease over from year to year.

The disease has also been recorded in this State on cultivated oats, wild oats, barley, and rye. It is known to occur in other parts of the world on maize, rice, and a large number of grasses.

Fig 25.—Ergot (*Claviceps purpurea*) on Wheat heads.

CONTROL MEASURES.

The following measures which already are recommended for the control of some of our more important wheat diseases should also prove effective in minimising losses from this source of trouble:—

1. Burn the stubble of crops which are known to have been diseased.
2. Do not use grain from such crops for seeding purposes.
3. Pickle all grain before sowing.
4. Do not sow wheat continuously on the same land. The introduction of at least one year's bare fallow should prove especially effective in the control scheme.

Ergot (*Claviceps purpurea*).

Hard, dark violet excrescences, which usually fracture easily and are white inside, make their appearance from time to time upon the ears of cereal crops and grasses. These excrescences are known as ergots, and as they occur most frequently upon rye, the Ergot of rye is by far the best known. Ergot, however, is found occasionally upon ears of wheat in the form of black or dark violet protuberances, sometimes as large as a maize grain (Fig. 25). These replace the grain in the head and are thus a source of definite loss.

The ergots or sclerotia will not germinate if sufficiently covered with earth, hence the stubble of an infected crop should be deeply ploughed, so that the ergots lying upon the ground are buried. Ergots or portions thereof may be separated from harvested wheat grain by sifting or by immersion in a 20 per cent. solution of common salt, which will enable the ergots to float to the surface, when they can be readily skimmed off.

Normal seasonal conditions throughout the wheat belt do not favour the development of this disease, and special remedial measures are not necessary as a matter of general practice.

Frost Effects and Other Abnormalities.

Considerable damage is sometimes caused by the incidence of late frosts. In most cases the injury is restricted to the young, developing wheat flower, which is then unable to develop normally into grain. Affected plants are readily picked out in a crop, first by the somewhat translucent green colour of the heads, and later by the prematurely-ripened appearance of the heads, which on close examination will be observed to contain no grain.

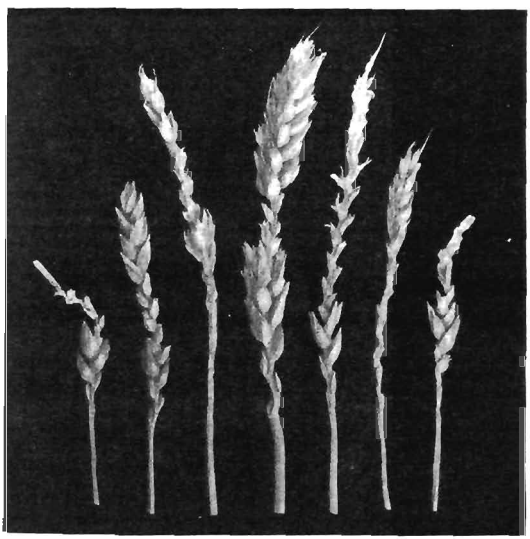


Fig. 26.—Wheat Heads Injured by Frost.

In other instances when subjected to frost just as the heads are emerging, whole portions of the young wheat head are affected, and development of the spikelets is completely checked. Such heads are quite conspicuous at a later stage when the aborted areas on the head may be readily picked out. Sometimes the injury occurs at the base of the head, sometimes in an intermediate position, and occasionally only the top portion is affected.

Frequently the straw of the plants also shows evidence of frost injury. The plant tissues, particularly near the lower nodes or joints on the stems, are killed. A brownish discoloration appears on this region, and the straw is invaded by soil organisms, becomes weakened at the point and readily falls over. Finally the straws of plants affected in this way develop extensive discolorations as a result of invasion by secondary organisms.

Somewhat similar effects are noted in oats and other cereals.

Tip injury in wheat plants may also result from causes other than frost. Excessively high temperatures experienced at the time of filling of the grain, combined with a slight deficiency in the water supply available to the plant at this period, may result in killing and bleaching of the tip spikelets on the head.

A deficiency in the water supply available to the plant as the grain is developing may also result in a premature "haying off" condition which is quite distinct from any condition attributable to the action of a parasitic organism.

INSECT PESTS OF WHEAT.

Fortunately the insect pests of wheat are few in New South Wales and of little importance when compared with the insect pests of other crops. Five species have been recorded, viz., the False Wireworm (*Cestrinus punctatissimus*) which bores into the grain soon after planting, a fly larva (*Cecidomyiidae*) which bores in the stem of the wheat, the Rutherglen Bug (*Nysius vinitor*), the Wheat Root Grub (*Anodontonyx tetricus*), and the grasshopper (*Chortoicetes terminifera*). Of these the three first mentioned are rare and of no economic importance, the Wheat Root Grub is widespread and the grasshopper, although capable of doing extensive damage, only appears at very long intervals.

Wheat Root Grub.

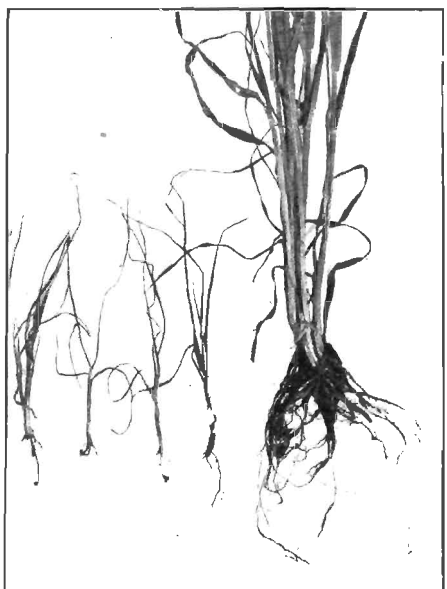
Serious injury to growing wheat by this grub is of comparatively recent origin, and was first recorded in 1925, although occasional unauthenticated reports were received many years previous to that date to the effect that the grubs had appeared in wheat crops.

Wheat and oats are the only economic plants attacked by this pest, and in all the infestations noted the injury has invariably occurred in red soils. Grubs have been found in white or light grey soils, but never in sufficient numbers to cause any noticeable injury. Wheat growing in black soils has never been found to be infested.

The presence of grubs in a crop is first manifested by the poor growth of the wheat in patches. As the injury increases these patches become more noticeable, until finally the young plants die, and bare patches appear in the crop in a similar manner to that produced by the disease known as Take-all, with which the injury is sometimes confused.

The injury to the young wheat is caused by the larvae feeding on the young roots and gradually cutting them off to the stem. As the roots are destroyed the plant endeavours to produce fresh roots, but these in turn are destroyed and the young plant eventually withers and dies. In some cases when all the roots are destroyed the grubs continue to feed upon the stem, and gradually pull the plant below the surface. The extent of the damage

is always greater when the crop lacks its normal vigorous growth. Thus in crops affected by drought the damage is correspondingly greater than where the growth is vigorous. In all cases the injury has been of a scattered character; one paddock may be considerably damaged and the adjoining ones may be almost free from attack. The pest may also manifest itself in one portion of a district and be entirely absent from the remaining parts.



Wheat Plants Damaged by the Root Grub.
Plants from infected and non-infected portions of the same crop. The upper portion of the healthy plant has been omitted.

The adult beetles appear in the field in their greatest numbers between 25th November and 15th December. They are comparatively small (about two-fifths inch long), and the general colour is black, slightly shiny, and finely pitted on both upper and under surfaces. The wing covers are furnished with four lines or ridges. A limited number of beetles emerge as late as January, and these are responsible for the smaller grubs often found in the field when the majority of the larvae have become full grown.

The incidence of the adult beetles in the field varies from day to day. One day they may be particularly numerous and the following day much less so—this seems to depend upon the temperature and sunshine—while the beetles appear to be particularly numerous on days immediately following rain. *The first beetles appear each day about 2 p.m., but it is not until 3 p.m.* that they become numerous. They congregate on any object in the field, such as fence posts, thistles, ears of wheat, isolated box trees, &c.

Between the hours of 3 p.m. and 5 p.m. the beetles are most abundant and a continual hum, similar to that produced by bees, is noticeable. When thus abundant the beetles cause considerable annoyance to men and horses in the field, and in some instances have caused harvesting operations to be temporarily suspended. The majority of the beetles return to the soil between 5 p.m. and 5.30 p.m., only odd specimens being observed after that time. The beetles are most active on bright sunny days. In the presence of wind and limited sunshine they remain more or less stationary. They are capable of making long flights, but are usually content to make short rapid flights to and from the objects on which they are congregating, or to crawl rapidly about, frequently becoming bunched.

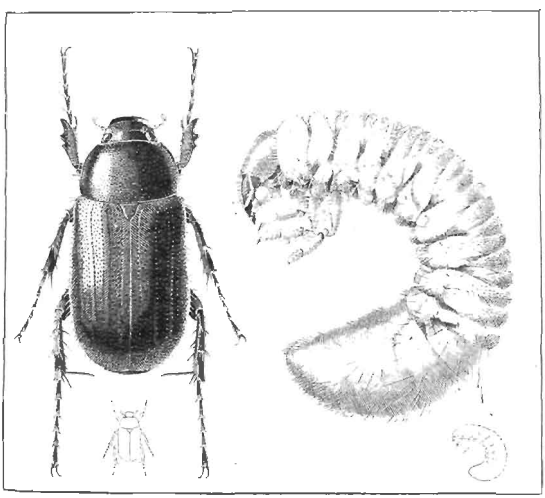
The factor which causes them to become active at a regular hour each day appears to be the gradual increase of the soil temperature as the day progresses. Observations at daybreak reveal the beetles at a depth of from 2 to 6 inches in the relatively cold soil in a somewhat torpid condition. As the day advances the temperature increases and the beetles nearest the surface are noticed to be more active when disturbed. The beetles have never been observed to feed above the ground, and emerge apparently to copulate.

The eggs are almost spherical in shape, about one-twelfth inch long and yellowish-brown in colour. In a laboratory test they were deposited in *clusters 2 to 4 inches below the surface in cavities made by the female.* Dissection of ten females in the laboratory showed sixty-six to be the highest number of fully developed eggs in a single female. In the laboratory about ten days elapsed before the beetles were ready to lay eggs, and as the life of the adult is short this indicates that in the field the majority of the eggs are laid during the first fortnight in December.

By far the greater part of the life cycle is passed in the larval stage, which is approximately ten months in duration. The larva is a fleshy curved grub, nearly an inch in length when the body is straightened, and one-fifth inch in width at the eighth abdominal segment where the body is thickest. The body is yellowish-white in colour, but the presence of dirt in the alimentary tract shows through the skin of the last few abdominal segments and gives them a black appearance. The legs are slightly darker yellow than the body, but the head, which is small, is yellowish-brown. *The body is sparsely covered with yellowish-brown hairs, and the upper* surfaces of the abdominal segments (two to seven), bear several irregular rows of short brown spines. The ventral surface of the last abdominal segment bears two patches of long spines hooked at the tips, and two rows of shorter spines which diverge outwards towards the extremity.

In its early stages of growth the grubs feed upon the roots of weeds and grasses, and upon decaying organic matter in the soil, and there is evidence that they can entirely subsist upon the latter. They are, however, about two-thirds grown when they first attack the young wheat, soon

after it germinates in April and May, and the damage becomes definitely apparent as early as July and August by the presence of thin or bare patches in the crop. During the day the larvae are found at an average depth of 2 inches below the surface, but there is evidence that the grubs approach the surface sufficiently close at night to disturb it, and observations in the laboratory indicate that feeding chiefly occurs during that period. Grubs are usually present throughout the entire crop in limited numbers, but may be very numerous in patches, as many as forty to the square foot being recorded. By the middle of October the grubs become full grown and construct earthen cells, the internal surface of which is



The Wheat Root Grub.
Left.—Adult. Right.—Larva.

finely packed and almost smooth. The cell is usually constructed from 4 to 6 inches below the surface in the more consolidated soil. In the cell thus constructed the grubs first assume the pro-pupal condition, during which the colour becomes pure white; later they change to the pupal stage. The pupa is light-yellow, about ½ inch long, with legs, wings, and other outlines of the future beetle plainly visible. When the adults first change from the pupa they are reddish-brown, but remain within the pupal cell until they assume their normal black colour. The duration of the pupal stages is about six weeks, and the complete life cycle about one year.

Control Measures.

It is not easy to suggest practicable control measures. Experiments with soil fumigants such as calcium cyanide (dust), calcium cyanide (granular), paradichloro-benzene, chlorocide, and naphthaline, and with paris green and bran as a poison bait, proved them unsatisfactory for large scale control in wheat fields. Calcium cyanide (dust), however, gave a 70 per cent. kill when applied heavily by hand at the rate of 30 oz. in small experimental areas of 100 square feet, but when applied at the rate of 20 lb. per acre through the manure hopper of a seed drill it was not effective in killing the grubs.

Cultivation of the soil to break up the pupal cells and the pupae within has also been tested, and although numbers of the pupae were injured by this means the numbers of beetles subsequently emerging proved this method to be of very limited value.

The rotation of a crop other than oats, which is also susceptible, is generally impracticable in our wheat areas.

Destruction of the adult beetle has also presented unusual difficulties owing to the limited time it spends above the ground, and the fact that it does not feed during that period. Consequently the use of bright lights to attract and trap the beetles, or the poisoning of them with arsenicals is out of the question.

The use of chemicals as attractants to the adult beetles has been tested. Of the substances used, guaicol, oleum wintergreen, butyric acid, and whale oil gave promise as attractants, their degree of attraction being indicated in the order in which they are mentioned. Guaicol was the outstanding attractant, and the result obtained with this substance at least warrants further and more extensive field tests.

The treatment of infested soil with insoluble arsenicals may prove of value in control, but further experimental work is necessary.

Grasshoppers.

Fortunately, the damage caused to wheat by grasshoppers occurs only at very long intervals. The grasshopper responsible for the damage appears in swarms and is a small brown species known as *Chortoicetes terminifera*.

Two main broods are noticeable throughout the year. The over-wintering eggs in the ground hatch during late August and through September and October. These young hoppers grow gradually and become winged (according to the date they hatch) from late November through till January. The eggs of these winged forms produce the second brood of hoppers, which may be in evidence throughout December until March. By April and May the second brood of winged hoppers has appeared, and these lay their eggs in the soil, where they over-winter until about the following September. It will be seen that although there are two main broods, the dates of their appearance are irregular owing to different dates of hatching, and also to the fact that the adult winged grasshoppers lay several batches of eggs, with the result that both hopper and winged stages may overlap even in the same district.

Both hoppers and winged forms feed wholly on grass, weeds, crops, and other vegetation. The winged forms fortunately possess the habit of congregating and settling on comparatively limited areas for the purpose

of laying their eggs. The swarm generally selects somewhat bare, scalded *patches on gently rising land when congregating for this purpose.* These egg-beds may, therefore, be patches of land of a few hundred square yards up to many acres in extent. The winged swarms may fly for miles, and

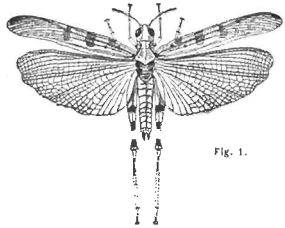


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1.—Plague Locust (*Chortoicetes terminifera*).
Fig. 2.—Youngest stage of "hopper," when spraying is most effective.
Fig. 3.—Late stage of "hopper," with wing pads well developed.

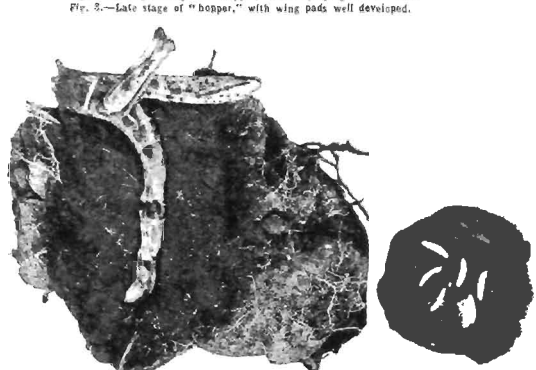


Fig. 4.—Left: Transverse section of Female Hopper Ovipositing.
This female, being "caught in the act," was promptly killed, and the soil carefully sliced to disclose the extended ovipositor.
Right: Eggs of Grasshopper in the Soil.

there is a tendency for swarms to avoid timbered land when settling to feed. The young hoppers on hatching spread outwards from the egg-beds, feeding on the grass and moving forward in long lines of thousands of tiny wingless hoppers. These increase in size, and by a series of moults

gradually attain to the adult winged stage. The male and female forms copulate, and when the female is ready to lay her eggs she settles on the ground and inserts the hind part of her body in the soil by working two pairs of short, hard, ovipositor blades at the extremity of the abdomen. Even the hard soil of scalded patches, roadways, and beaten tracks may be penetrated and the eggs deposited at depths of from 1 inch to 3½ inches. The abdomen of the female is abnormally extended to enable it to deposit the eggs so deep in the soil. A frothy, liquid secretion is exuded along with the eggs, which hardens into an irregular sheath of a tough, spongy nature, and considerably protects the eggs from predaceous insects and from the effects of moisture.

An average of thirty-six eggs is laid by the female in each hole, and each female may lay more than one cluster of eggs. A very great number of egg holes are constructed side by side in the soil when the swarms cluster together for egg-laying. The number of egg-holes per square foot varies considerably; counts made where swarms were dense have revealed from 200 to 800 holes, with an average of about 300 per square foot over several acres. At a conservative estimate, therefore, there were 10,000 eggs per square foot in these areas, or over 400 million eggs per acre. This emphasises the great advantage of locating these egg-beds, and of destroying the young hoppers immediately they hatch and before they spread.

Briefly recapitulated, the life stages may be presented thus:—

Over-wintering egg stage—Five months, hatching about September.
First hopper swarms—September to November.
First winged swarms—December to February.
Midsummer egg-laying—December to February.
Second hopper swarms—January to March.
Second winged swarms—March to May.
Autumn egg-laying—March to May.

Due allowance must be made for variations in climatic and local conditions.

Control Measures.

The best control of this pest is to be obtained by either baiting or spraying the swarms of young hoppers during the first three or four weeks after they hatch from the ground and before they have spread far and scattered—which they do as they grow older, and especially when they are allowed to reach the winged (flying) stage.

Crops are chiefly attacked by winged or advanced immature forms which have previously developed from egg-beds laid in grass lands. Attention should, therefore, in the first place be directed to the young hoppers as soon as they hatch from the eggs to limit the possibility of them later advancing into adjoining crops. Spraying with arsenite of soda is recommended for this purpose, but the poison bait must be used when the crops are being attacked.

An important factor in the scheme of control is to mark the egg-beds. Having done this, or noted, in the spring, where the young hoppers are hatching, organised working parties should treat the patches within three or four weeks of emergence, and kill the young hoppers before they do any appreciable damage. If this was universally carried out, the pest could be

controlled in the spring before a second and larger swarm of hoppers could be produced in the midsummer. Labour, time and material can all be saved by spraying or baiting early in the spring, as the subsequent swarms will then be almost negligible.

For pastures, the complete efficacy of arsenite of soda spray as a control for grasshoppers in the hopper stages has been demonstrated over a number of years. The spray formula recommended is:—

1 lb. arsenite of soda;

2 lb. of treacle or molasses (preferably molasses);

16 gallons of water.

Even without treacle or molasses, this spray is valuable for control.

Dissolve the arsenite of soda in some hot water in one vessel, and the molasses also in warm water in another vessel. Allow the two solutions to almost cool before mixing them together and diluting to the correct strength.

The spray should first be applied on a strip of grass about 30 to 50 feet wide immediately in front of the advancing hopper swarms, and then directly on to the swarms. The spray kills partly by caustic action, but mainly because the hoppers drink the liquid or feed on the poisoned grass. Spraying need only be light. About 75 to 80 gallons of spray per acre is quite sufficient—it is not necessary to waste material by drenching the grass, but merely to apply it in a fine mist. The cost for ingredients works out at about 4s. 6d. per acre. It has been proved by severe tests that the spray, made and applied as directed, is not harmful to sheep.

In crops, the poisoned bran bait previously referred to is recommended. This bait is broadcast (from carts or from sacks carried across the shoulders or on horse-back) in or on the edge of the crop as may be necessary over a strip of 30 to 50 feet wide in front of the advancing swarm at the rate of about 20 lb. per acre, according to the extent of the invasion.

The following formula is recommended:—

Arsenite of soda ½ lb. or Paris green 1 lb.;

Molasses 4 lb.;

Bran 24 lb.;

Water 3 gallons.

Dissolve the arsenite of soda in hot water and allow the solution to cool; then add the molasses and mix until dissolved. This liquid is then added to the bran and mixed thoroughly to form a crumbly mash. It is important to see that all the bran is thoroughly wet, as otherwise the bait will be less effective.

If Paris green is used, it should be mixed thoroughly with the bran while dry, and the mixture then made into a crumbly mash with the water in which the molasses has been dissolved. Arsenite of soda is recommended for preference, as it is cheaper and more toxic to the grasshoppers. Avoid mixing the bait with the hands, particularly if any cut or wounds are present, as the poison may be absorbed.

The poison bran mash can also be used with success on grass lands where the hoppers are massed or are advancing soon after hatching. Care should be taken to scatter it in a finely-divided state to prevent pellets or heaps. As it has not yet been proved definitely that the bait is harmless to stock

when scattered in the manner recommended, it is important that stock should not be permitted where the poison bran has been scattered until several days have elapsed to allow the bait to become dry and unattractive. Hoppers are poisoned by this bait within twenty to forty hours.

In America sawdust or horse manure have been employed in place of the bran, and have been found fairly attractive, and cheaper. Experiments abroad have also shown that the addition of chopped-up oranges, at the rate of about five to each 24 lb. of bait, makes it more attractive.

The efficacy of arsenite of soda spray and of poison bran mash have been demonstrated, and it is obvious that all that is required is timely action throughout each district. The problem is a community one, and should be *taken up as such. The best results can only be obtained when every* landowner is on the lookout and is prepared to aid in combating the pest. Preparations should be made before the first spring hatching of the hoppers. A sufficient stock of material should be purchased and stocked in each district. Local committees should be elected to employ labour and organise co-operative campaigns to control the swarms. It is essential that all districts where grasshopper swarms occur should be prepared, and should undertake this co-operative work, so that adjacent districts carrying out control work shall not be re-infested by flying swarms from districts that have neglected to adopt control methods. The expense is limited to treat*ment of the initial swarms, and the outlay is only likely to occur in any* district once in five years or more. With control measures universally adopted the grasshoppers should not be able to appear in destructive numbers in any part of the State. A nominal levy once in five years or so of a fraction of one penny per acre or based upon the stock held would provide all the funds necessary.

All such grasshopper control committees should insist on landowners giving notice of the presence of egg-beds or winged swarms, and also of the first appearance of any batches of young hoppers hatching from the ground. This would enable prompt treatment and the destruction of the swarms before they assumed dangerous proportions.

SECTION V.

Cereals other than Wheat.

OATS.

Oats are not cultivated to the same extent in New South Wales as in New Zealand and Tasmania, for the simple reason that the climatic conditions and rainfall of this State are much more adapted to the growing of wheat. The conditions that favour the successful cultivation of oats cannot be considered altogether satisfactory from a wheat-growing point of view. Speaking generally, the best oat-producing countries have a cold climate associated with a high average rainfall, whereas with wheat the best results are usually obtained in comparatively warm countries, with only a moderate or even a low average rainfall. United States of America is the greatest oat-producing country of the world, the proportion of oats to wheat grown being as three to four—in other words, 3 acres of oats are sown to every 4 acres of wheat.

Apart from the climatic conditions and rainfall required for the successful cultivation of this crop, the demand for the grain for making oaten meal is never very strong, as this commodity is only used to a limited extent, whereas from wheat the principal food of the human race is manufactured. Oats, therefore, are never likely to be grown on anything like so extensive a scale as wheat in this State.

In recent years, however, the advisability of growing oats in rotation with wheat has been clearly demonstrated. The crop is not subject to attack by flag smut, foot rot, or take-all, as explained in the sections on those diseases (pages 338, 347, and 348), and if a year of bare fallow follows the oats before the wheat crop is sown, the fungous spores are given an opportunity to germinate, and to perish in the absence of a host. Moreover, the newer varieties of oats produced by the Department can be grown successfully throughout the wheat areas—even in the drier districts the earlier-maturing sorts will succeed. The crop can be used for many purposes, though it would soon cease to be profitable if large areas were sown for the sole purpose of producing oats for market.

The grain is one of the best concentrated feeds for stock, and can be stored as a reserve against drought. Oats are most valuable as a hay or green fodder crop and can be conserved in the form of silage. They are especially valuable as feed for horses on the wheat farm, because the crop is not liable to certain fungous diseases that attack wheat, and there is no danger, therefore, of the spores being distributed on the fallows from season to season, as is the case with wheaten hay.

An early-maturing oat, such as Mulga, provides an excellent winter fodder crop on which to graze sheep, and is of special value for lambing ewes and for fattening lambs for market.

There is no world's market for oat grain as there is for wheat, and thus the oat crop is for local consumption. Oats yield 50 per cent. more grain than wheat on an average, and the crop can be harvested by sheep or

machinery just as it pays the farmer best. It can be fed off continuously at intervals until the soil is ploughed, or it can be conserved as silage, hay, grain and straw.

The coastal dairy-farmer keeps up the milk flow by growing oats to feed in the winter and spring months; the wheat grower finds oats enable him to increase his flock of sheep and make them more or less a permanency; while the pastoralist will find a paddock of early-maturing oats a great stand-by to supplement the natural pasture.

Some idea of the area devoted to oats each year may be gained from the following figures, taken from the Government Statistician's reports for the past five years:—

AREA under Oats in New South Wales.

Year.	Grain.		Hay.		Green Fodder.	Total Area.
	Area.	Production	Area.	Production.		
	acres.	bushels.	acres.	tons.	acres.	acres.
1924	86,693	1,570,300	242,416	299,571	30,901	360,010
1925	123,517	2,511,400	275,334	400,431	29,498	428,349
1926	101,097	1,615,650	210,271	244,520	44,517	355,885
1927	105,115	1,898,750	218,351	293,659	37,173	360,639
1928	114,988	1,654,560	200,872	212,535	55,259	371,119

Climate and Districts.

Oats may be grown with a fair amount of success under a diversity of climatic conditions, but they thrive best in a cold climate, associated with a good rainfall that is evenly distributed throughout the crop-growing season. As previously mentioned, the climate of this State, taken on the whole, is much more adapted to wheat-growing, but in some of the colder districts oats may be grown almost to perfection. In a general way, it can be said that a good potato district will, as a rule, prove suitable for growing oats, as these crops require similar conditions of climate. As an example of this, we may take portions of the Northern Tablelands of the State. Some of our very best potato districts are situated there, and at the same time some of our best oat districts. Glen Innes, in particular, is a district where the climatic conditions are favourable to the production of potatoes and oats of the highest quality, and there are other portions of the State that are similar in their suitability for the two crops.

On the Central Tablelands, from Blayney to Orange, is the pick of the oat country, although some exceptionally good returns have been obtained in the Bathurst district. On the Southern line, the best oat districts are situated in the vicinity of Goulburn, Taralga, and Crookwell; and some excellent crops have been grown in the country between Junee and Albury. The districts mentioned can be classed as about the best for oat-growing, but good crops can be grown in any wheat district by choosing varieties adapted to the local climatic conditions. So that to-day the position is far different from fifteen years ago, when Algerian was the only variety grown in the warmer districts.

In districts with a lower average rainfall than 25 inches the short, white oat favoured for oatmeal cannot be grown to perfection, but in such districts oats may be largely grown if proper early-maturing varieties are employed.

Soils.

Oats may be grown successfully on soils entirely unsuited to wheat, and also on low-lying situations where it would be extremely inadvisable to sow wheat. They may be sown on land that is too strong and rich for wheat, and also upon heavy, wet soils, that have a natural tendency to be cold and sour. The red basaltic soils met with in the best potato-growing districts produce excellent crops of oats, but the crop will do well on practically any soil, provided it is worked into good tilth previous to planting and the rainfall is not too low. Oats are often grown on new land which has not been sweetened after clearing of timber. Although yielding a better crop on undrained soil than wheat and barley, oats respond well to drainage and good cultivation.

The Preparation of the Land.

Land intended for oats should be prepared in a similar manner to that intended for wheat, except that in the more favoured oat districts slightly deeper ploughing may prove advantageous. In the drier districts fallowing is essential to obtain the best results, and in regard to the time the operation should be commenced, the same general remarks apply as to wheat, and the implements to use for working the fallow are also the same. Clean cultivation paddocks are very necessary to the growing of prime oaten hay, as nothing detracts so much from its general appearance when placed on the market as the presence of weeds, thistles, burrs, &c. When oats are grown for green feed on the coast, the land should always be prepared early, say, about two months prior to sowing, provided, of course, the weather conditions will permit. It is wonderful how great is the effect on the resulting crop of a short fallow. A good, moist seed-bed is a great aid to success for the reception of the seed, and every farmer who wishes to obtain the best results with this crop must do all in his power to bring this about by careful methods of cultivation before planting.

In wheat districts where the rainfall is fairly good, the practice now being largely adopted by farmers is to sow portion of the wheat stubble land with oats for hay. This enables them to make more use of their land than would be the case if it were all fallowed; furthermore, there is a risk of oats lodging badly if the land is fallowed in these districts.

Varieties Recommended.

The varieties recommended by the Department for the various portions of the State are as follows:—

North Coast.—Algerian (for grazing), Sunrise, Mulga, Buddah.

South Coast.—Algerian, Guyra, Sunrise, Mulga, Buddah.

Central Tableland.—Algerian, Guyra, Lachlan, Mulga.

Northern Tableland.—Reid, White Tartarian, Algerian, Guyra.

Southern Tableland.— Algerian, Guyra, Sunrise, Mulga, Myall, Buddah.

Monaro.—White Tartarian, Algerian, Guyra, Mulga.

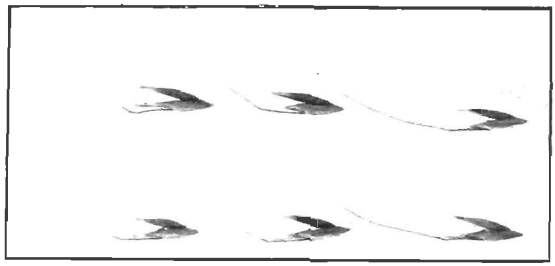
South-western Slopes and Riverina.—Algerian, Lachlan, Guyra, Belar, Mulga.

Central-western Slopes.—Algerian, Lachlan Guyra, Belar, Mulga.

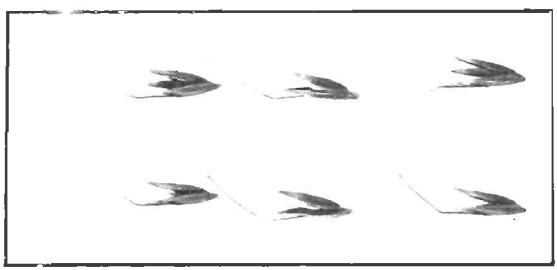
Northern-western Slopes.—Algerian, Guyra, Belar, Mulga.

Under Irrigation.—Algerian, Guyra, Sunrise, Mulga.

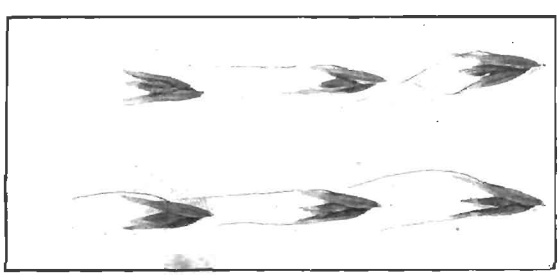
Western Plains.—Sunrise, Gidgee, Mulga, Buddah.



Burdah.



Belah.



Algerian.

Oats may be grouped according to their stooling or tillering capacity, and with this their period of maturity coincides. Algerian is the thickest and one of the latest of the varieties, and Buddah is the earliest to ripen and the smallest in number of stalks produced.

Although Algerian is a good drought-resister, a plump sample of grain cannot be expected under dry conditions. On the other hand, Lachlan or Guyra will yield a good plump grain, though the bulk of hay produced may not be quite equal to that of Algerian. Should a farmer's land grow too much straw and the crops go down easily, they should be fed off, or a variety like Lachlan should be grown, which will safely stand until stripped or cut. Should Algerian grow rather too short to make good sheaves in a dry district, Mulga is recommended in its stead. Algerian and Sunrise are excellent oats for feeding off; the other varieties feed off well, but Guyra and Lachlan are perhaps more especially adapted for grain, while Mulga is a good general-purpose oat for late sowing.

Descriptions of Varieties.

Algerian.—This is more widely grown than any other variety, and is a most useful oat for green feed, hay, silage, and grain. It is rather drought-resistant. Although a profuse stooler, spreading over the ground for a considerable time after planting, it has fairly fine stems, purplish straw, and should be sown early to get the best results.

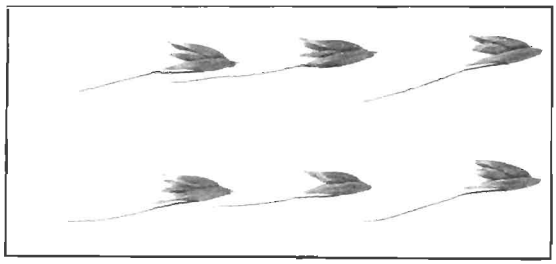
Belar is a selection from Sunrise; an early to midseason variety with tall, rather strong but not coarse straw, which shows a purple tint when ripe. The grain is brown with rather coarse awns, but it threshes readily and grows a plump sample; it is not very liable to shed. Belar is a good general-purpose oat, making a better sample for drilling than Lachlan, and equally productive for hay.

Buddah is a selection from Sunrise, and it is more rust-resistant and comes into head several days earlier. Though remarkably early it grows to a good length; the straw is similar to that of Mulga and the grain is creamy white.

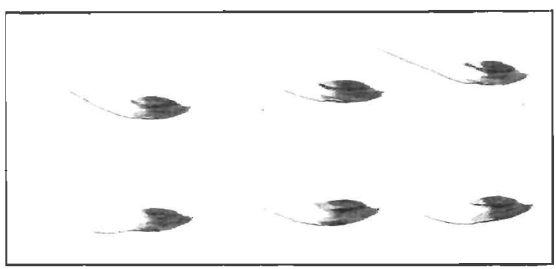
Gidgee is a crossbred resulting from the mating of two strains of White Ligowo x Algerian. It seems more adapted to inland than to coastal conditions, and should be sown late or else fed off if sown at all early. It gives more length of straw than Lachlan, is of the same season as Sunrise, than which it stools rather less, and has stout, medium-coarse straw, which is purple and in some seasons inclined to be brittle. The awned grain is remarkably plump, brown, and of medium length, and suitable for feeding to sheep in drought, as it is easily picked up.

Guyra.—This variety matures in about the same time as Algerian, with straw about equal in height to that variety, but rather coarser, though not as coarse as the late ripening white oats. It may be called a moderate stooler, has a compact head, and dark-brown grain with a fairly strong awn, like its parent (White Ligowo). The grain is plump, and the husk fairly thin. Guyra will be found suitable to typical oat districts.

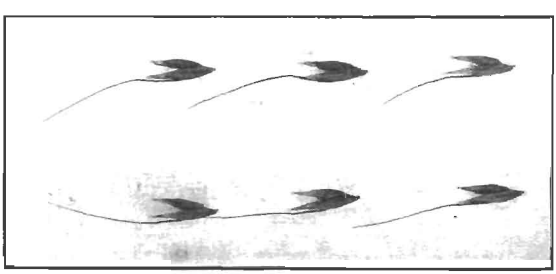
Lachlan.—This variety is the result of a cross between White Ligowo and Algerian. It combines the chief qualities desirable for our warmer districts which are found in the two parent varieties. Lachlan is a vigorous grower,



Lapwing.



Guyca.



Oldger.

maturing a plump sample of grain in almost any season. The straw is stronger than that of Algerian, so that it can be stripped without fear of lodging when ripe. At the same time, the stems are not too coarse for hay purposes. It resembles Algerian in the brown colour of the grain and purple tint of the straw, but the awn is much coarser. This is not a serious disadvantage, except for seed purposes; the grain needs to be thoroughly threshed to render it satisfactory for drilling. Lachlan ripens a little earlier than Algerian, but its young growth is erect and the leaves rather broad, while the foliage of Algerian is prostrate and narrow. Lachlan stands feeding off well and is just as susceptible to rust as Algerian, but being a few days earlier sometimes counts in its favour in a rusty year. It always *ripens a plumper sample than Algerian.*

Mulga is a selection from Sunrise oats, made at Cowra in 1915. The young growth is erect and sparse, and the leaves of medium breadth. It heads a few days before Sunrise; the straw is tall with a purple tint. Mulga stools rather less than Sunrise which gives a greater bulk of fodder. Mulga is a heavy grain yielder, the seed being creamy to pale brown, plump, with thin husk and somewhat stout awn.

Myall is a sister to Mulga which it much resembles, but it suits rather cooler districts where it yields slightly better than Mulga.

Reid is almost identical with White Tartarian, but has slightly denser *ears and matures a little earlier. It is a side oat, erect growing when young,* rather sparse stooling in most districts. The straw is yellow, rather coarse—unless late sown, when it is fine—rust-resistant and tall. The small grain is white and plump. A late variety only suited for cold districts where it is a heavy cropper.

Sunrise.—A sport discovered in Algerian oats. It is very early, sparse stooling, with tall, medium coarse straw, which shows only a trace of purple colour. The grain is greyish-white, of large size, has a thin husk, and is borne in a head resembling Algerian, but larger. The awn is rather stout, but comes off in threshing. Sunrise stands feeding-off well, and requires to be sown more thickly than Algerian, being a shy stooler.

White Tartarian.—This is a side-bearing variety worthy of special mention. It is supposed to be very bitter, and not so palatable as other *varieties, particularly if cut on the green side. It is late in maturing,* has a good length of straw, and a long, thin, white grain. This variety is particularly suited for late planting on the tablelands. Excellent crops of hay are obtained on the Northern Tablelands from sowings made as late as the end of August.

When to Sow.

This will depend upon a number of factors, the chief being the object of *the grower—whether for green feed, hay, or grain—the district, and the* season of the variety it is intended to sow. If Algerian is sown on the coast for green fodder it should be put in in February, as it covers the ground, growing slowly for some time before it is fit for feeding off or cutting. Earlier varieties, however, can be sown with good results in March or April, and be ready for the cows in July and August. On the tablelands and in most of the large wheat districts oats are sometimes sown after wheat seeding is finished. This is sound practice with an early maturing variety

White Tartarian.

Sunrise.

Mulga.

of oats, but if Algerian be employed the crop must be sown before the commencement of wheat sowing. Like wheat, the longer the growing season of the variety, the earlier it should be sown, and *vice versa*.

In the colder parts of the Northern Tablelands, particularly in Glen Innes and higher country, it has been found in recent years that, owing largely to the depredations of rabbits, it is advantageous to sow oats about August or early September. Sown then the crop comes along at a time when grass is becoming plentiful, and when it is not therefore so liable to the particular attentions of the rabbits. On account of being able to sow oats thus late, the farmer finds it a very suitable crop to follow maize, ample time being available to prepare the land after the maize is off. For such sowings *the variety must be selected with care. The most suitable* is White Tartarian. Algerian and similar sorts are liable to run to head too quickly.

In some districts the farmers sow any oats they intend growing as early as in the first and second week in March before the wheat planting commences. In individual localities the circumstances will be altered, but for the majority of districts in this State Algerian oats should be sown between the last week in March and the last week in April, for both hay and grain.

If sown before this, and the weather conditions are very favourable to growth, they may grow too rank, and are apt to lodge unless the growth is checked by feeding-off. Where sheep are of more importance to the grower than his grain crop, February sowing of Algerian oats for feeding off may be quite justified.

From a hay point of view, very early sowing has a tendency to induce a heavy growth of flag, which in wet seasons may turn brown and much detract from the quality of the resultant crop.

Selection of Seed.

As with all crops, the first of the essential points in the successful growing of oats is the selection of a good sample of seed. The grain chosen should be plump, and well cleaned and threshed so that it will run freely through *the drill* without clogging. *The threshing* is even more important than grading, for a dirty, half-threshed sample causes patchy and uneven sowing. Oats may be graded with a blower or winnower to separate the light and empty kernels. The latter can be used for feeding stock, and the heavy grains for seed, so as to ensure a uniform, vigorous stand. Where an area not very extensive is to be sown, a good way of preparing a sample of seed that is not too well threshed, *i.e.*, contains too much tail or oats not *separated, is as follows:—Put 1 bushel of seed in a bag at a time, choosing* hot weather or a warm day; tie the mouth and beat the bag a few seconds with a flail or heavy stick. When sufficient seed has been so treated, put it through a blower or winnower, and a good sample for sowing will result.

Cultivated oats are supposed by some to have originated from the wild oat (*Avena fatua*), and there are farmers who believe that they throw back of the original wild strain; this idea has arisen from the appearance of dark-*coloured grains in a sample having a hairy end or point. These are retro*gressive mutations which occur in cultivated oats, but are not derived from the wild oat, as breeding tests have proved. This fact, together with the extreme prevalence of the wild oat as a weed, has probably led to the notion. There are scores of instances where wheat paddocks are overrun with this pest, though oats have never at any time been sown in them. Farmers need

have no fear that by growing oats in their wheat paddocks they are likely to introduce black oats on to their farms, unless, of course, the seed contains seed of that pest. As a matter of fact, the cultivated oat is botanically quite a different plant from the wild or black oat.

Experiments have shown that change of seed is more beneficial with oats than in the case of wheat. It has also been noticed that seed taken from a cool district to a hot one has a tendency to become paler in the colour of the

A Good Crop of Lachlan Oats, Cowra Experiment Farm.

husk: brown oats raised in New England have a darker tint than the same variety raised in the western or Riverina districts. The thickness of the husk varies too with the climate.

In growing oats in the warmer districts it often pays to get the seed from cooler country, the resultant growth being then taller and more vigorous. For instance, a Trundle grower should, if possible, get seed from Bathurst, Orange, or even Cowra. There is an element of risk in changing seed, however, and unless a grower is sure of his source of supply it is safer to practise plant selection and to raise one's own seed on the farm. An alternative course would be to obtain small supplies of pure seed at regular intervals from one of the Government farms, and to keep the increase as seed for a larger area the following year.

Treatment of the Seed for Smut.

If the crop is sown for green feed, treatment of the seed is unnecessary: but if it be intended for hay or grain, the seed should always be treated or there will be a great risk of Smut appearing in the crop. Some farmers will argue that a little Smut in the hay is of no consequence, but smutty heads always detract from the appearance, reduce the value from a feeding point of view, and if the infection is serious, lower the prices obtained on the market. Cases have been reported where stock have actually refused to eat hay that has been badly smutted.

The same remarks apply to the grain. Large quantities of oats are purchased to feed racehorses and animals doing fast work, and trainers and agents authorised to buy will not touch grain that contains Smut in any quantity. Methods of prevention must be employed if a clean crop is to be harvested and top market prices obtained.

Seed treatment with copper carbonate is not completely effective in the control of oat Smut, apparently because some of the spores are protected by the enclosing husks of the oat grain. The formalin treatment is more effective and should be used, as described on page 387, whenever seed is obtained from a somewhat smutty crop.

Quantity of Seed per Acre.

This depends upon a number of circumstances, the chief among which are the method of sowing (whether broadcast or with the drill), the use to which the crop is to be put (whether for green feed, hay, or grain), the time of sowing, the district, and the habit of the variety (whether it is a scanty or profuse stooler).

On the coast, where oats are largely grown for green feed, and where the sowing is usually done broadcast, from 2 to 2½ bushels per acre should be sown. If sown too thickly, and heavy rain or showery, windy weather is experienced, the crop is liable to lodge, and as a result it may be partially or totally spoilt before it can be cut. A few farmers on the South Coast have seed drills, and where this method of sowing is adopted the amount of seed can be reduced to half that recommended for broadcasting. No matter what the crop may be intended for, drilling will always give the best results.

For hay on the tablelands, 1½ to 2 bushels per acre is ample when sowing is done with the drill. Like wheat, oats may be sown a little earlier for hay than for grain, but the season of the variety must not be overlooked. In the drier wheat districts, 1 to 1½ bushels per acre is sufficient for a hay crop, provided the variety being sown is not too coarse in the stem. Very coarse-stemmed varieties should always be sown thicker than varieties with comparatively fine stems such as Algerian, as the thicker the sowing the finer the stems will invariably be in the resultant hay. Where the rainfall is sufficient, thick seeding is preferable, especially for hay, as the finer stems make better quality hay and a better sample of chaff. This is a very important point, as there is always considerable waste in feeding hay with coarse stems or chaff that has been cut from coarse-stemmed varieties. Under certain climatic conditions, and with certain varieties, 3 bushels of seed per acre might not be an excessively heavy seeding for hay.

Oats for grain on the tablelands should be sown at the rate of 1 to 1½ bushels per acre, according to the time of sowing and the variety. In the drier districts, a bushel to the acre is ample for grain; from 30 to 60 lb. is about the best range for these districts.

Manuring.

Oats, like wheat, require manuring under most conditions, and respond bountifully to the application of superphosphate. On most soils, from 40 to 56 lb. per acre will be found sufficient, but on poorer lands the quantity can

be increased up to ¾ cwt. with beneficial results. They appear to respond much more to heavy manuring than wheat. When sown early in the season, ½ cwt. of superphosphate is ample, but as the sowing season advances, the

Algerian Oats on Farmers' Experiment Plots, Stewart's River.

Left.—Manured with 1½ cwt. superphosphate per acre. Yield: 11 tons 4 cwt. 1 qr. 6 lb. per acre.

Right.—Unmanured. Yield: 5 tons 10 cwt. 0 qr. 4 lb. per acre.

quantity can be slightly increased. In coastal districts, where there are practically no drills, and the manure (if used) has to be broadcasted, the quantity per acre should be increased to double that recommended for sowing with the drill. In some experiments conducted by the Department the addition of a little nitrogenous fertiliser in combination with superphosphate has resulted in slightly higher yields.

The Sowing Depth.

Oats take a little more moisture to germinate than wheat, and while 2 inches is a good depth in a moist seed-bed, the seed should be put down 3 inches in a dry seed-bed, provided the soil is moist at that depth. If the soil is dry to a depth of 3 or 4 inches it would be wiser to plant 2 inches deep and wait for rain. Although wild oats will come up from a depth of 4 to 5 inches, the plants are not so strong as if they had germinated nearer the surface.

Feeding-off.

Feeding-off oat crops is always a safe practice: it reduces the risk of lodging, lessens the damage from rust should the disease appear, and if done judiciously, will always pay the farmer who has stock. Sunrise and Mulga give a good plump sample of grain after feeding off in an average season.

In most years with early sowing, oats can be fed off three of four times till the end of August; the crop may then be stripped for grain or else eaten off with sheep till the ground is ploughed.

While a variety of feed, such as natural pasture, lucerne, and field peas, is always desirable, we cannot deny that oats are the most useful fodder for the man with a relatively small property. If sowing is started in March and continued till the end of April the sheep would be supplied with a green picking in May, provided an early variety, such as Sunrise or Mulga, is sown and the soil had sufficient moisture at the start.

The year's feed bill might be worked out as follows:—

December to April.—Grazing stubbles, supplemented with grain if necessary.

May to August.—The grazing of the green crop, subdivision fences being necessary for this to be done economically.

September, October, and November.—The paddocks shut up for hay and grain crops, the sheep having access to silage and grain to top off the lambs.

Grazing should be the main feature, crops being continuously fed off at intervals till the soil is ploughed. In this way the stock-carrying capacity of the farm could be very greatly increased. With some farmers who make sheep their main source of income, the rotation, wheat, oats, oats, fallow, is gaining favour; half the area is then under oats, quarter fallow and a quarter wheat each year.

Palatability trials with oat varieties seem to indicate that Mulga, Guyra, and Sunrise are most liked by sheep, but Algerian finds less favour. Symptoms of poisoning are reported in good seasons, particularly where sheep are put in to feed off crops, but this also occurs on natural pastures with very succulent herbage and grass. Care must be taken not to put hungry sheep on, and to watch for signs of sickness. At certain stages the growth is more dangerous to stock than others, but with judicious changes of paddock and feed the trouble can be fairly well controlled.

Harvesting Methods.

The mode of harvesting will partly depend on the season, but chiefly on the number of sheep kept by the farmer. If the number is negligible the crop will be cut for hay or stripped for grain and sold off the farm. This, of course, means a drain on the fertility of the soil which will have to be faced sooner or later, as wheat-growers have found to their cost. Where sheep are relied upon for about half the income and wheat for the other half, the crop will probably be grazed once and the oats eventually cut for hay and a portion stripped to provide seed.

If the grower is making sheep the main issue, the handling of the crop might well take the following form:—Graze off successive sowings; turn a proportion of the crop into pit silage, and strip a section for grain, leaving an area for hay sufficient to feed the working horses. In this way the crop is sacrificed for the benefit of the stock.

Oats for Hay.

For hay purposes, oats should be left till nearly ripe, and not cut on the green side as in the case of wheat. In fact, some farmers have had disappointments with oaten hay on this account, for when cut green it has a bitter flavour that is disliked by stock and that makes it unsaleable on the market. The best stage to cut oats for hay is when the upper tips of the heads turn white; at this stage the grain is fully formed, but only in the dough stage. The presence of grain in oaten chaff is absolutely essential for the Sydney market, and the chaff should be of a nice purplish-green colour. In selecting varieties for hay, those that ripen from the top should be selected.

There is always a good demand for oaten hay on the Sydney market, and if the sample is bright and clean, and has fine stems, not too long, and of a nice purplish-green colour, good prices are assured. It should be pressed in bales about 1½ cwt. in weight, but certainly not heavier than 2 cwt. The bulk of this commodity is utilised by horse-trainers for rack purposes, and from these men the best prices are obtained. They prefer hay that has been cut with the mower and cocked in the field, as it is usually more evenly made. Algerian is the variety in greatest favour. The hay, if cut with the binder, should have the bands taken off the sheaves, and should be shaken up before being put in the press. On no account should the hay be pressed with the butts showing all the one way at the ends of the bale. The bales should have three wire bands of No. 8 or No. 10 gauge. The hay should not be pressed with a derrick press.

Oaten Chaff.

Prime oaten chaff also sells well on the Sydney market. It should be about ⅜ of an inch in length, clean cut, of pleasant odour, free from mustiness, and of a nice, purplish-green colour. Like oaten hay, the bulk is used by horse-trainers or for horses doing fast work. Unlike wheaten chaff, oaten chaff is preferred with a fair quantity of grain. It should be put up in new bags, weighing from 85 to 112 lb. Algerian or a sample showing a purple tinge is preferred to "white oaten" on account of its generally being sweeter.

Harvesting for Grain.

In the cool, moist districts, where the binder is usually used for harvesting, the crop should be cut when the heads are well whitened, of a nice even colour, and the grain firm. It is very necessary to harvest before the chaff opens, as otherwise a considerable quantity will be lost through shedding. The harvester is not at all an ideal machine, but it is perhaps the best where sheep are kept and turned in when the crop is off. It is estimated that no more than 60 bushels per acre of grain can be harvested with the stripper or harvester, whereas by cutting and threshing, up to 80 bushels per acre can be bagged from a heavy crop.

No variety of oats can be relied upon to stand long when the grain is ripe. The crop soon begins to shatter, and bushels or even bags to the acre are lost if stripping is delayed in windy weather. Oats may be stripped a little greener than wheat; the dry grains will take up the moisture of the immature ones. The main stalks should have their grain ripe when the crop is stripped; lower heads may be a trifle green, but there is no need to wait for them to ripen. If it is the intention to strip a considerable area of oats, it is wise to grow an early and a mid-season sort, and to make two or three sowings, so that the losses at harvest time may be minimised.

Storing Oats on the Farm.

Oats are cheap early in the year, but advance considerably in price towards the end of the year. Whether the grower subsequently markets the grain, or uses it for feeding stock at a time when grass is scarce, the cost of storage will be easily recouped. Rats and mice always have to be reckoned with, and the farmer might well ask himself whether it would not be more profitable to make fewer oat stacks, and erect a grain bin or two instead. On a ration of straw and oat grain, both horses and sheep do well, and straw stacks are not so likely to be fouled by vermin as hay stacks. New South Wales does not produce nearly all the oats consumed, and consequently there should be a safe market if the grain can be stored until prices are satisfactory.

Galvanised-iron silos are becoming very popular for the storage of oats, and are giving great satisfaction. These are best erected on a wooden platform or decking, 3 feet off the ground. Sawn timber makes for easy construction, but if it can be had only at great expense, there is no reason why round timber should not be used as long as the silo is given a good flat surface on which to stand; this may be provided by roughly adzing the round timber and afterwards laying a bed of pug or clay. It is important to have sufficient support in the centre because the greatest weight occurs there, and any great settlement will break the soldered floor joints.

Posts make for easy construction and are very necessary supports to large tanks, particularly when they are of 24-gauge corrugated iron. There is a limit to the dimensions of a tank in which 24-gauge iron can be safely used without supports. If fixed to round posts, 24-gauge iron will be quite strong enough for all capacities up to 12 feet in diameter or, say, 1,500 bushels.

The following table gives the quantities of curved and plain iron required for silos of various dimensions, together with their capacities in bushels:—

Diameter.	Height.	Bushels.	Materials required.	Sydney Prices.
ft. in.	ft.			£ s. d.
7 0	8	240	16/6, 24-gauge cor. iron, each curved to ¼ circle; three sheets 72″ x 36″ x 24-gauge plain iron (bottom); 3 sheets 72″ x 36″ x 26-gauge plain iron (top).	5 6 0
8 3	8	334	16/7, 24-g. cor. iron, each curved to ¼ circle; 5 sheets 72″ x 36″ x 24-g. plain iron (bottom); 5 sheets 72″ x 36″ x 26-g. plain iron (top).	6 15 4
8 3	10	417	20/7, 24-g. cor. iron, each curved to ¼ circle; 5 sheets 72″ x 36″ x 24-g. plain iron (bottom); 5 sheets 72″ x 36″ x 26-g. plain iron (top).	7 17 6
9 9	8	466	16/8, 24-g. cor. iron, each curved to ¼ circle; 7 sheets 72″ x 36″ x 24-g. plain iron (bottom); 7 sheets 72″ x 36″ x 26-g. plain iron (top).	8 6 8
9 0	10	583	20/8, 24-g. cor. iron, each curved to ¼ circle; 7 sheets 72″ x 36″ x 24-g. plain iron (bottom); 7 sheets 72″ x 36″ x 26-g. plain iron (top).	9 12 0

Diameter.	Height.	Bushels.	Materials required.	Sydney Prices.
ft. in.				£ s. d.
9 9	12	700	24/8, 24-g. cor. iron, each curved to ¼ circle: 7 sheets 72" x 36" x 24-g. plain iron (bottom): 7 sheets 72" x 36" x 26-g. plain iron (top).	10 17 4
11 0	10	742	20/9, 24-g. cor. iron, each curved to ¼ circle: 8 sheets 72" x 36" x 24-g. plain iron (bottom): 8 sheets 72" x 36" x 26-g. plain iron (top).	10 18 0
11 0	12	890	24/9, 24-g. cor. iron, each curved to ¼ circle: 8 sheets 72" x 36" x 24-g. plain iron (bottom): 8 sheets 72" x 36" x 26-g. plain iron (top).	12 6 8
12 3	10	920	20/10, 24-g. cor. iron, each curved to ¼ circle: 10 sheets 72" x 36" x 24-g. plain iron (bottom): 10 sheets 72" x 36" x 26-g. plain iron (top).	12 11 8
12 3	12	1,104	24/10, 24-g. cor. iron, each curved to ¼ circle: 10 sheets 72" x 36" x 24-g. plain iron (bottom): 10 sheets 72" x 36" x 26-g. plain iron (top).	14 3 4
13 6	10	1,118	20/11, 24-g. cor. iron, each curved to ¼ circle: 13 sheets 72" x 36" x 24-g. plain iron (bottom): 13 sheets 72" x 36" x 26-g. plain iron (top).	14 13 0
13 6	12	1,342	24/11, 24-g. cor. iron, each curved to ¼ circle: 13 sheets 72" x 36" x 24-g. plain iron (bottom): 13 sheets 72" x 36" x 26-g. plain iron (top).	16 7 4
14 9	12	1,602	24/12, 24-g. cor. iron, each curved to ¼ circle: 15 sheets 72" x 36" x 24-g. plain iron (bottom): 15 sheets 72" x 36" x 26-g. plain iron (top).	17 18 0

NOTE.—Small quantities of No. 9 tinman's rivets and soft solder (equal parts lead and tin) are required for the bottom and top of the silo; also 1¼-inch galvanised screws and steel washers for fixing curved iron to posts. In addition, a lid to manhole and two grain spouts are required.

This table of capacities is for silos of diameters that call for four sheets of curved iron to each ring, so that in ordering the material for them it is only necessary to order the required number of sheets of corrugated iron curved to a quarter circle. Thus, for a silo which is 12 feet 3 inches in diameter and 12 feet high, there being four sheets to a ring and each ring measuring approximately 2 feet, the number of curved sheets required will be twenty-four. The order will then be for twenty-four sheets of 24-gauge corrugated galvanised iron, each 10 feet long, and curved to a quarter circle. Most country plumbers who make tanks have a machine for curving iron, and the charge made for curving will be something like 9d. or 1s. per sheet. For the bottom, 24-gauge plain iron is needed, and for the top, 26-gauge.

The making of corrugated galvanised-iron water tanks is described in detail in the "Handy Man on the Farm" section of this Handbook, and the methods there described for putting the sheets of iron together are applicable to the erection of a grain silo. The curved iron is fixed to the wood posts with 1¼-inch galvanised screws in the same manner as roofing iron, except that steel washers may be used in lieu of the lead washers ordinarily used for roof work. It is not necessary to rivet and solder the joints and laps in the curved iron as is done for water tanks. A good grain storage silo may be made by inserting felt packing in the laps and screwing up tight with ½-inch galvanised roofing bolts.

Felt for the laps is put up in rolls 2 feet 6 inches wide. Each roll contains 25 yards and costs 35s. There is considerably more in a roll than is required for the average silo. It will, therefore, be necessary to determine just what quantity is required. For the horizontal and vertical laps strips 3 inches wide are required.

The bottom and top of the silo should be soldered. As it is necessary that the top keep out moisture it should be pulled up from the centre until it has sufficient fall to throw off the rain. By projecting cross pieces a platform can easily be erected on which bagged grain may be placed by means of a pulley, and emptied through the manhole into the silo. This manhole should have a raised flange about 3 inches high, over which a flanged lid can be fitted, similar to the lid of a garbage tin.

Two sliding doors—those taken from the grain box of an old harvester are excellent for the purpose—should be provided in each silo, one on each side, so that it can be almost completely emptied before it is necessary to get inside and shovel the oats to the door. The doors should be fitted with bag hooks, and being 3 feet above ground, emptying is an easy operation.

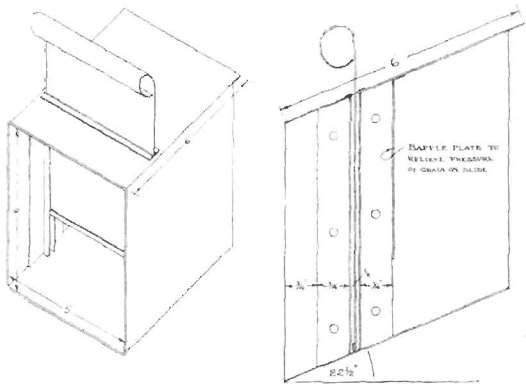
Two spouts of the type illustrated on page 384 may also be fitted.

The approximate cost at current prices of the complete materials for a silo 12 feet 3 inches in diameter by 12 feet high, which has a capacity of 1,104 bushels or 368 bags, is as follows:—

	£	s.	d.
Round posts (6-inch diameter at small end)—six 19 feet long and two 23 feet long, at 9d. per foot	6	0	0
Stumps (10-inch diameter)—eleven, 9 feet long, at 9d. per foot	2	1	3
7-in. x 3-in. H.W. bearers—150 sup. feet; 5-in. x 2-in. H.W. top bearers—25 sup. feet; 4-in. x 2-in. H.W. decking—200 sup. feet; 4-in. x 2-in. H.W. top plates—30 sup. feet; 4-in. x 2-in. H.W. scaffold rails, &c., 23 sup. feet. (428 sup. feet H.W., at 33s. per 100.)	7	1	3
Bolts and nuts—say	0	5	0
Curved and plain iron	14	3	4
Felt—say 15 yards at 1s. 6d. per yard	1	2	6
Galvanised screws—say 2 lb. at 1s. per lb.	0	2	0
Steel washers—2 lb. at 5½d. per lb.	0	0	11
No. 9 Tinman's rivets—1 packet	0	1	3
½-inch galvanised roof bolts—1 gross	0	3	4
Solder (50/50)—say 3 lb. at 1s. 7d. per lb.	0	4	9
Spirits of salts	0	3	6
Spouts—two at 10s. each	1	0	0
Lid	0	7	6
Total cost of materials	£32	16	7

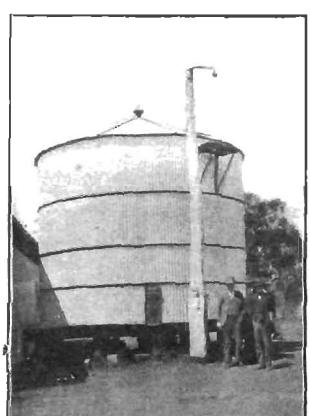
Add for freight and labour.

A number of firms contract for the erection of galvanised-iron silos of large capacity, a bin of 1,100 bags capacity costing about £100. Silos of this type usually have a conical roof, and are stayed with angle iron. An



A Useful Type of Spout for Grain Silos.

On the left—An Isometric Sketch. On the right—A Section.



A Suitable Type of Oat Grain Silo.

It has a capacity of 1,100 bags of oats, and cost £100 to erect

elevator is sometimes used to lift the grain into them. Even erected by this method oat silos are a good proposition financially. Taking the cost as £140 (£100 for the silo and £40 for the elevator) 7 per cent. would represent an interest charge of £9 16s. for, say, 3,300 bushels, which is less than 1d. per bushel per year for storage, to which might be added another 1d. *per bushel for depreciation of the silo over a period of, say, ten years.*

The possibility of weevil infestation should be taken into consideration. In order that weevils may increase and multiply in stored oats the presence of a certain degree of moisture (about 10 per cent.) is essential. Under ordinary conditions at harvest time there are no weevils in the grain, nor does the grain contain nearly sufficient moisture for their development, and unless moisture actually gains access from without the grain remains weevil-proof. Care should therefore be taken to protect the grain from infection by the weevil and from becoming moist, and there is no better way of achieving this than by making the tanks quite air-tight.

Sometimes it may be difficult to carry out these precautions effectively, and if even a very small number of weevils gain access to the stored grain they are capable, if conditions of moisture and temperature are favourable, of multiplying very rapidly. In the event of infestation the weevils can be killed by fumigating with carbon bisulphide, as described in connection with maize on page 440.

Diseases of Oats.

Oat Smuts (*Ustilago* spp.).

Two distinct types of oat smut occur in New South Wales—(*a*) Loose or Open Smut, *caused by the parasitic fungus Ustilago avenae*, and (*b*) Covered Smut, caused by the fungus *Ustilago levis*. It has been shown that there are distinct strains of each of these parasitic fungi, but both types of disease may be controlled by the same method of seed treatment; hence for all practical purposes the oat smuts may be considered as belonging to one group.

Loose Smut is the most common form of the disease under local conditions. The smut destroys the oat grain and the enclosing glumes or chaff and reduces them to a mass of black sooty powder. The black sooty particles are the spores of the fungus and they serve to carry the disease over from season to season. The heads or panicles are reduced in size and are somewhat erect in contrast to normal healthy panicles. The smut may also sometimes develop in the uppermost leaf of affected plants. Later in the season the spores are blown away by the wind, leaving only bare stalks on the panicle. (Fig. 1.)

Covered Smut differs from Loose Smut mainly in that it does not cause such extensive destruction of the glumes or chaff. The glumes are only partially destroyed, and the spore masses of this fungus are not so readily broken up and scattered by the wind. (Fig. 2.)

The life histories of the oat smuts are in many respects similar to that of Bunt or Ball Smut in wheat.

The smut spores, on being dislodged by the wind or by harvesting operations, may be carried on to healthy grains and become lodged in the crevices of the grain, or may merely rest on the surface of the grain. In some cases the spores may germinate and produce a resting mycelium or fungus thread

inside the enclosing glume of the oat grain. Generally, however, development of the spore is delayed until the grain is sown, and by germinating simultaneously with oat grain, the fungus is able to penetrate the first shoot of the oat plant and thus become established in the plant. These

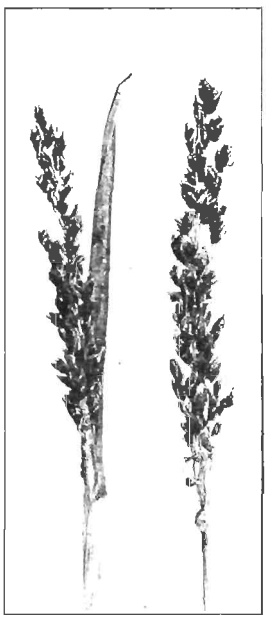


Fig. 1.—Loose Smut of Oats.

Fig. 2.—Covered Smut of Oats.

infected plants show no signs of disease until heading time, when the fungus reproduces itself at the expense of the developing grain in the manner described above.

Control Measures.

If oats are sown early in a dry seed-bed, there may be sufficient moisture to germinate the oat smut spores before the oat grains germinate. The oat smut fungus may then be destroyed before germination of the grain and a clean crop may result. If oats are grown merely for feeding off there is no necessity to treat the seed, since grain is not allowed to be produced. But if the seed has been obtained from a diseased crop and if there is any possibility that hay or grain will be required, the seed should be treated before sowing.

With the exception of the Skinless type, the oat varieties under cultivation produce grain which is enclosed in hulls or chaff. Most of our commercial varieties belong to the latter group. The structure of the grain does not permit satisfactory penetration by fungicidal dusts at present in use, hence treatment with copper carbonate dust is not as effective as it is in the control of Bunt in wheat. It is preferable, however, to treat with copper carbonate dust if the alternative is to be no treatment.

Oat smuts can be most effectively controlled by the use of formalin, but unless precautions are taken some seed injury may result. The procedure is *as follows*:—

Place the grain on a tarpaulin or on a clean floor, and while shovelling sprinkle with formalin (1 lb. formalin to 40 gallons water) until the grain is uniformly but not excessively moistened.

A little less than a gallon of solution will be required per bushel of seed. The grain should then be covered for four to five hours with wet bags or canvas to retain the gas. If the right amount of solution has been added, the grain will absorb the moisture and, though swollen, should run freely through the drill.

The grain should be bagged in clean bags to prevent re-infection, and sown as soon as possible after treatment.

The grain may also be dipped in formalin solution and covered with bags as described above, but in this case it is difficult to dry the grain sufficiently prior to planting.

Treatment with copper carbonate dust at the rate of 2 to 3 oz. per bushel is satisfactory only when seed has been obtained from lightly diseased crops.

Rusts (*Puccinia* spp.).

Rusts are exceedingly common in oats, but systematic cross-breeding and selection has resulted in the production of certain varieties which are "rust escaping." The varieties recommended by the Department for particular districts should be adopted. Superphosphate, which gives the plants a good start and hastens maturity, will thus sometimes help a variety to escape serious damage following rust infection. Fallowing may help in dry districts by giving the crop a good start and thus enabling it to mature early. It also assists in destroying self-sown wheats which carry over the rust. On irrigation areas water should not be applied to the growing crop. In moist climates, as in the coastal areas, drainage may help since rust is generally worst in moist hollows.

For details of the causal fungi see "Stem and Leaf Rusts of Cereals" on page 341.

Other Diseases.

Downy Mildew (*Sclerospora macrospora*).—This disease may develop on oats which have been growing in wet situations. Abnormalities are produced in the appearance of the panicle. See article on "Downy Mildew of Wheat," page 354.

Mildew (*Erysiphe graminis*).—A biologic form of this fungus sometimes attacks oats in moist seasons. See article under the heading of "Wheat Mildew" on page 345.

Take-all (*Ophiobolus graminis*) is rare in oats under New South Wales conditions. For practical purposes oats may be considered immune.

Foot Rot (*Helminthosporium*).—A condition resembling the Foot Rot of wheat has been met with in oats in this State. The Foot Rot disease of wheat, however, is not considered as a disease affecting oats.

BARLEY.

The total area sown to barley in New South Wales in the season 1927-1928 was 11,038 acres, of which 2,642 acres were for malting, 2,958 acres for grain (feed), 615 acres for hay, and 4,823 acres for green feed; the yields of grain and hay were 65,850 bushels, and 666 tons respectively.

In America barley is extensively grown for stock food as well as brewing, and until pig raising is a very big industry in New South Wales there is not likely to be great scope for the production of this crop. Moreover, although barley is the ideal ration for baconers, very satisfactory results are obtained with lucerne, topping up with wheat grain. In this country wheat is universally grown, and is likely to be the chief source of wealth (with wool) for some time to come. The screenings and by-products of wheat can most economically be fed to pigs, poultry, and dairy cattle, so that in most parts of the State there is not the same place for barley as a crop that we find obtaining in the closely-settled districts of older countries. As farming becomes more diversified, with increased population and smaller holdings, more barley is likely to be grown, as it is pre-eminently the crop for a relatively small mixed farm, responding well to intensive cultivation.

Uses of Barley.

Although most of the grain produced is utilised for malting purposes, the object of these notes is mainly to draw attention to the feeding value of the crop. In 1927-28 the amount of grain produced for feed was 33,900 bus. If a sample is not good enough for the brewery it may be used for feeding to stock. As a grain food barley is coming more into favour in Victoria, mainly in the western districts and in the north-east. Professor Henry, of America, says that "barley lies between oats and maize in protein and carbohydrates, and has less oil than either. On the Pacific Coast of the United States of America it is much used for horse feed, because maize and oats do not grow so well there. . . . If ground it forms a pasty mass in the mouth: it is better to crush the grain between iron rollers." At the Wagga Experiment Farm working horses have been fed either wheat or barley at the rate of 4 lb. per day with good results. The grain is scalded or boiled, and for horses not at work barley straw is preferred to wheaten. Professor Perkins, of South Australia, says that "taking yield into consideration, barley is one of the cheapest concentrated foodstuffs that we can grow, and if not satisfied with local prices it can always be converted into pork or mutton at a profit, or fed to horses instead of oats." In Asia, North Africa, and Southern Europe horses are fed on barley grain and straw: the climate is too warm for oats.

Barley is useful as green fodder, both on wheat and sheep farms, and also in the coastal districts for dairy stock. It is the earliest straw crop for green feed the farmer can grow, and a succession of feed can be maintained. Barley as human food is limited to a preparation known as pearl barley. As poultry food it is valuable, and all pig-raisers attest to its high qualities as a producer of pork and bacon of the best grade.

Classification.

The barleys in cultivation may be classified in the following way:—

Two-row barleys.			Six-row barleys
Erect-eared as Standwell.	Drooping Ear or Chevalier as Kinver	Cape.	Skinless or Naked.

The two-rowed barleys are so called because they have a row of grains on either side of the mid-rib of the ear, while what we call the six-row type has six rows of grains to the ear. These rows are not all level to the eye if an ear is broken across (as in the true six-row type which is not commercially grown), but six-row barley is a convenient term for the group.

Skinless barley, though included, is a very distinct type; there are no beards to the ear, the grain is enveloped in thin chaff, and is easily threshed, the absence of husk giving it the appearance of wheat. In the bearded barleys the six-row type can be identified by the presence of two smaller twisted grains for each large straight one, while in the two-row type there are no twisted grains. The seed of the latter is usually fuller and more rounded, with less husk than that of six-row barley.

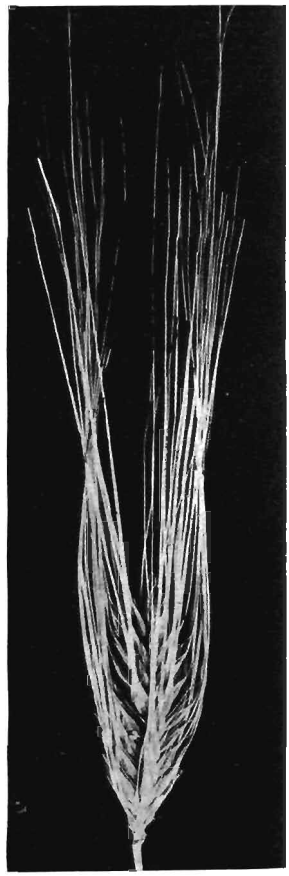
Climate.

A district with a comparatively good rainfall and a cool climate is well adapted for two-row barley. The western and southern wheat districts produce good samples, as do also the northern districts, except where a good deal of summer rainfall is registered. In the warmer districts where the grain ripens quickly, it is not possible to grow a good sample of this class of barley, and the six-row varieties will be found more profitable. Of course, the latter will not command quite such a high price as two-row barley, but the increased yield more than compensates for a lower price per bushel. Skinless barleys are drought-resistant and well adapted for grain production in dry districts, as well as for silage, the earliness of the crop enabling the grower to fill the silos before haymaking begins. They are also much used for green fodder on the coast, where there is a good demand for the seed. In districts of good rainfall this barley grows weak straw that lodges badly if the crop is left to ripen grain.

Soil.

For barley the soil should be only moderately rich: the best grain is obtained after a crop of wheat or oats, given a sufficient period of fallow between. The most important consideration is the condition of the soil, although any wheat soil will grow good barley; it should be so worked that it is in a mellow and friable condition when the crop is sown. It is an early ripening cereal, and the root growth is shorter and less abundant than that

Cape.



Trabut.

of oats and wheat, so that it is necessary to sow it on land that is in a high state of cultivation. Too rich a soil will cause the crop to lodge; while low-lying, undrained land is unsuitable, as barley cannot withstand a great amount of moisture in its young stages.

Rotation.

Barley should follow a straw crop, such as wheat or oats, though on light or poor land it would be better to come after a green crop or a good fallow. A good plan is to sow barley after wheat which has been cut for hay. If the hay stubble is ploughed as soon as possible there is time for a few months fallow before sowing barley in May. Another most important consideration is that by this method there is no risk of self-sown wheat in the barley, and if a hay crop of wheat is sown after barley, the farmer will be able to keep his land free from self-sown barley. Sheep turned onto the stubble will usually pick up any fallen grain. Millers strongly object to barley mixed with wheat, and such a sample is not satisfactory for seed.

In many districts where wheat-growing and sheep-raising are combined barley will be found an excellent substitute as a crop for grazing, either alone or sown with field peas, in February or March.

Varieties Recommended.

The varieties recommended by the Department are:—

Two-row type (commonly called "malting barleys").—Pryor.

Six-row type (commonly called "feed barleys").—Skinless for early winter green feed. Cape and Trabut for green fodder, and grain for stock in the cooler districts.

The following are brief notes on these varieties:—

Trabut.—A rather short, compact-eared awned barley of the Cape type, with attractive yellow grain. About the same season as Cape.

Cape.—A very largely-grown six-row type variety, ripening early, and with long awns and grains of a bluish-green tint. Though usually regarded as a feed barley, bright samples are suitable for malting purposes.

Skinless.—Awnless, very early; grain very distinct in appearance, as the hull comes off in threshing.

Pryor.—This variety matures about the same time as Cape, and may be sown at the same time. It is a good variety for the wheat districts, as it may be harvested before wheat-stripping starts. The ear is long and drooping with full awns and two rows of grain. It stools heavily with slender straw of medium height, and yields a plump, bright, yellowish-white grain.

Skinless.

Pryor.

Time and Rate of Sowing.

May is the best month to sow in the warmer districts for grain; April in the cooler parts of the State. The crop should ripen before the hot weather sets in, and if sown much earlier or later than the months indicated the grain is liable to be more or less shrivelled. Very early sowings induce heavy stooling, and the plants are unable to fill the unduly large number of heads. The quantity of seed usually drilled is about 50 lb. per acre, and 2 bushels if sown broadcast for green fodder, as is general on the coast. If sown too thickly the crop is very apt to lodge, and as barley stools freely there is no advantage in heavy sowings.

Manuring.

The requirements of barley are much the same in this respect as those of wheat, a similar amount of superphosphate being used and, if necessary, a little potash fertiliser. Large applications of fertiliser are only necessary on very poor land, but it should be borne in mind that barley is a short-lived plant; its roots grow rapidly and they are ill-adapted to surmount obstacles such as are presented by a compact soil, or to utilise fertilising matters which are not ready and waiting to be assimilated.

Harrowing and Feeding-off.

Harrowing the crop is not often necessary, as it is with wheat, though circumstances may arise in which rolling followed by harrowing will be beneficial, or a stroke of the harrow alone. Barley being a surface feeder, weeds stand but little chance.

Where the crop is grown for grain it is not advisable to feed off unless the winter has been mild and the growth too rank; in such a case it should be thoroughly fed down with sheep. There is no crop that responds better after being fed-off with sheep than barley, provided the land is not tramped out of condition; but it is not wise to put stock on to the crop if cold, frosty weather has set in.

Harvesting.

This should be done with the reaper and binder, if possible, though with care a satisfactory sample can be made with the header. By the use of the binder the grain is mellowed and improved by standing in the stocks, and the risk of loss from winds by harvesting when the grain is dead ripe, as is necessary for the header, is avoided. The best time to cut is when the grain is in the dough stage.

Stooking and Stacking.

Barley should be stooked the same day as it is cut to prevent discolouration of the grain, and it must be dry before stacking. This is more important than in the case of oats and even wheat; if barley becomes heated in the stack the colour and vitality of the grain will be affected.

On account of the soft absorbent nature of its straw, a barley stack requires to be well protected.

Threshing.

When threshing barley for malting the machine must be set so that the grain is not clipped and closely dressed—a little "tail" or beard left on the seed is not objected to. If the harvester is used the combs should be more open than is necessary with wheat, and it is an advantage to remove the concaves. All machinery agents will supply full information in regard to harvesting, as they recognise that their machines require a little adjustment before going from wheat into barley. A new threshing machine will break the grain more than one that has been in use for a while. On the other hand, if a machine is much worn the grain will be threshed more closely at the ends than at the centre of the drum, and new parts must be put in to even up the threshing. The sheaves must be fed very regularly and steadily, avoiding rushing the crop through. Proper care should be taken in adjusting the machine. Six-row barley will need different setting of the machine to two-row barley.

A combined harvester is very often used instead of a thresher and will satisfactorily deal with barley. Instructions for each make will vary slightly, but as a rule barley requires more sieve-room and a wider aperture in the comb than wheat. Barley-straw hangs together more than wheat-straw, and more cavings result from the threshing, but by watching the sample of grain as it comes through, any necessary adjustments can be made. The less straw taken into the machine the lighter is the work for both machine and horses. For a brittle, dry crop a little more space should be allowed under the beaters than when the crop is not quite so fully ripened. A reaper-thresher makes a rather better sample than a stripper as a rule, and there is no pulling up of the roots and waste of grain.

The main consideration in a sample for the brewer is that the grain should be evenly ripened, plump, bright in colour, mealy rather than flinty when broken, and free from cracked and damaged kernels, which cause faulty germination and moulds in the process of malting.

Improvement of the Crop.

A prime sample of barley is high in starch and low in nitrogen, so that it is not a difficult matter to increase the yield of this crop since proteids, which are expensive to produce, do not enter largely into its composition. A start should be made just before harvesting the crop in selecting a number of vigorous, healthy plants. The seed of these should be bagged, and sown again next season in a small plot, as described in methods of wheat improvement. This plan will result in increased yields, as well as smut-free crops: a stock of high-class seed can soon be raised in this way, and the grower will be well repaid for his trouble.

Some artificial crossing with barleys has been done by the Department, but nothing of any particular value has been secured as yet. A beardless barley with fairly strong straw would be valuable for fodder.

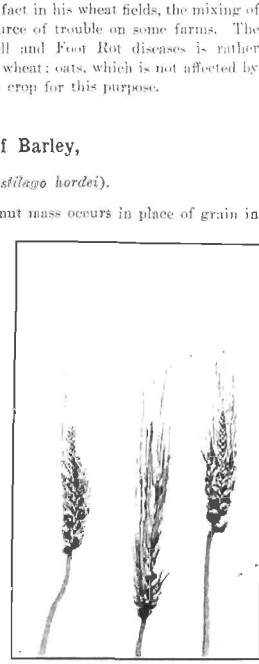
Disadvantages.

There are certain drawbacks to barley-growing, the chief of which is the fluctuation in price. When there is a good season and a full supply the merchants cut down the price, which is not regulated as in the case of wheat, by the world's market, but has a purely local value. Damage by unfavourable harvesting weather occurs in some seasons, causing a big drop *in prices*: rain *at harvest time* discolours the grain, and is more apt to cause lodging of the crop than in the case of wheat. The harvesting of barley demands more care and attention than need be given to wheat; cracked or chipped grains are very objectionable. Although the farmer who grows barley is not compelled to advertise the fact in his wheat fields, the mixing of wheat with barley grain is found a source of trouble on some farms. The fact that barley is subject to Take-all and Foot Rot diseases is rather against its inclusion in a rotation with wheat; oats, which is not affected by these diseases, is a much more suitable crop for this purpose.

Diseases of Barley,

Covered Smut (*Ustilago hordei*).

This smut is so called because the smut mass occurs in place of grain in the heads of barley, but remains covered by a membrane somewhat resembling that found in Bunt of wheat. The disease is spread by the breaking of the smut balls and the spread of the spores to healthy seeds. Smutted heads may be threshed with clean ones and in this way the clean seed becomes infected, the spores adhering to the outside of the seed and resulting in infection of the barley seedling. Soil infection may also occur occasionally.



Barley Heads attacked by Covered Smut.
After McAlpine.

The copper carbonate dust treatment as described for wheat (page 334) will be effective for Skinless barley.

Other barleys should be treated by thoroughly sprinkling a heap of the seed with formalin solution (1 pint to 40 gallons of water) and covering the wet heap with a bag for four to six hours to allow the vapour of the formalin to penetrate the mass. Sowing should then be carried out soon

after treatment in a moist, well-prepared seed-bed. Where formalin is used, seed should be obtained from clean crops where practicable, and sowing should not be made in land infected by the smut.

Barley should be grown in a rotation with other crops.

Loose or Flying Smut (*Ustilago nuda*).

This smut can be readily distinguished from the Covered Smut by the appearance of the heads. The smut heads are ruptured fairly early and the spores are blown by the wind on to the flowers of healthy plants. There they infect the seed and the embryo within it. Such seed when sown produces smutted plants.

Heads of Barley showing effects of Loose Smut. (After McAlpine.

Fungicide treatments of the seed are unsatisfactory. The most practicable method of avoiding the smut is to select seed from crops that are disease free. This can be most effectively accomplished by growing a seed plot for the production of smut-free seed for the main crop. If seed treatment is to be used the hot water treatment described under Loose Smut of Wheat (page 338) will be found effective. The temperature used should be 52 deg. Cent. (126.6 deg. Fah.) and the time of immersion fifteen minutes. It is to be noted that the temperature is slightly lower and the time of immersion longer than for wheat.

Other Diseases.

Foot Rot, Take-all, Black Stem Rust, Ergot, Powdery Mildew and Downy Mildew, which are discussed as diseases of wheat, are also diseases of barley.

RYE.

Rye (*Secale cereale*) is grown to a very limited extent in Australia, mainly because oats are being grown successfully for grain on land formerly considered only suitable for rye. Rye is grown for grain, hay, and green feed, but where wheat and oats grow well it is unwise and wasteful to grow rye.

The following table shows the acreage under rye and the yields obtained in New South Wales during the years 1924 to 1928:—

Year	Grain.		Hay.		Green feed.	Total Area.
	Area.	Production.	Area.	Production.		
	acres.	bushels.	acres	tons.	acres.	acres.
1924	1,089	23,160	628	721	643	2,360
1925	2,373	30,540	238	351	627	3,238
1926	1,617	26,710	343	325	1,501	3,461
1927	862	15,070	255	370	657	1,774
1928	1,611	27,630	278	402	1,200	3,089

The Uses of Rye.

Grain.—In other countries rye grain is principally used in the making of bread and alcoholic beverages. In Australia it is used to a limited extent for feeding live stock; it is usually ground and fed in combination with other grains to horses and pigs.

Green Manure and Forage.—Rye is chiefly valuable in New South Wales (*a*) for the production of early winter feed on very poor country, and (*b*) as a green manure crop on very poor soils, on account of its hardiness and ability to grow on those soils most in need of assistance. The adaptability of rye to poor sandy soils has been shown by its growth at Hawkesbury Agricultural College, where it has been cultivated as a green manure crop on the sandy parts of the orchard, and has given better results than any other crop. Rye used for pasture and soiling is especially valuable for later winter and early spring feed. Owing to its hardiness it grows during the cold period of the year. Planted early, it may be pastured some time in early winter and again for a few weeks in spring.

While rye will yield the largest amount of green feed if cut when the ear is just peeping through the sheath, it yields a fair amount of palatable fodder if cut early, and experience shows it is relished by stock when it is young. The value of rye as green feed is greatly enhanced if vetches or field peas are grown with it.

Hay.—Rye makes poor hay for feed purposes, as the straw is too hard and more or less solid. Rye straw is used for stuffing horse collars and for bedding.

Soil and Climate.

Rye is adapted to wide climatic ranges, and will do better at high altitudes and in exposed situations than any other cereal. On account of being a fairly deep rooter it is also drought resistant. It responds well to good soils, cultivation, and manuring, but is especially suited to light sandy loams.

It is sometimes called "the grain of poverty," because it can be grown on soils too poor, or where the climate is too severe, to grow the other cereal crops successfully. If the farmer has a very poor patch of pasture from which he desires to obtain an improved quality of feed, and if it is not considered suitable for oats or wheat, it is a good plan to plant it to rye. Good feed is obtainable from this crop in the early stages of its growth.

Preparation of the Land, Sowing, &c.

The preparation of the land for rye should be as thorough as for other cereals for the best results, but even on badly or roughly prepared land good crops can be obtained. Rye should be sown in autumn, earlier or later according to when the feed is required; it is a quick grower, and matures early. One to two bushels of seed are required per acre. Where conditions are favourable and long coarse straw is desired, the smaller quantity is used, but under less favourable conditions and where the crop is intended for green feed or green manure the larger quantity is advisable. A good mixture for green feed is one composed of 1 bushel of rye and ½ bushel of field peas per acre. Superphosphate may be drilled in with the seed at the rate of ½ to 1 cwt. per acre.

Harvesting.

For grain the crop should be allowed to become quite ripe in the paddock before harvesting. For straw for the padding of horse collars, the crop is cut while still green, stooked, and when dry, stacked. This leaves the straw tough and with a good colour. There is a small local demand for rye straw for collar-making.

Varieties.

Varieties that can be recommended are:—Black Winter (for early winter feed and grain); Emerald (for late fodder); and White (for collar-making), though the area devoted to the last two in this State is very small. Slav is a new and rather promising variety, but so far the Department has no seed for distribution.

Diseases of Rye.

Rye is fairly free from diseases and insect pests. The most harmful fungous disease is Ergot (*Clariceps purpurea*), the plants being attacked by this disease while in bloom. The early form of the disease is not very perceptible, but affected heads may be picked out by the fact that they are covered with a sticky secretion which attracts insects. These insects may then carry the spores of the fungus to other plants. Later in the season, a second form of the fungus develops. This second stage is known as an ergot, and is readily recognised as a black, hornlike growth which replaces the grain and extends beyond the glumes or chaff of the ear. (See also Ergot on wheat, page 356.) The decrease in yield of grain, however, is slight. Ergot, though used medicinally in small quantities, contains a principle that in larger quantities is poisonous to man and animals; it is said to cause abortion in stock. To protect rye from Ergot the best plan is to cut before the ears show up.

MAIZE.

Since both the grain and the green stuff produced are among the most valuable fodders for livestock, and because it is easy to grow on good land, maize has long been recognised as a crop of the greatest importance in countries suited to its production. In New South Wales, however, the area devoted to the crop is considerably less than would be expected from the acreage of soil suitable for its cultivation, the average annual production amounting to about 4,000,000 bushels.

The high value of maize grain as feed for sheep in times of partial shortage or drought is being increasingly recognised, together with its convenience of feeding, ease of handling, and its capacity for safe storage for long periods, giving an insurance against lean times at a low rate of premium. Its value as feed for pigs, for poultry, and for maintaining stamina and warmth (particularly in cold weather) in horses doing heavy work, has long been known, but as a concentrate for dairy cattle it is not sufficiently appreciated. Too little maize is used for livestock feeding, and its greater utilisation for this purpose will be found highly profitable—a fact well known to those stockowners who have already adopted maize feeding.

As green fodder there is no better crop for stimulating milk production, and maize makes the best possible silage. In some districts, particularly those with cold, dry winters, the crop is utilised as stover to provide both grain and fodder. The great value of maize as stock feed will not be fully realised until a greater proportion than at present is utilised on the farm on which it is grown.

In addition to its utility on the farm, maize provides the raw material for the manufacture of cornflour, starch, glucose, and a number of breakfast foods.

The following table shows the area and production of maize in the State for the past five years:—

Year.	Grain.		Green Fodder Area.	Total Area.
	Area.	Production.		
1923–24	166,974	4,623,000	23,011	189,985
1924–25	146,564	4,208,200	20,568	167,132
1925–26	120,955	3,278,350	26,230	147,185
1926–27	128,516	3,598,530	19,308	147,824
1927–28	148,801	3,930,570	18,606	167,407

Two-thirds of the maize produced in New South Wales is grown on the coast, chiefly along the river flats, and two-fifths of the State total on the North Coast. Apart from the coast, the only districts devoted to maize to any extent are the Northern and Central Tablelands, and the North-western and South-western Slopes. Some is also grown on the Southern Tableland and the Central-western Slopes, but very little elsewhere. The Northern Tableland is a district that is rapidly increasing its area under maize; the yields obtained there, though not large, are profitable and dependable. The area in the Inverell district has increased rapidly of late years due to better results being obtained generally with maize than with wheat, particularly on the rich black soils. There is also room for further

expansion in the districts of better rainfall—on the Central-western Slopes, and (with the introduction of very early varieties) on the Southern Tableland.

The best development and the highest yields of maize are obtained on the coast with warm, moist, long-growing seasons, and deep, rich soils such as are found on the alluvial river flats. Frost will injure maize at almost any time in its growth, but more particularly during the flowering and cobbing stages. Young maize has often been observed to withstand frosts of several degrees—especially on the tablelands—apparently the result of acclimatisation.

A good summer rainfall is almost essential; indeed, many districts that have suitable soil are impossible for maize just on this account. A sufficient supply of moisture in the soil is urgently needed at the tasselling and cobbing stages, *and if this cannot reasonably be expected, maize-growing is hazardous.* Many soils can, however, be considerably improved in their water-holding capacity by the addition of large quantities of stable manure or green crop residues; and, in districts of good winter rainfall, methods of cultivation can be adopted to conserve sufficient moisture to enable an early maturing variety sown in spring to produce its crop before the dry summer, with its attendant high rate of evaporation, can affect the result. This is often done on the western slopes. Another alternative is to plant in midsummer and depend on the monsoonal rains during the late summer and autumn. This practice is resorted to on the Murrumbidgee Irrigation Area, with the exception that irrigation takes the place of rainfall. It is found that pollination is not interfered with when tasselling takes place during February, whereas the hot scorching winds of midsummer "blast" the tassels and kill the pollen—preventing fertilisation and the formation of grain.

Excess of rainfall is injurious, especially on heavy or badly-drained soils, for maize will not stand "wet feet," more especially if the ground is cold.

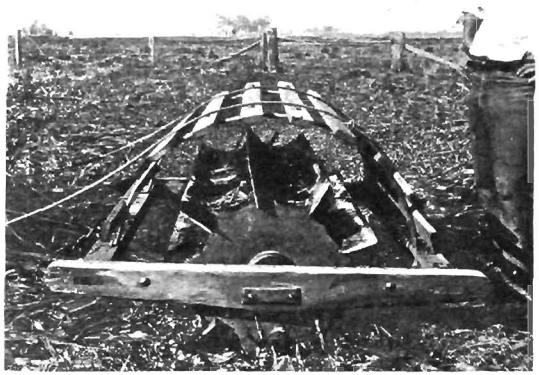
A free, deep, well-drained loam, well provided with organic matter, is the ideal soil for maize, and these conditions are best satisfied on the alluvial flats of the coastal and of some of our inland rivers and creeks. Deep volcanic soils of basaltic or basic character grow excellent crops, both on the coast and tablelands, and even the lighter granitic soils on the Northern *Tablelands are extensively used for growing profitable, though not heavy* crops.

Preparation of the Soil.

Some rotation or change of crops is desirable in maize-growing. Where land receives periodical enrichment by silt from flooding, the fertility of the soil is usually well maintained, but where this is not the case, recourse must be had in time to artificial methods of maintaining or increasing the fertility of the soil if good yields are still to be obtained. Grass pasture, or perennial or biennial leguminous crops like lucerne and the different clovers, are the best crops to precede maize, and green manuring with, or the feeding off of crops like velvet beans, cowpeas, soybeans, vetches, and field peas increases the yield of the succeeding maize crop.

Maize, being comparatively shallow-rooted, especially in the later stages of its growth, requires a thorough and deep working of the soil, for it is mainly in this depth of worked soil that the roots are distributed and on which they depend almost wholly for the nourishment of the plant during later growth. The ground *should therefore be deeply ploughed—as deeply as possible* without turning over an undue amount of subsoil. This ploughing should be given in the autumn or early winter, and the ground allowed to lie in the rough state and to mellow down under the action of frosts and winter rains.

In the moister districts on the coast, winter cover-crops, like wheat or oats and field peas or vetches, may be grown on part of the land for green feed or green manure as required. Shallow soils which have been ploughed for a number of years to the depth of the subsoil should not be suddenly deep-ploughed ; it is better to deepen the ploughing by an inch or so every year, until a sufficient depth is attained, and then to come back for one year to the shallow ploughing. This method also prevents the formation of a hard or plough-pan in shallow soils with a heavy subsoil.



The Chopping Roller, used for Cutting old Maize Stalks prior to Ploughing.

On heavy soils which are inclined to run together after rain, the mouldboard plough is the best to use, as it leaves the land rough and open for the reception of the winter rains. The disc plough pulverises the soil more, and a heavy soil runs together quickly after its use. The disc plough is therefore not the best for a first ploughing on heavy soil, especially where the winter rainfall is high. The disc plough is, however, a valuable implement for turning under old stalks, weeds, or other rubbish. Where the mouldboard plough is used for this purpose, it should be preceded by a chopping roller or by a smooth roller and disc harrow.

Too many of our maize-growers still allow their land to lie under the old stalks during the winter, and are content with a spring ploughing to prepare the land for the next crop. It is estimated that this practice is one of the biggest factors in lowering the acre yield all over the State, and its discontinuance is strongly urged.

In early spring the land should be given a second ploughing (preferably a cross ploughing), so as to destroy all weeds and make a good clean seed-bed. This second ploughing should not be deep if it immediately precedes planting, as the seed-bed requires a certain amount of firmness. The spring ploughing should be followed immediately by harrowing to conserve moisture,

as evaporation is becoming more active at this time of the year. If a green crop or much weed growth is being turned under in the course of the spring ploughing, the furrow can be made a little deeper than would otherwise be advisable, and the work should be completed at least a month or six weeks before sowing. As soon as the top of the ground is sufficiently dry, the roller should be used to consolidate the soil, and ensure that the buried vegetable matter comes into firm contact with moist ground, thus facilitating its rapid decomposition. If this is not done, large air spaces will be formed, which are particularly injurious to the succeeding crop during a dry season. This rolling should, of course, always be followed by harrowing. Rolling is also sometimes found necessary to produce a proper seed-bed from cloddy land, but the judicious use of the harrow on such land at the right time after rain is better than the roller. The disc harrow is coming into great favour of late years on the coast for preparing a seed-bed for maize, and it has been found possible to dispense with a second ploughing in some instances by the use of this implement.

The importance of a thorough preparation of the soil for maize cannot be too strongly stressed, as it seems to be a prevailing idea with many that a well-prepared soil is not so necessary owing to the large size of the seed of maize. No greater mistake can be made, for no amount of after-cultivation can make up for insufficient preparation of the soil for this crop.

Varieties Recommended.

Varieties of maize differ chiefly in maturity and growth, average size of ear, size of grain (particularly breadth and length), colour of grain, and general character of dent. Some latitude must be allowed in the description of a variety, because of the many different types of which a variety is composed. The recognition of varieties is a matter of some importance to farmers, on account of the recommendations which have been made by the Department as to the most suitable varieties for particular districts.

Classification of Maize Districts.

The maize districts of the State are classified as follows for the purpose of these recommendations:—

1. Upper North Coast, comprising the Tweed, Richmond, Clarence, and Bellinger Rivers.

2. North Coast Tablelands, comprising Dorrigo and Comboyne districts.

3. Middle North Coast, comprising the Nambucca, Macleay, Hastings, and Manning Rivers.

4. Central Coast, comprising county of Cumberland, and Hunter and Hawkesbury River districts.

5. South Coast, comprising the Illawarra, Shoalhaven, Milton, Moruya, Bega, and Pambula districts.

6. Northern Tableland, comprising Tenterfield, Glen Innes, and Armidale districts.

7. Central Tableland, comprising Bathurst district.

8. Southern Tableland, comprising Moss Vale district.

9. North-western Slopes, comprising—(*a*) Inverell district. (*b*) Tamworth and Upper Hunter districts.

10. Central-western Slopes, comprising Molong, Manildra, Mudgee, Canowindra, and Coonabarabran districts.

11. South-western Slopes, comprising Tumut and Gundagai districts.

12. Murrumbidgee Irrigation Areas.

Approximate Order of Maturing of Varieties Recommended.

Very Early.—Early Morn, Golden Glow.

Early.—Wellingrove, Gold Coin, Golden Superb, Funk's 90-Day, Kennedy, Iowa Silvermine, Funk's Yellow Dent, Iowa Goldmine, Auburn Vale, Craig Mitchell, Goldmine Crossbred.

Midseason.—Hickory King, Leaming, Golden Nugget, Early Clarence, Golden Beauty, Boone County White, Manning Silvermine, Manning White.

Late.—Yellow Hogan, Fitzroy, Large Red Hogan, Yellow Moruya, Ulmarra Whitecap, Bega Yellow, Pride of Hawkesbury.

Varieties Recommended for Grain.

UPPER NORTH COAST.

(*a*) *Tweed River.*

Early Crop.—Leaming, Craig Mitchell, Iowa Silvermine.

Main Crop.—Fitzroy, Ulmarra Whitecap, Large Red Hogan (for early sowing only).

(*b*) *Lower Richmond River.*

Early Crop.—Hickory King (second-class soils only), Leaming.

Main Crop.—Golden Nugget (second-class soils only), Fitzroy.

(*c*) *Upper Richmond River.*

Early Crop.—Leaming.

Main Crop.—Fitzroy, Large Red Hogan, Ulmarra Whitecap.

(*d*) *Clarence River.*

Early Crop.—Leaming.

Main Crop.—Fitzroy, Ulmarra Whitecap.

Second-class Soils.—Golden Nugget, Hickory King.

(*e*) *Bellinger River.*

Early Crop.—Leaming, Iowa Silvermine.

Main Crop.—Fitzroy, Ulmarra Whitecap.

NORTH COAST TABLELAND.

Dorrigo and Comboyne Districts.

Main Crop.—Leaming, Golden Superb, Golden Nugget.

MIDDLE NORTH COAST.

(*a*) *Nambucca River.*

Early Crop.—Golden Superb, Leaming.

Main Crop.—Fitzroy, Yellow Hogan.

(*b*) *Lower Macleay River.*

Early Crop.—Funk's Yellow Dent, Golden Superb.

Main Crop.—Fitzroy, Large Red Hogan, Yellow Hogan, Golden Beauty, Pride of Hawkesbury, Manning Silvermine.

(*c*) *Upper Macleay River.*

Early Crop.—Golden Superb, Funk's Yellow Dent.

Main Crop.—Large Red Hogan, Fitzroy, Yellow Hogan.

(*d*) *Hastings River.*

Early Crop.—Funk's Yellow Dent, Craig Mitchell.

Main Crop.—Fitzroy, Large Red Hogan, Golden Beauty.

(*e*) *Lower Manning River.*

Early Crop.—Funk's Yellow Dent, Craig Mitchell.

Main Crop.—Fitzroy, Large Red Hogan, Yellow Hogan, Pride of Hawkesbury, Manning Silvermine, Manning White.

(*f*) *Upper Manning River.*

Early Crop.—Golden Superb, Funk's Yellow Dent, Iowa Silvermine, Craig Mitchell.

Main Crop.—Fitzroy, Leaming, Golden Beauty, Yellow Hogan.

CENTRAL COAST.

(*a*) *Lower Hunter River.*

Early Crop.—Funk's Yellow Dent, Craig Mitchell, Golden Superb.

Main Crop.—Large Red Hogan, Fitzroy.

(*b*) *Hawkesbury River.*

Early Crop.—Golden Superb.

Main Crop.—Large Red Hogan, Fitzroy, Yellow Hogan, Leaming.

(*c*) *County Cumberland.*

Early Crop.—Hickory King.

Main Crop.—Fitzroy.

SOUTH COAST.

(*a*) *Illawarra District.*

Early Crop.—Funk's Yellow Dent, Iowa Goldmine, Iowa Silvermine, Craig Mitchell.

Main Crop.—Large Red Hogan, Fitzroy, Yellow Hogan.

(*b*) *Shoalhaven River.*

Early Crop.—Funk's Yellow Dent, Craig Mitchell.

Main Crop.—Leaming, Funk's Yellow Dent, Fitzroy, Boone County White.

(*c*) *Milton District.*

Early Crop.—Funk's Yellow Dent, Craig Mitchell, Iowa Goldmine, Iowa Silvermine.

Main Crop.—Fitzroy, Large Red Hogan, Leaming.

(d) *Moruya River.*

Early Crop.—Funk's Yellow Dent, Craig Mitchell.

Main Crop.—Large Red Hogan, Yellow Moruya.

(g) *Bega River.*

Early Crop.—Funk's Yellow Dent, Craig Mitchell, Iowa Goldmine, Iowa Silvermine.

Main Crop.—Large Red Hogan, Yellow Moruya, Golden Beauty, Bega Yellow, Yellow Hogan.

NORTHERN TABLELAND.

(a) *Tenterfield District.*

Wellingrove, Funk's Yellow Dent, Golden Glow, Iowa Silvermine.

(b) *Glen Innes District.*

Strong Soils.—Wellingrove, Iowa Goldmine, Goldmine Crossbred.

Light Soils.—Wellingrove, Iowa Silvermine.

(c) *Ben Lomond, Llangothlin, Guyra, and Black Mountain Districts.*

Early Morn, Golden Glow.

(d) *Armidale District.*

Funk's Yellow Dent, Wellingrove, Golden Glow, Gold Coin, Golden Superb.

(e) *Uralla District.*

Wellingrove.

CENTRAL TABLELAND.

(a) *Bathurst District.*

Alluvial Soils.—Funk's Yellow Dent, Iowa Silvermine.

Upland Soils.—Iowa Silvermine.

(b) *Colder Districts.*

Early Morn.

SOUTHERN TABLELAND.

Moss Vale District.

Golden Glow.

NORTH-WESTERN SLOPES.

(a) *Inverell District.*

Heavy Soils.—Funk's Yellow Dent, Kennedy, Auburn Vale, Funk's 90-Day.

Light Soils.—Wellingrove, Iowa Silvermine.

Late Sowing.—Early Morn, Golden Glow.

(b) *Tamworth and Upper Hunter Districts.*

Alluvial Soils.—Funk's Yellow Dent, Iowa Silvermine.

CENTRAL-WESTERN SLOPES.

Alluvial Soils.—Funk's Yellow Dent, Iowa Silvermine.

Upland Soils.—Iowa Silvermine, Early Morn.

SOUTH-WESTERN SLOPES.

(a) Tumut River.

Rich Alluvial Flats.—Main Crop (October sowing), Early Clarence; Early Maize (late sowing), Funk's Yellow Dent, Craig Mitchell.

Second-class Alluvials.—Funk's Yellow Dent, Iowa Silvermine.

(b) Murrumbidgee River (Gundagai District).

Funk's Yellow Dent, Iowa Silvermine, Golden Glow.

MURRUMBIDGEE IRRIGATION AREAS.

Funk's Yellow Dent, Iowa Silvermine.

Varieties Recommended for Green Fodder.

COASTAL DISTRICTS.

Early Varieties.—Hickory King, Leaming, Craig Mitchell.

Late Varieties.—Fitzroy, Pride of Hawkesbury, Ulmarra Whitecap, Whitecap Horsetooth.

TABLELAND DISTRICTS.

For Warmer Districts.—Fitzroy.

For Cooler Districts.—Hickory King, Leaming.

For Coldest Districts.—Wellingrove.

WESTERN SLOPES AND MURRUMBIDGEE IRRIGATION AREAS.

Fitzroy.

Improving the Yield by Seed Selection.

Many farmers hold the opinion that without a change of seed from time to time maize will "run out." There is some truth in this if the selection of the seed is not given careful attention each year. The best method of invigorating a strain of maize is to procure unrelated seed of the same variety from another source now and again, and mix it with one's own seed. The fresh "blood" introduced will have the effect of adding vigour, which will be reflected in the increased yielding capacity of the subsequent seed

It is surprising that more selection of seed is not done by farmers, because the comparatively large size of the ears, the large number of grains they contain, the few ears it is necessary to select in order to plant an acre, together with the easily observable types and characters of the different ears, all make the selection of seed maize an interesting and easy operation.

Field Selection.

The first step in selection is to take cognisance of the field characters of the mother plants from which the ears are to be selected. In the first place, a large ear may be due to the fact that its stalk had an advantage while it was growing in the field. It may have had a greater space, or a richer bit of soil, or more abundant moisture. Any of these conditions will enable a plant to produce a larger ear. Such an ear cannot be expected to yield well, unless it has similar advantageous conditions when it is sown in the following season. The best ears to select in the field are those of good or moderate size, which have been produced under normal or even adverse conditions in the field.

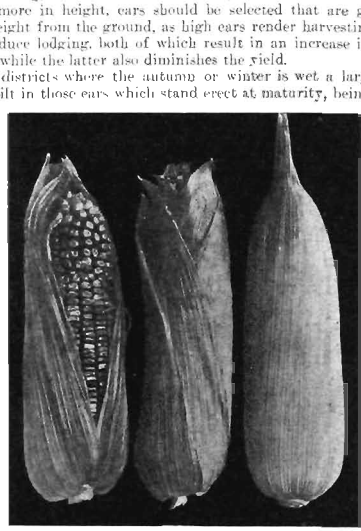
Plants which produce a large ear in comparison with the size of stalk constitute a valuable basis for the improvement of the grain yield of any variety.

Selection for two or more ears per stalk is not likely to give increased yields, unless the first ear is up to normal size; otherwise there is the danger of merely increasing the number of ears per stalk and reducing the average size of the ears.

Stalks with one or two suckers have been regarded, curiously enough, as undesirable in field selection, but experience shows that they should not always be rejected. Some varieties sucker more freely than others, and in some cases, especially on rich soils, it might be difficult to select ears only from suckerless stalks. There is no reason why stalks bearing good ears should not be selected, even though they have suckers.

In tall-growing, late varieties on the coast, where the stalks are sometimes 12 feet or more in height, ears should be selected that are growing at a moderate height from the ground, as high ears render harvesting more difficult and induce lodging, both of which result in an increase in the cost of harvesting, while the latter also diminishes the yield.

In those districts where the autumn or winter is wet a large amount of maize is spoilt in those ears which stand erect at maturity, being held so by



1 2 3

Types of Ears, showing—1, husk open and much of the ear exposed to insect and fungus attack; 2, tip exposed; 3, a well-covered ear.

a short thick supporting shank, especially if the husk covering is deficient. In these districts it is desirable to select ears which turn down at maturity. On the North Coast, where such insect pests as weevil and grain moth are abundant, much damage is done where the husk does not completely cover

the tip of the ear, for in those ears which are completely and tightly covered no trace of weevil can be found. By increasing the number of such ears by selection it is possible to keep the crop longer in the field, and the unhusked ears longer in storage.

Avoid the selection of ears from plants which are blown down or broken down, no matter how good the ears may be: root and stalk rot diseases are transmitted readily through the seed. Ears from prematurely ripened stalks should be avoided and brace-rooted stalks regarded with suspicion.

Select seed early to prevent, as much as possible, mycelium of the root and stalk rot fungus penetrating the seed. Dry the seed ears quickly by storing in a dry, warm, well-ventilated place in an endeavour to prevent the fungus making further growth from the core into the seed.

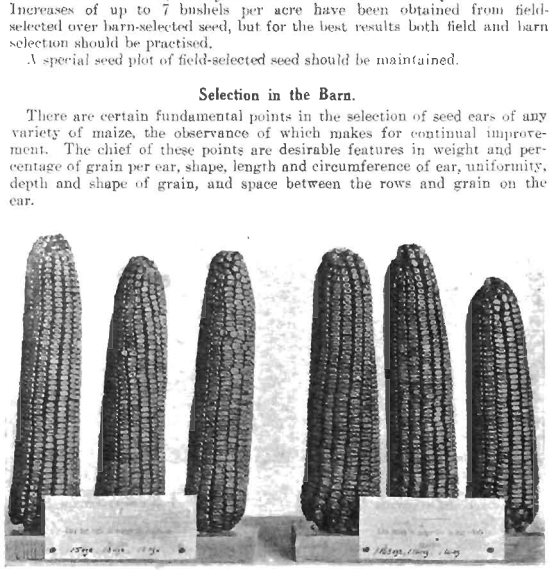
Field selection may be done during the ordinary process of harvesting, a small box being attached to the dray or waggon in which the selected ears are placed, to be kept separate in the barn from the bulk, and there subjected to a further scrutiny and selection.

Apart from the improvement in field characters which can be effected by selection in the field, the yield can also be increased by this method. Increases of up to 7 bushels per acre have been obtained from field-selected over barn-selected seed, but for the best results both field and barn selection should be practised.

A special seed plot of field-selected seed should be maintained.

Selection in the Barn.

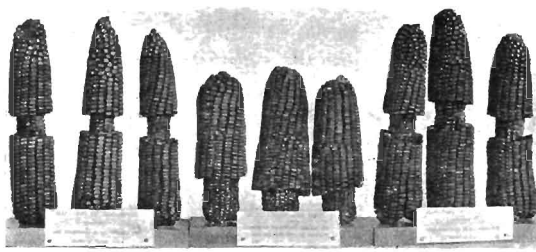
There are certain fundamental points in the selection of seed ears of any variety of maize, the observance of which makes for continual improvement. The chief of these points are desirable features in weight and percentage of grain per ear, shape, length and circumference of ear, uniformity, depth and shape of grain, and space between the rows and grain on the ear.



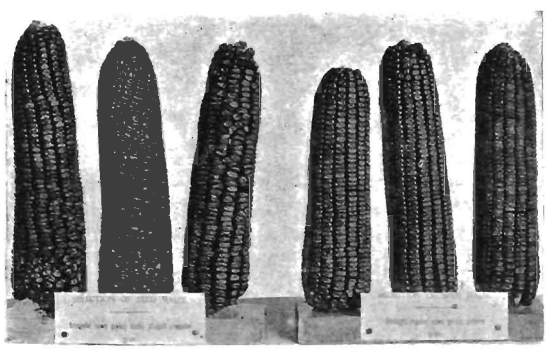
The weights of these ears, reading from left to right, are 15 oz., 13 oz., 13 oz., 1 lb. 3 oz., 1 lb. 1 oz., 1 lb. 1 oz., respectively. The three on the left are too light in weight in proportion to their size, a fact which is readily discovered on handling the ears.

Soundness, weight, plumpness, and good bright colour of grain are of more importance than depth; deep grain may be light and chaffy, and of poor colour and feeding value. Cobs of average size, typical of the variety, which are, when dry, heavy in proportion to their size, are more to be desired than large or outsize cobs, which may be later in maturity and show variation in type; at all times care must be taken that cobs are thoroughly representative of the variety.

Wide furrows between the rows should be avoided, being indicative of a lower weight of shelled grain, and cobs on which the grain is tight are always to be preferred.



The three ears on the left have too small a core and circumference of ear for their length. It will readily be observed that they will not shell as much grain as the ears with cores of moderate size on the right. The three centre ears have too thick a core and too large a circumference for their length



The ears on the right show straight regular rows of uniform grain, while those on the left have irregular rows and grain, and are undesirable for seed.

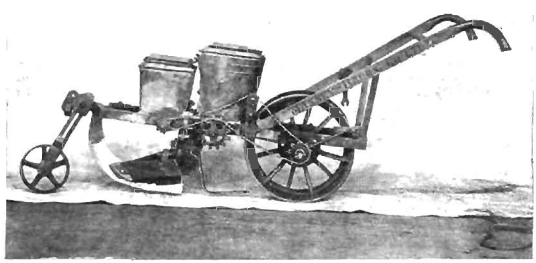
Rough dented, soft grain is more likely to carry the infection of root, stalk and cob rot diseases than medium-hard grain of smooth to medium-rough dent; it is sometimes considered that a rough dent indicates a pinched grain, but this is not the case, as dent roughness is usually a sign of higher soft starch content.

Ears showing split, mouldy or darkened grains should be rigorously avoided as they are indicative of root and stalk rot disease infection; ears showing a shredded, stringy, or discoloured stalk attachment, and ears shelling grain with a stringy tip cap should be discarded for the same reason.

Uniformity is to be aimed at in size, shape, and appearance indicating the variety type, with the object of achieving uniformity in time of flowering and greater regularity in maturity.

Sowing the Crop.

On the far North Coast sowing may commence with early varieties towards the beginning of August, in order to catch the higher price which usually prevails in January and February. These crops are, however, often light (sometimes failures) owing to the dry springs usually experienced, and only small areas and light seedings are recommended.



Maize Drill, with Fertiliser Attachment.

On the Clarence and Richmond Rivers the main crops should be late varieties, sown in November and December. Such crops nearly always yield well owing to the monsoonal rains of February and March being fairly dependable. *Further south, on the Macleay, Hastings, and Manning Rivers,* and along the lower North Coast, sowing usually commences at the beginning of September and continues till November. Later sowings than this usually take leaf blight badly.

On the South Coast October is the best month, and this month also sees the bulk of the sowing complete on the Northern Tableland, in the North-west (Inverell district), and the South-west (Tumut district). In the western district, the bulk of the maize should be sown either towards the end of September or in December, in order that tasselling or flowering shall not occur during the hottest part of the summer. On the Murrumbidgee Irrigation Area a December sowing stands the biggest chance of success.

For green fodder or silage, maize can usually be sown a month or six weeks later than the latest safe time for sowing grain.

Methods of Sowing.

1. *Ploughing-in.*—This is a method which is largely used in some districts, but which cannot be recommended except when the land has been well prepared, and is in good tilth and not weedy. There may be some justification also for using this method when the land is of a heavy nature, and has been beaten down by rain. Either single or multiple ploughs are used, the latter, of course, ploughing the whole ground, and the seed being dropped by hand behind the plough in every fourth or fifth furrow. If the ground is scarcely moist enough to germinate the grain, sowing should be followed by a rolling, and subsequently by a harrowing. The ploughing should only be shallow, especially on heavy ground, or during early spring, so as not to turn too much covering on the seed

2. *The Maize Drill.*—The maize drill is easily the most satisfactory method of sowing. Single- or double-row drills may be used, and the depth of sowing regulated by raising or lowering the runner wheel. The rate of seeding can be accurately regulated by the use of plates, with various sizes and numbers of holes, and a heavy press-wheel behind the planter-box presses the soil round the seed, and ensures immediate germination if the soil is moist. Drills can be had with fertiliser attachment, and a scribe or marker for marking the position of the next row. Some double-row drills are also fitted with check wire for sowing in "squares" or "checks," dropping from two to four grains per hill. This method can only be used in rectangular paddocks, and where the ground does not slope badly. It is, perhaps, an advantage in weedy ground, in that cultivation may be given in two directions. A disadvantage of most double-row drills is that the distance between the drills is fixed, and they cannot be used where a greater width is required.

Sometimes a home-made marker is used for marking the rows, five or six rows being marked at a time. Using marked sticks of equal length at the ends of the field is also a handy way of getting straight rows of any desired width with the single-row drill. A small lister furrow-opener on the front of the drill is very useful on trashy ground. Deeper listing may be obtained by ploughing furrows, and then planting in these furrows with the drill. This is an invaluable method in dry districts or hot climates, where the top soil dries up quickly. It is especially recommended for late spring and early summer plantings on the North Coast, as the young weeds which come up in the furrows with the maize can be easily smothered as the furrows are filled in by cultivation.

3. *The Wheat Drill.*—This implement may be used in sowing maize for fodder. There is some difficulty in getting it to sow a crop thinly enough for grain. With a 13 tube drill every tube but two should be plugged. This will give rows about 3½ feet apart.

4. *Broadcasting followed by Harrowing.*—This method is only permissible when maize is being grown for green feed or silage in good districts, and then is only to be recommended where the ground is unevenly shaped, as on the edge of a creek or river bank. Under most circumstances better results will be obtained by sowing in drills, although there may be some justification for broadcasting on newly broken paspalum sod, where cultivation is difficult.

Width between Drills and Distance between Plants.

Sunlight is essential for the proper fertilisation and development of the ears, and if the rows are planted too closely, especially in a cool, cloudy season, the crop does not "cob" properly. Dry spells also seriously interfere with proper "cobbing" if the rows are too close, owing to moisture limitations or lack of available plant-food material. With late tall-growing varieties on the North Coast, the rows should not be planted closer than 4½ feet apart. In the North-west, Central Tableland, and Central-western Slopes, the same distance, or even 5 feet, should be observed, not on account of the tall growth, but because of the limitation of moisture.

The plants can average from 10 to 18 inches apart in the rows, according to the fertility of the soil, the closer planting being adopted on richer soil. In cooler districts, and where moisture is not so likely to be a limiting factor, *e.g.*, the South Coast, Northern Tablelands, South-western Slopes, or under irrigation in the west, the rows may be 3½ to 4 feet apart, and the plants from 12 to 15 inches apart in the rows. These distances might also apply to the earlier varieties on the North Coast. On rich soils, or under conditions in which varieties of maize sucker freely, it is better to sow three grains every 2½ to 3½ feet apart in the rows, as this "hill" sowing inhibits the formation of suckers to some extent.

For green feed or silage the rows may be 2½ to 3 feet apart, and the plants average from 6 to 9 inches apart in the rows.

Quantity of Seed per Acre.

The foregoing recommendations cannot be exactly translated into a given quantity of seed per acre, as this depends largely on the variety of maize, and the number of grains required to weigh a pound. The following figures can therefore only be regarded as approximations. For late varieties on the coast, from 8 to 10 lb. will be required: for earlier varieties, 10 to 12 lb. In the drier districts in the west, from 4 to 6 lb. is sufficient.

For green feed and silage from 2 to 2½ times as much seed as is used for a grain crop has given the best yields.

For broadcasting, from ¾ to 1½ bushels per acre are required.

Descriptions of Varieties.

The following descriptions apply to the more important of the varieties recommended by the Department:—

Bega Yellow.

This variety is somewhat similar to Yellow Moruya in appearance, and is probably of a similar origin (*i.e.*, the result of a cross between Golden King and a smaller-grained yellow variety), and selection to the present type, in which the grain is smaller still than Yellow Moruya, but of the same hard, bright-coloured type.

It is a medium late variety, and the husk covering has been considerably improved as compared with Golden King. This character and the hard grain have been maintained to make the variety able to withstand damage by floods, which occur somewhat frequently on the Bega River flats.

The ears are of good length, fairly cylindrical in shape, with about twelve rows of uniform, regular grain, with a smooth dent and with fairly wide furrows between the rows. The grain is thick, fairly broad, and of good depth, hard, and of very bright colour.

Boone County White.

This is a variety which does best on rich soils, but also does comparatively well on poorer soils well supplied with moisture. It does not seem to stand too hot a climate, and is therefore not suited to the North Coast. It matures in about five months on the South Coast. The stalks are not tall, but rather coarse. They do not sucker much, and under good conditions the ears, which are mostly borne singly, grow to a large size. The ears droop at maturity, and the husk covering is fairly good.

The ears are cylindrical in shape, 9 to 11 inches long, and 7 to 7½ inches in circumference. The rows vary from sixteen to twenty, and are usually very straight and regular, with a medium to small furrow between them.

The grain is fairly thick, moderately broad, pearl white in colour. The cores are of medium large size, but chaffy and comparatively light in weight.

Craig Mitchell.

This is a comparatively new variety which originated in Victoria—possibly a selection from Boone County White, which it resembles in some respects. It is, however, somewhat earlier maturing and has thicker grain with a much smoother dent. On good land this variety has done extremely well, producing very heavy yields of very large cobs. It must be sown early on the coast for good results.

Early Clarence.

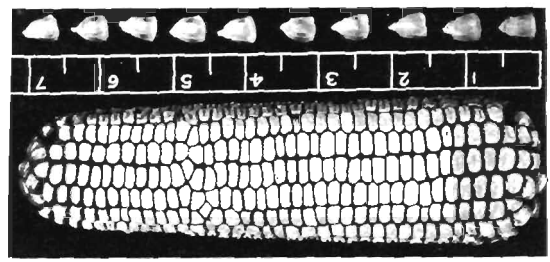
This is a local yellow variety which has been acclimatised to the Tumut district. It matures in about 5½ months. The stalks are stout and not very tall. The ear is large, with a large core. The dent is fairly rough, and the rows, which vary in number from sixteen to twenty, are fairly straight, with a medium to small furrow between them. The grain is thick, fairly broad, and not very deep. It is of excellent colour and quality.

Early Morn.

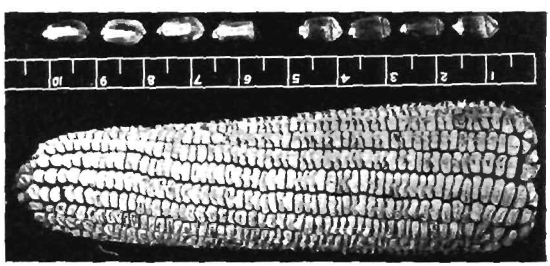
An exceptionally early variety of dent maize, which is only recommended for very cold districts, and for hot, dry districts where an early variety is essential. The growth is only about 5 or 6 feet as a rule, with small cobs 6 or 7 inches long, of short, fairly thick grain of good, bright-yellow colour with a smooth to medium dent.

Fitzroy.

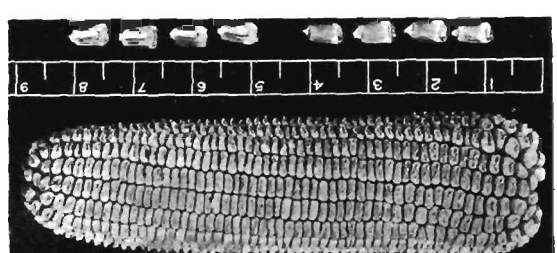
This variety (formerly known as Improved Yellow Dent) has been extremely popular on the North Coast for many years, and of late years is being largely grown also on the South Coast. On the North Coast it takes about six months to mature and is, in addition to being a good yielder of grain, the most popular variety throughout almost the whole State for green fodder or silage on account of its heavy yields and fine succulent stalks. It attains a height of 12 to 15 feet or more on the North Coast, and though the ears mostly remain erect at maturity, the husk covering is extremely good, which makes the cobs very resistant to the weather and also to weevil attack.



Early Morn.



Early Clarence.



Bronze Gnania White.

The ear is cylindrical in shape, 9 to 10 inches in length and 7½ or 8 inches in circumference. The dent is medium to rough, and the rows vary from fourteen to eighteen in number, with a furrow of medium width between them.

The grain is moderately thick, broad, and deep, and of a bright amber colour, which makes it sell well on the market.

Funk's 90-Day.

This is a promising, fairly early maturing variety. It was introduced from Queensland and is doing particularly well in the Inverell district. It is badly named, as it is not by any means a "90-day," and matures later than Wellingrove.

Funk's Yellow Dent.

This variety has been evolved from Reid's Yellow Dent by the selection of a different type, and it is important to note that this selection has fitted the resultant variety for conditions under which the original Reid's Yellow Dent would not grow successfully. Funk's Yellow Dent is rapidly gaining popularity on the Northern and Central Tablelands, North-western Slopes, Central-western Slopes, the Murrumbidgee Irrigation Area, and the South Coast, on account of its ability to beat other varieties under dry conditions. It has a poor husk covering, but this defect is not of any great account in these districts.

The ears are cylindrical, 9 to 11 inches long and about 7 inches in circumference. The rows number from sixteen to twenty-two, straight, and with a medium wide furrow between them.

The grain, which is rounded in outline, is very tight on the cob, thick, medium broad and medium deep. It is thicker and shallower than Reid's Yellow Dent, and the dent is smooth to slightly rough. The colour is dark amber, with a small bright yellow cap.

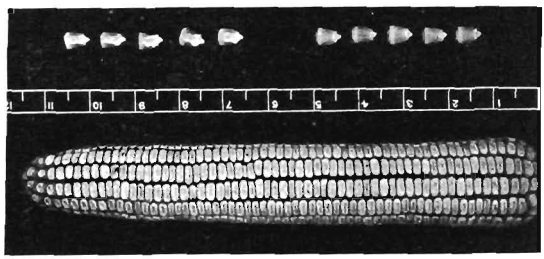
Reid's Yellow Dent has a softer grain, deeper, and with a rougher dent than Funk's Yellow Dent, but the general experience with it has been that it requires rich soil and very good conditions to do well. Owing to the greater hardiness of Funk's Yellow Dent, Reid's has passed from the list of the Department's recommendations.

Gold Coin.

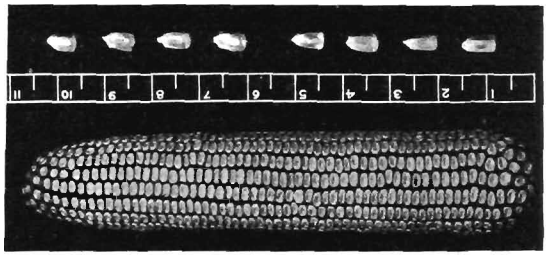
This is a recently named variety, which has been developed in the Armidale district, apparently by crossing Large Goldmine with some other variety. The preponderating type of grain is not quite as large as Large Goldmine and has a tendency to be rounded on the sides due to somewhat wide furrows between the rows of grain on the cob.

Golden Beauty.

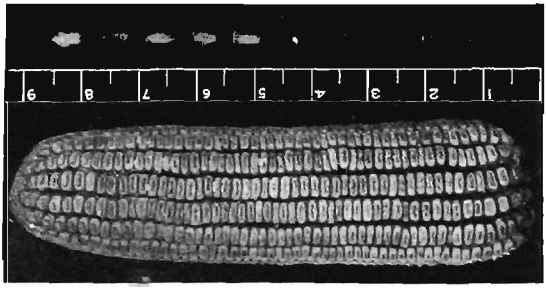
A type of maize easy to identify on account of its long narrow cobs of about twelve rows of fairly broad, yellow, medium hard grain of light-amber colour, with a fairly small bright yellow cap, and medium smooth dent. This maize reaches its best development on the Upper Manning, where it is largely grown; the cobs often reach a length of 12 or 13 inches.



Golden Beauty.



Funk's Yellow Dent.



Pitroy.

Golden Glow.

An early variety which is proving a good yielder in some of the cooler tableland districts. It is somewhat similar to Early Morn, but has slightly tapering and larger cobs with more closely packed rows of grain with a rougher dent, and is a paler yellow colour than that variety.

Golden Nugget.

A very useful variety which has given good results on land of only moderate fertility, and which is also useful for late sowing on the coast on account of its resistance to leaf blight, which occurs most abundantly in late sown maize. The cobs are usually well covered with husk, which character enables it to withstand the attacks of weevil in the field and also ensures absence from damage in wet seasons. The cobs are not usually long, averaging 8 or 9 inches, with about fourteen rows with medium wide furrows between them. The grain has a tendency to become rounded on the sides, or at least to narrow off to a small, smooth, very shallow dent. The grain is hard, a very bright yellow colour, with a small bright yellow cap.

Golden Superb.

An early variety of maize very popular on the Macleay River for first sowing to get the early market. For this purpose it is valuable both on account of its earliness and because of its hardness of grain which makes for a good sample.

The ears are slightly tapering, 7 or 8 inches long, with about fourteen rows of moderately broad and fairly thick grain with a shallow smooth dent. The colour of the grain is dark amber often with a reddish tendency, while the cap colour is very pale yellow, almost white.

Goldmine Crossbred.

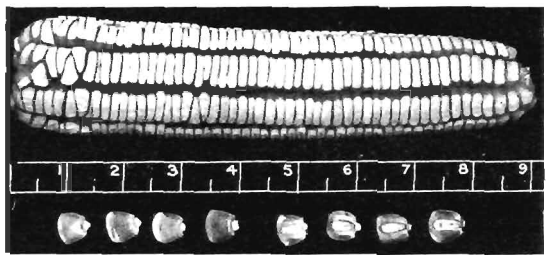
This is an improved crossbred variety—probably between Large Goldmine and Wellingrove. It has achieved a certain measure of popularity on the New England tableland, more particularly in the Glen Innes district. The cob and grain bear a close resemblance to Large Goldmine.

Hickory King.

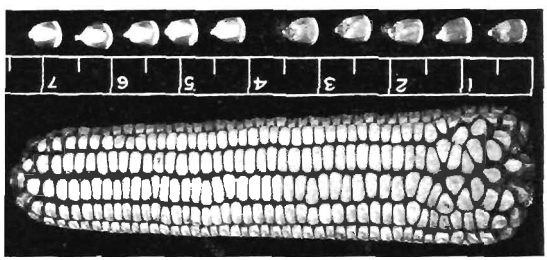
This is a popular variety on account of its large attractive grain. It is, however, one of our lightest yielding varieties on good land, but has the ability to do better than most varieties on poorer soils. It matures in about the same time as Boone County, and has established a reputation for doing well on the highlands for fodder. The stalks are rather fine, and the variety suckers freely. The ears are borne on long thick shanks, and they mostly droop at maturity. The husk covering is not good, and many ears are spoilt when the weather is wet during ripening.

The ears are cylindrical in shape, 8 to 10 inches long and 6 to 6½ inches in circumference. The dent is smooth to slightly rough, and the number of rows eight to ten and sometimes twelve, with a medium to wide furrow between them, and there is a great tendency to irregularity in shape of grain.

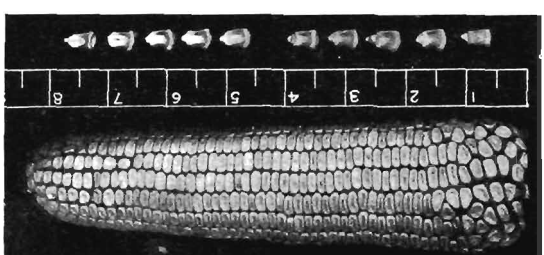
The grain is thick, broad, and of average depth. It is pearl white in colour.



Hickory King.



Golden Superb.



Golden Glow.

Iowa Goldmine.

This variety has given good results as an early variety in some parts of the South Coast and New England tableland. It is somewhat similar to Iowa Silvermine in growth and type of ear, but it has a yellow grain with a significant beak on the upper edge of the dent.

Iowa Silvermine.

This is a small, white variety which is popular on the Northern Tableland and Western Slopes on account of its earliness and drought resistance. It is also becoming popular now on the Murrumbidgee Irrigation Area and on the South Coast. It will mature in four and a half months on the coast, and grows a very short stalk compared with most other varieties. The ears are carried on long shanks, and readily droop at maturity.

The ears are cylindrical in shape, 8 to 9½ inches long, and about 6½ to 7 inches in circumference. The dent is rough, and mostly pinched, with the upper end drawn out into a projecting beak or spur. The rows are straight and regular, with narrow furrows between them. The cores are small and very light in weight. The number of rows varies from sixteen to twenty.

The grain is rather thin, narrow, and of moderate depth when grown under dry conditions, but very deep under good conditions.

Kennedy.

This is a fairly early variety, growing a somewhat tall, thin stalk for the size of the ear, which is usually only small, slightly tapering, with fourteen to sixteen rows of grain with a slightly roughened dent. The grain is small, fairly narrow, thin, and of fairly good depth, and the cobs have a rather small core. The grain has a bright yellow colour and is fairly hard. This variety is being somewhat extensively grown in the Inverell district, where yields have been promising.

Large Goldmine.

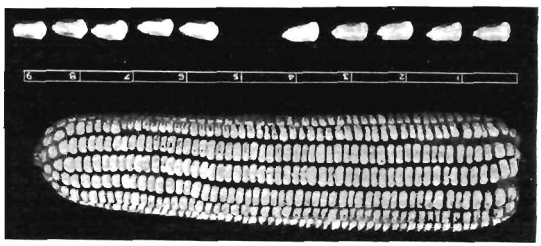
This variety is grown in parts of New England with a certain measure of success. It is similar to Iowa Goldmine in most characteristics, but has a much larger grain.

Large Red Hogan.

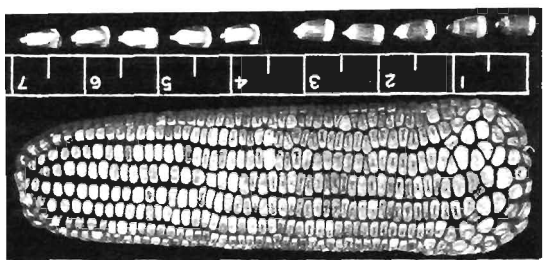
This is one of the latest varieties of maize grown in the State, being extremely popular on the Hawkesbury River flats and on the lower Hunter, where it takes about six or six and a half months to mature. The stalk is stout, and grows to about 10 or 12 feet. It does not sucker much. The ears are borne somewhat high on the stalk, but the stoutness of the stalk usually resists the force of strong wind. The ears are often held erect owing to the short thick shank, but they are mostly resistant to the weather owing to the good husk covering.

The ears are cylindrical in shape, 9 to 11 inches long and 7½ to 8 inches in circumference. The dent is medium to rough. The rows number usually fourteen or sixteen, with a medium furrow between them.

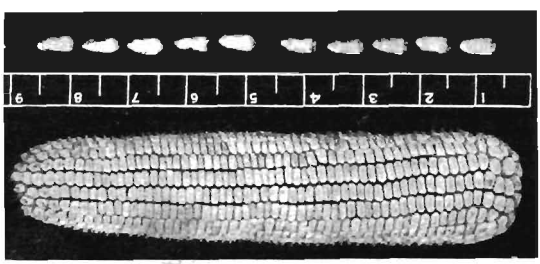
The grain is fairly thick, broad, and deep, of bright medium red colour.



Manning Silvermine.



Kennedy.



Iowa Silvermine.

Leaming.

This is one of the most popular varieties in the State. It takes about five months to mature on the North Coast, where it is largely grown for early planting. It has a fine stalk, which grows 8 to 10 feet high on the North Coast. The ears are borne on moderately long shanks, which cause the ears to droop at maturity.

The ears are 8 to 9 inches long and 6½ to 7½ inches in circumference, mostly somewhat tapering, with a smooth to slightly rough dent. The number of rows varies from eighteen to twenty-four, and curving or dropping of the rows is not uncommon. The rows are usually irregular at the tip. There is a medium to small furrow between the rows, and the grain is very tight on the cob.

The grain, which has rounded sides, is rather thick, narrow, and deep, with a dark amber colour and a small bright yellow cap.

Manning or Macleay White.

This variety, which is synonymous with Giant White, is a fairly large-grained, white sort that produces characteristically short cobs with about twelve rows of grain and with a fairly open space between the rows. It has earned a reputation for doing well under the somewhat drier conditions on the upper Manning and upper Macleay rivers.

Manning Silvermine.

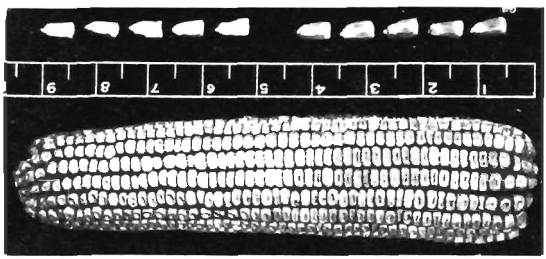
This is a variety of midseason maturity which has come into prominence as the result of yield contests on the Manning River. Its origin is unknown, but its characters place it almost definitely as a cross between Iowa Silvermine and Manning White. The ears are of fair length, averaging 9 inches or more, with about fourteen rows of grain well separated by fairly wide furrows. It differs in this respect from Iowa Silvermine, which has a larger number of rows with narrower furrows. The grain is fairly narrow, like Iowa Silvermine, and very deep, being well over half an inch, and has a rough, pinched dent, with a tendency to "beak." It does not appear to have yielded well so far outside the Manning River. The maturity is about the same as Manning White, about three weeks later than the true Iowa Silvermine.

Pride of Hawkesbury.

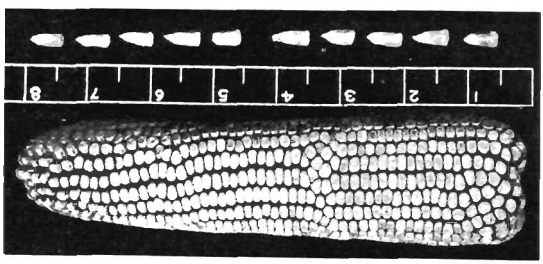
Pride of Hawkesbury is a late-maturing variety, and grows a tall thick stalk and large cobs with thick shanks, which make it somewhat more difficult to harvest than most other varieties. The husk covering is not usually too good, and in a wet season a fair amount of spoilt and mouldy grain is evident on the cob.

The cobs are 10 inches or more in length (sometimes a length of 13 inches or so is attained under very good conditions), of good weight and fairly thick. The dent is usually deep, but not usually very rough or pinched, and there are generally sixteen to eighteen or more rows of fairly regular grain, with a narrow to medium furrow between the rows.

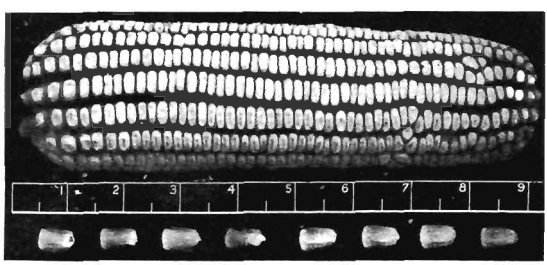
The grain is not generally uniform in this variety as to size, being particularly variable in breadth, but the most dominant type is not very broad; it may rather be described as somewhat narrow. The grain, however, is fairly thick and of great depth, often up to ¾ inch. It is soft and starchy, and generally of a dull yellow appearance, owing to the large cap or soft starch extending often down to the tip of the grain.



Pride of Hawkesbury.



Leaning.



Large Red Rogan.

Pride of Hawkesbury takes about six and a half months to mature, and yields particularly well on many parts of the coast, especially in rich soil. It has been giving exceptionally good results also for green fodder, especially for silage, on the coast.

Ulmarra Whitecap.

A local variety largely grown on the Clarence River, particularly round Ulmarra. As the name implies, it is a maize of crossbred origin not yet fixed as to colour, having mostly a yellow grain with a pale white cap. It is a very late tall-growing maize with large cobs. The grain is very deep, of generally pale yellow colour (though it is being improved in this respect to a brighter yellow), rather soft and starchy, with a rough pinched dent. It has been yielding well also on other parts of the North Coast.

Wellingrove.

This variety (formerly known as Early Yellow Dent) is extensively grown on the New England Tableland, where it can be depended on to mature before frost, as well as to give very profitable yields. It is not a suitable variety for the coast, but is sometimes sown on the Western Slopes on account of its earliness. The stalk is short and thick at the base, and the ear mostly stands erect at maturity on a short thick shank.

The ears are tapering, 8 to 9 inches long, and 6½ to 7 inches in circumference. The dent is smooth, and the rows number from fourteen to eighteen. The space between the rows is medium to large, and the grain is tight on the cob.

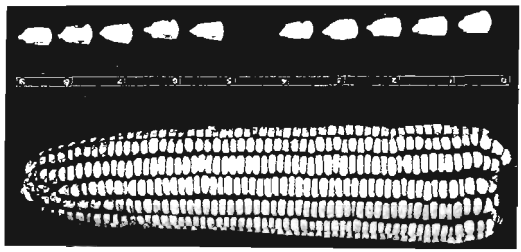
The grain is fairly thick, moderately broad, and not deep. It is a pale amber colour, with little variation in shade from that of the cap.

Yellow Hogan.

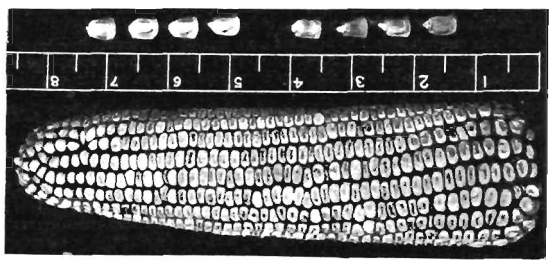
A late variety, which is grown to a large extent on the Macleay River, where it is highly successful. The cobs are not very long, usually only about 8 or 9 inches, with about fourteen rows of grain and somewhat open furrows between the rows. The grain is only of medium depth, with a smooth, shallow dent and a very bright colour. The grain is very heavy, and is reckoned to be the best selling variety which comes on to the Sydney market.

Manuring.

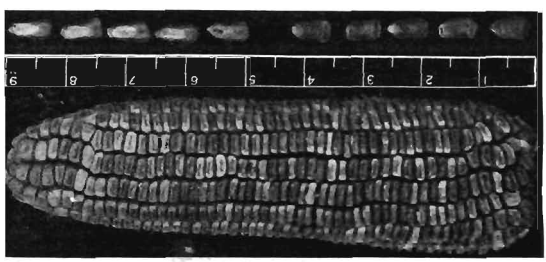
Maize is one of those crops that make great demands on the plant-food in the soil. It has been estimated that a 50 bushel crop of maize removes from the soil approximately 75 lb. of nitrogen, 30 lb. of phosphoric acid, and 50 lb. of potash. On very heavily manured fields of small area in the United States of America, yields of up to 255 bushels per acre have been produced. This is rather valuable evidence that it is impossible to have the soil too rich for maize—a remark that cannot be made of many other crops. Although good cultivation to a large extent unlocks the store of plant-food present in the soil, we are beginning to see, on our well cultivated alluvial soils, increasing evidence of diminishing maize yields compared with those of twenty years ago. This is surely a sign of failing fertility. We have only to consider how the yields of maize are suddenly increased on "worn-out land which has been sown to pasture for a few years, and how comparatively good



Yellow Hogan.



Wellingrove.



Ulmarra Whitecap.

crops are produced on some virgin soils for only a year or two, to realise what is lacking. Undoubtedly it is humus, or decayed organic matter, without which the soil richest in mineral constituents may become quite poor. The retention of moisture by the addition of humus to the soil, together with good cultivation, will do much towards producing a successful crop. In America, where the conditions necessitate the housing of cattle in the winter, the necessary organic matter can be supplied to the soil in the cheap and excellent form of farmyard manure. Wherever it is possible to obtain farmyard manure by any means under our conditions it should most certainly be applied. To supply that valuable ingredient, humus, it will be found necessary, under most conditions here, to resort to ploughing in or feeding off green crops, particularly legumes. The most suitable for our maize districts are velvet beans, cowpeas, field peas, vetches, and the clovers. Besides supplying humus, such crops as these gather nitrogen from a cheap source—the atmosphere—and fix it in the soil. This element is removed by the maize crop from the soil in large amounts, and it is the most expensive element purchased in the form of chemical fertilisers. Indeed, it seems that the application of readily soluble nitrogenous fertilisers to maize is likely to have the effect of promoting a soft and sappy growth, to which a dry spell in the later stages is particularly injurious.

Experiments with fertilisers have been carried out for several years by the Department on all classes of maize soils in different districts, and the results point conclusively to the decided profitableness of artificial fertilisers in certain quantities and mixtures for different districts even on some of the best soils where high yields are still obtained. For instance, on the coastal alluvial soils, in several cases yields of 80 or 90 bushels per acre without fertilisers have been increased another 10 bushels or so by the use of a moderate quantity of fertiliser of the right kind.

The question of what kind of fertiliser or which mixture is a very important one, as in some cases fertilisers have been found to diminish the yields. For instance, on the coast the application of a mixture containing *easily soluble nitrogenous fertilisers, such as sulphate of ammonia or nitrate* of soda, has been found to decrease the yield by 2 or 3 bushels per acre, which, with the cost of the fertiliser, has resulted in a loss of about 30s. per acre. On the other hand, on the coast the application of 2 cwt. per acre of superphosphate has given an average increase of 9 bushels per acre, thus showing a profit of about 30s. per acre after the cost of the fertiliser has been allowed for.

This instance shows how valuable to the farmer are the results of properly conducted fertiliser tests, and the information to be had from the Department on this question is vitally important to maize-growers throughout the State. Unfortunately, too many farmers who have been converted to the use of fertilisers at present take no account of the kind of fertiliser they apply, mostly leaving it to the nearest store or the fertiliser merchant to supply *them with a good fertiliser for maize.*

On the Northern Tableland ½ cwt. superphosphate has given an average increase of 5 bushels per acre, showing a profit of over 20s. per acre. In the Tumut district the best increase has been made from 2 cwt. of superphosphate, an increase of 11 bushels being obtained, showing a net profit of 39s. per acre over cost of fertiliser.

The use of fertilisers for fodder maize is a question that must be considered apart from that of fertilising a grain crop. On the North Coast an average increase of 4½ tons green fodder has been obtained from the application of 2 cwt. superphosphate per acre, giving a profit of over 50s. per acre. It is likely that in addition small quantities of sulphate of ammonia or nitrate of soda would also be profitable. On the South Coast a profit of 30s. per acre from an increase of nearly 2½ tons fodder has been secured by the application of 1 cwt. superphosphate per acre. On the Southern Tableland an increase of 4 tons per acre has been made from an application of 2 cwt. superphosphate, thus showing a profit of over 50s. per acre.

The Growing Crop.

Important as is the thorough preparation of the soil for maize, it is no more important than thorough after-cultivation. The cultivation of maize should begin almost from the day the crop is planted, and the first operation should be a light harrowing. This harrowing may be left with advantage until four or five days after planting, as it then becomes almost imperative if rain falls soon after sowing, especially on heavy land. In such circumstances, this harrowing will make all the difference between a poor and a good germination: the harrowing kills a heavy crop of weeds, and aerates and warms the soil.

The use of the harrow should be continued until the crop is about 6 inches high. The single-horse cultivator is an implement that is used far too early in the cultivation of the crop by many farmers. Many cannot yet reconcile themselves to the use of the harrow on the growing crop, but the practice is growing rapidly, for it is a case of "once tried, always used." There are, however, two words of caution to be remembered when harrowing growing corn: the first is to select a bright day for the work, as the plants are soft and brittle on a cloudy, cool day, or in the early morning, but quite tough and supple in the heat of the day; the second is to keep the harrow free from clogging rubbish, as this is the cause of many plants being torn out. The use of the harrow on young maize saves a very large amount of more expensive cultivation and hand-hoeing later on, as it destroys a big crop of young weeds and grass which later become troublesome. A light lever harrow is the best type of implement for this purpose.

The next cultivation should be done with a riding implement which straddles the rows—either a springtooth or rigid-tooth cultivator, or a disc cultivator. The last-named is an implement which has rapidly gained favour in the maize districts on account of the good clean work done by it. It can be made to throw as much hill to the rows as is desired by altering the set or cut of the discs, and it is a considerable improvement on the objectionable practice of hilling with the plough. The rigid-tooth cultivator is a better implement than the springtooth for tearing out summer grass, couch or paspalum which threatens to obtain a hold, and which is not so easily dealt with by the disc cultivator.

When the maize becomes too high to "straddle" with a two-horse cultivator, recourse must be had to a single-horse implement, the use of which should be continued for as long as practicable up to the tasselling stage.

The depth of the cultivation should be regulated according to the height of the crop, it being borne in mind that as the crop grows in height its roots

more nearly approach the surface. During the early stages of growth, cultivation may be given to a depth of 4 or 5 inches, but later, this must be reduced to 2 or 3 inches, or a large number of valuable feeding roots will be destroyed.

Hilling.

For this reason the practice of hilling with the plough is not recommended, as, when the maize is 18 inches or 2 feet high, a large number of roots are cut through by ploughing close to the rows. If hilling is thought necessary at this stage, it should be done with a disc cultivator, or with mouldboard sweeps on the single-horse cultivator. It is thought, however, that hilling is a practice for which, in many cases, no good reason can be given. Where young maize "goes over" with the wind, it usually "picks up" again readily of its own accord, and hilling is not necessary for this reason alone. The only justification for hilling with the plough is in a wet season when a heavy weed growth or grass has obtained a good hold in the rows, and requires early smothering to kill or check it. But this condition can be avoided in most seasons by a thorough preparation of the soil before planting, and by harrowing after planting both before and after the maize is up.

Do not Remove the Suckers.

Many farmers practice the removal of suckers from the maize crop with the idea of increasing the yield and incidentally of providing a little fodder for stock. The experience of the Department has been that the value of suckers is practically offset by the cost of their removal, and that the yield of the crop is much reduced by desuckering.

Harvesting and Other Problems.

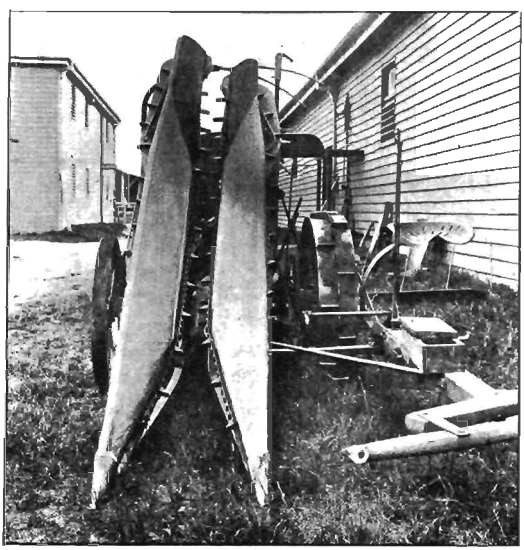
(1) *For Silage.*—As the maize plant matures it increases in water-free substance, feeding value, and digestibility. Although this is the case right up to maturity, it has been found advisable to cut for silage while the crop is fairly green and contains a fair amount of moisture, as otherwise it does not pack well in the silo; air spaces are left and mould develops. The best stage to cut for silage has been found to be when many, but not all, of the ears are dented or "glazed," a portion of the husks dry, and the upper leaves still green. If maize is cut before or after this stage, the loss in the silo is the greater. Too immature or succulent a growth is apt to cause an over-acid condition in the silage.

(2) *For Fodder.*—The best stage for fodder is slightly more mature than that recommended for silage, and the grain should be fully glazed or dented. Maize is, however, often cut in the milk or "roasting ear" stage for fodder of high palatability, and sometimes even in the silk or only in the tassel when a continuous supply is required, though in these cases the feeding value is seriously reduced. In the glazed or dented stage it possesses the advantage of being in a suitable condition to "stook" in the field without danger of mould.

Green maize fodder is harvested either by a special maize harvester, which cuts and binds the stalks in bundles, and is capable of harvesting from 6 to

8 acres a day, or it may be done by a home-made implement in the form of a sickle or blade attached to a sliding platform. The ordinary cane-knife is used for cutting maize by hand.

(3) *For Grain and Stover.*—Where the stover is required to be of as much feeding as possible while the grain is also needed, it will be necessary to harvest the whole stalk before the grain is mature, and to cure the stover in the field for another month or two in "stooks"



Front View of Maize Harvester

containing from 200 to 300 stalks. The best stage of cutting for this purpose is when the ears are nearly all dented or glazed and the husks dry, *though the upper leaves and stem are still green. After curing, the ears are* husked from the stooks and the stover fed to stock or stored for future use. It may be stored either (*a*) by cutting up into silage at once with other green material, and well sprinkled with water if required, or (*b*) by drying the fodder and stacking it.

This method of harvesting is mostly applicable to cold districts—more especially those which as a rule do not have particularly wet winters. The tableland districts could profitably adopt this practice.

At Glen Innes Experiment Farm a husking and shredding machine deals with the whole of the stalk, husking and shelling the cobs, shredding the stalks, and elevating the shredded fodder into a stack. Such a stack is an extremely valuable and palatable form of roughage for the winter, especially for dry cattle, which should have *ad libitum* access to it from a bush paddock.

When the grain is allowed to mature thoroughly on the stalks, the latter are of very little value for feeding purposes.

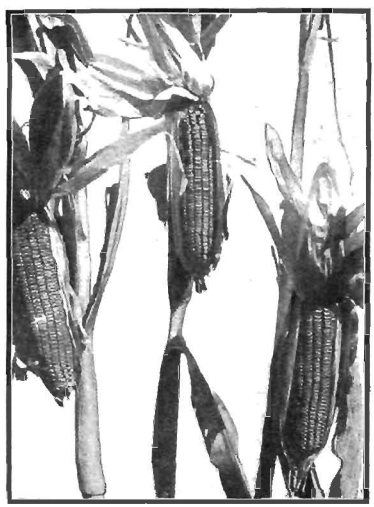
(4) *For Grain Only.*—The ears are snapped off by hand with the husks attached when they are properly dry, and carted to the barn, where they are stored for husking. In some districts the ears are husked from the standing stalks and bagged in the field. A crop is usually fit to pull when about 80 per cent. of the stalks are quite yellow.

Side View of Maize Harvester.

Yields.

A yield of 45 tons per acre of green fodder has been obtained on the South Coast, and 100-bushel crops of grain are still obtained on the coast in good seasons. The yields vary greatly with the district. On the coast 60 bushels of grain or 20 tons of green fodder are reckoned to be good crops. On the Northern Tablelands, a 30-bushel crop is profitable, although 45 bushels per acre and over have been obtained. On the Central Tableland and Central-western Slopes 30-bushel crops are obtained on upland soil in a good season, but often not more than 10 or 15 bushels per acre. Under irrigation in these districts 60- or 70-bushel crops should be possible. In the north-west

(Inverell district), a yield of 60 bushels per acre is often obtained in a good season. In the south-west (Tumut district) 80-bushel crops are not uncommon.



A good "three stalk" hill of Fitzroy Maize.

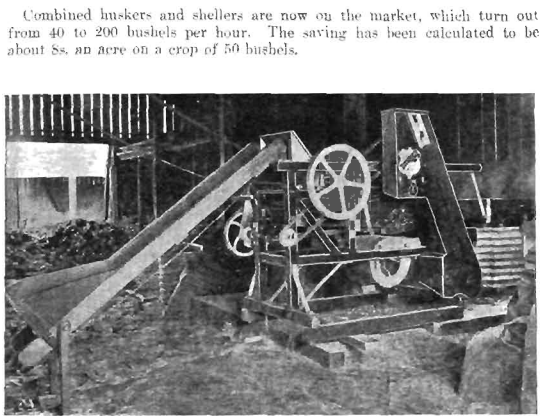
Husking and Shelling.

If the grain is to be used for pig-feed, the husking may be left to the pigs, or the pigs may be allowed to "hog down" the ripe corn in the field. This is done by temporarily fencing off small areas in the paddock and running about 20 to 40 pigs to the acre, or at any rate as many as will clean up the area in two or three weeks. In this way little will be wasted.

Pulling and husking, if done by contract, costs from 10s. to 15s. per acre, according to the crop. A good man should be able to husk about 5 or 6 bushels per hour of ordinary sized corn.

Shelling machines range in size from small hand machines, with a capacity of 2 bushels per hour, up to power-machines with a capacity of 50 bushels per hour. Shelling costs about 1d. per bushel when done by contract.

Combined huskers and shellers are now on the market, which turn out from 40 to 200 bushels per hour. The saving has been calculated to be about 8s. an acre on a crop of 50 bushels.



Maize Husker and Sheller, in use at Grafton Experiment Farm.

Mechanical Maize Harvesters.

Mechanical maize pickers which, it is claimed, are meeting a big demand from maize-growers in other countries because they make available a method of harvesting that eliminates pulling and husking by hand, and for that reason alone are considered to justify the expenditure necessary for their purchase, are now being put on the market. Under New South Wales conditions, however, it would be obviously unwise for a grower to procure a machine when he has only a small area, but for the growers in the inland maize districts there should be much of interest in a description of such a machine. On the coast maize is customarily, and advisedly harvested in the husk, and the individual areas are too small to warrant the purchase of a machine as a business proposition.

A maize picking and harvesting machine was recently imported into Australia by the Victorian Department of Agriculture and tested out in the large maize-growing areas of Orbost and Lindenow under actual field conditions in a light crop, which yielded about 35 bushels to the acre. Weeds (milk thistle, mustard, and trefoil) were thick, and in the middle of June were sufficiently dense to keep the ground and stalks wet and tough throughout the day. The picker was originally intended to be used with the elevator loading direct into a box wagon, which it pulled along at the picker's side, but the substitution of a platform to hold about eight bags of cobs was found to be a distinct advantage, eliminating the need for a wagon and team, and permitting of the bags being taken off and stacked at convenient collecting points.

It is possible to work the machine with horses, but this practice is not recommended as the power required is comparatively high and the rate of progress when horses are used is too slow. At Lindenow a 10-20 h.p. tractor was used with a power take-off, and the outfit worked quite satisfactorily.

The crop was planted with rows 3 feet apart, and the machine worked in lands and picked and husked the cobs very efficiently. When the stalks were bent down and away from the rows the cobs were all collected, and only in those cases where the stalks were lying lengthwise along the row, and in the same direction as the machine was working, were cobs missed. With the tractor outfit the machine travelled at about 3 miles per hour and operated on one row at a time. In its method of approaching the crop, the machine is similar to a maize binder, but it has two knobbed rollers revolving between the guides, and these pull the cobs from the stalks and carry them up by means of these rollers working on the screw conveyor principle. The cobs in the husks are then directed to a set of four pairs of husking rollers on which are short spikes to catch and remove the husks, the cobs being retarded by four spring-actuated plates whilst the rollers are removing the husks. The cobs are then conveyed by means of an elevator to the bagging platform. If the crop is harvested on the green side some of the grain is bruised by the husking rollers, and, on the other hand, if the crop is very dry a little of the grain is shelled, but this is no great fault as it is collected by the elevator buckets. The crop in which the machine was seen operating was uneven in maturity—while some cobs were dry others were very immature.

The machine tried is not unduly complicated in construction, and although some of the quicker-moving parts are light, allowance could be made for a fast rate of depreciation without the costs of operation becoming excessive. The following costs were taken from the actual field tests supervised by the Victorian Department of Agriculture:—

	Orbost Trial.	Lindenow Trial.
Actual time worked	3½ hours.	3½ hours.
Bags (105 lb. each) harvested ...	169	96
Labour	£2 5s. 0d.	15s. 3d.
Fuel	8s. 10½d.	9s. 1½d.
Estimated yield of crop	92 bus. per acre.	35 to 40 bus. per acre.
Cost per bag to harvest	3¾d.	3d.

To these figures must be added the depreciation and cost of upkeep of the machine and the tractor, and these were liberally estimated at 1½d. for the Orbost trial, and 2½d. for the Lindenow trial, making the total harvesting costs per bag 5¼d. and 5½d. respectively at the two centres.

The Storage of Maize.

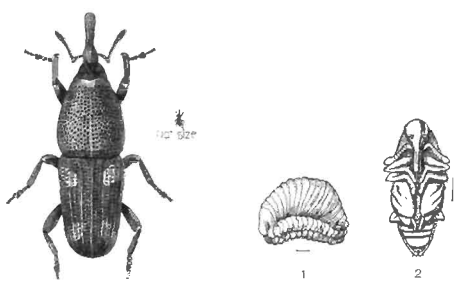
The climate of the North Coast is better suited for maize than that of any other portion of the State, and the greatest production of the crop is centred in this area. In this district, however, the toll taken by insect pests (chiefly weevil) is much greater than in any other. The individual maize-grower suffers much annual loss from weevil, as much as 10 or 15 per cent. of the crop being estimated in some cases to be destroyed by this pest. The North Coast farmer regards this loss almost as a necessary evil. Although he sometimes gets the bulk of his maize off to market before it

becomes too badly affected, he has perforce to keep a portion of it back for feeding on the farm until his next season's crop becomes available, and as this portion is not subjected to any protective treatment, it usually suffers considerable damage. This loss can be very largely avoided by the farmer. Many North Coast maize-growers have solved the problem of keeping sufficient seed maize free from weevil to enable them to have good sound seed for planting, and it only requires an extension of this system to save greater loss on the bulk maize.

It is necessary, in order to apply intelligent methods of control, for the farmer to understand something of the life-history of the insects which are chiefly responsible for the damage of maize grain in storage. The most important of these, by far, are the so called "grain weevil," which is really the rice-weevil (*Calandra oryzae*), and the Angoumois Grain Moth (*Sitotroga cerealella*).

The "Grain Weevil."

The "grain weevil" is a black to reddish-brown insect, about $\frac{3}{16}$ in. long, with a long proboscis or snout, at the end of which is its mouth. Many farmers persist in thinking that the grain moth is a stage of the weevil and that the weevil itself cannot fly. The first two things that farmers must learn about this insect are—(1) that it has nothing whatever to do with the



The Adult Weevil. 1.—Larva. 2.—Pupa.

Common Grain Weevil (*Calandra oryzae*).

grain moth, which is an entirely different insect, with its own life-history, and (2) that the weevil itself has perfect flying wings under its black wing covers and that it can fly.

Fields of maize become infested with weevil which fly from the sheds and barns at the time the crop is ripening. These weevils lay their eggs on ears of maize which have a poor or damaged husk covering and are thus exposed to view or to the ready entrance of the weevil. Ears which are well covered with a close, tight-fitting husk are almost invariably free from weevil infestation. Once inside the husk, the weevil travels about

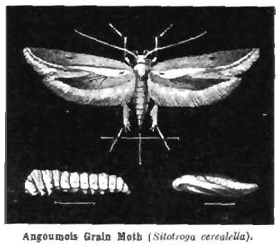
the ear freely and lays its eggs on the grains. The weevil punctures the grain with its hard minute jaws which are at the tip of its sharp proboscis, and lays an egg in the small cavity of the grain. The egg (too small to be distinguished by the naked eye) is then covered with a cement-like secretion for protection. A minute grub hatches out, and eats its way into the grain. On practically every grain which is infested is seen the white tunnelling mark left by the grub. This mark is not difficult to detect in red or yellow varieties of maize, and farmers should be on the look-out for this first sign of infestation, for its detection means a lot in the early treatment and control of the pest. The young grub has hard chitinous mouth parts, brownish black in colour, which it uses for eating its way into the grain. The rest of the body of the grub is very soft, creamy white in colour, and very thick, with the under surface straight and the back very much raised and curved into an almost semicircular form. Much damage is done to the grain by the weevil grub at this stage, as a good part of it is eaten before the grub changes to the pupa. In the pupal stage the insect elongates in form and is surrounded by a pupal skin, which is cast off when the pupa changes to the adult weevil. The pupa is white or creamy white in colour at first, but before it sheds the pupal skin, a considerable brown or reddish brown coloration appears. When the pupal skin is shed and the adult emerges, it remains inside the grain for three or four days actively feeding. It is usually during this stage that the germ of the grain is injured. The adult weevil finally forces its way out, leaving the characteristic small irregular hole in the grain. It then mates and the females lay eggs on sound grain for the next brood.

During favourable (warm, moist) weather, the eggs hatch in about three days. The grubs become full grown under the same conditions in two or three weeks, and the pupal stage may be gone through in three or four days. The whole life-history may thus be passed in a month or less, but each of the stages in development may be prolonged for months under unfavourable conditions. In the egg, grub, or pupal stages, the insect is somewhat resistant to injury from fumigants and cold weather. Infestation in the field may occur in the dough stage of the grain, and in an early maize crop on the North Coast ripening in warm weather the next brood of weevils is already out by the time the grain is mature. The female adult weevil lays about 200 eggs, and theoretically, if all these eggs were to hatch and live to mature, it is possible for a single pair of weevils to increase to 200 in one month, 20,000 in two months, and 2,000,000 in three months. Even under practical conditions, therefore, weevils breed up and increase in numbers very quickly, and the amount of damage they do if left unchecked is not surprising. Cold weather checks the activity and development of weevils, and the winter on the North Coast, even though mild, holds the weevil in check for a time, but it is ready to resume its work of destruction in spring

There is an impression that maize from certain districts (such as the tablelands and Tumut) has some qualities which resist or repel weevil, but the fact is that in these districts weevil does not exist in any stage in the maize grown there, as it matures in the winter and the climate is so cold that weevil could not live through it. But let Tumut or tableland maize be taken to a coastal district and exposed to weevil and it will soon become infested. Hard, flinty maize is also supposed by some to be resistant to weevil, but although it may be somewhat less attractive to the weevil than soft maize, no maize is too hard and flinty for the weevil to attack.

The Grain Moth.

There is a widespread opinion among farmers that the Angoumois grain moth is a stage of the weevil just described, but a knowledge of its life-history at once dispels the idea of any connection between these two insects. Moreover, the Angoumois grain moth is found in many districts where the weevil does not exist, —even in the tableland district. It is only in the very coldest districts where but little maize is grown that the climate is too severe for the grain moth.



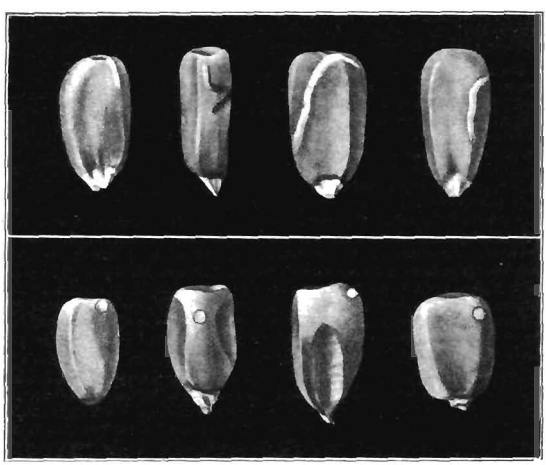
Angoumois Grain Moth (*Sitotroga cerealella*). Moth, Larva and Pupa.

The moth is of a pale buff-brown colour, about $\frac{3}{8}$ inch in length, and $\frac{1}{2}$ to $\frac{5}{8}$ inch across the expanded wings. It also has a few dark-coloured markings on the fore-wings, and a fringe of hairs on the lower side of each pair of wings. It is active at a lower temperature than the weevil, and consequently does more damage than the weevil during the winter, laying eggs when the weevil is inclined to be quiescent. One or several eggs are usually laid at the base of the grain on the ears while they are still immature in the field, only the tip grains on the ear usually being affected at this stage. The grain moth differs again from the weevil in that it seems to be able to infest any ear, no matter how well it is covered by the husk. It is not clear how the delicate moth can directly cause this infestation in ears so well protected, but the fact of infestation suggests that the young caterpillars find their way down through the dried silk to the grain.

Under favourable conditions, the young larva or caterpillar hatches out from the egg in a few days, and usually makes its way directly into the grain near the tip. On feeding further into the grain, it makes a straight burrow just large enough to hold it, and leaves a circular patch of skin or hull on the outside of the grain which can easily be pushed aside by the mature moth when ready to emerge. The size attained by the larva seems to be determined by the size of the grain it enters. In wheat or in the small grains at the tip of ears of maize, the caterpillar grows no larger than $\frac{3}{8}$ inch, but in large maize grains it grows to over $\frac{1}{2}$ inch in length. The grain moth caterpillar is easily distinguished from the weevil grub by its greater length, cylindrical shape and annulated or winged appearance. Two or three grain moth larvae are often seen in a single maize grain, and the characteristic sign of their presence is always the circular piece of skin already referred to which is left on the grain. Unlike the weevil grub, the grain moth caterpillar usually leaves no sign of the point at which it enters the grain.

After eating its way through the grain in a straight line to the opposite side near the crown of the grain, the full-grown larva spins a light cocoon round itself and pupates, or goes through a resting stage before changing into the adult moth. The larval or caterpillar stage usually lasts about three weeks, and the pupal stage a few days under favourable conditions; but, as in the case of the weevil, each stage may be prolonged considerably when these conditions are absent.

The moth is so delicate that if any obstacle is placed in the way of its emergence from the grain the pest is at once controlled. This actually happens when the grain is shelled and stored in bulk or in tightly rammed bags. A grain pressing tightly against the exit hole of the infested grain will entirely prevent the moth from making its egress, and consequently no further infestation of the grain can take place. Stored in the ear, moth-infested maize goes from bad to worse. So the control of grain moth in maize becomes quite simple and effective—shell and store in bulk.



Evidences of Insect Attack.

The top grains show the characteristic white mark made by the Weevil.

The bottom grains, attacked by the Grain Moth, show the circular patch of skin or hull on the outside of the grain, which can be easily pushed aside by the mature moth when ready to emerge.

There are indications that the grain moth in all its stages (caterpillar, pupa, and moth) resists fumigation with carbon-bisulphide (see page 141) to some extent at low temperatures, though this may possibly be due to the fact that the gas does not diffuse so readily in cold weather. It is advisable, therefore, to select a warm day for this operation should treatment be found necessary during the winter.

Dispose of Early-harvested Maize.

On the far North Coast, late sown crops of maize (December and January) mature in July or August and are generally comparatively free from weevil in the field at harvesting, but they only remain so until September or October,

and from then onwards weevil makes headway and causes great loss if the maize is held through the summer without protection or treatment. In this district, however, early maize can be sown in August or September, and it will be mature and fit for use on the farm in December or January. There is a period of a few months, then, on the North Coast farm in which maize must be stored for use on the farm, and during which it must be treated in storage to prevent loss from weevil. The early-sown crops are affected with weevil in the field before harvest, and a fair amount of practically unavoidable damage is done to these crops before the maize can be treated. The amount of damage done to a maize crop in the field depends largely on the time between the maturity of the crop and the advent of cold weather, the earliest maturing crops usually suffering most. This is because the weevils which have bred out from the over-wintering stage fly out from the sheds and barns to the earliest maturing crops in the vicinity. Such crops, ripening their grain in warm weather, when the development of weevil is at its height, quickly become infested, and if left for any time become liable to additional broods of weevils, which increase rapidly in numbers with each brood while climatic conditions remain favourable. On the advent of cool or cold weather, the pest becomes less prolific and destructive, and maize crops which mature in winter are not generally much affected.

It will thus be seen that early crops of maize which ripen in warm weather require to be harvested quickly in order to save loss from weevil in the field. There is of course a danger in harvesting this maize while too soft and storing it in a shed, as heating may develop which will favour further marked damage from weevil and moulds. Maize which is inclined to be soft or to contain excess moisture generally stores better if the husk is removed, and the removal of the husk in harvesting weevil-infested maize also has the effect of disturbing the weevils and shaking a large number free from the cobs, so that fewer weevils are taken into storage with the maize.

The best advice that can be given regarding such early harvested maize is to get it on to the market as quickly as possible, not attempting to hold it for feeding on the farm any longer than necessary, nor attempting to store it for a better price. In the first place, the price of maize from December or January to March or April is usually higher than it is later on in the winter or in spring. In addition to this, a loss in weight takes place from loss of moisture and from weevil damage, and in order to cut these losses of price and weight, it is far better business for the farmer to sell early harvested maize as soon as it can be shelled. To do this, farmers will see that it is an advantage to husk the maize in the field at harvesting to facilitate drying and to rid the maize of weevil for the period of storage necessary before it is sufficiently dry to shell. Where large areas are grown, they are dealt with more economically, of course, by harvesting in the husk and shelling with the husker and sheller. Generally, however, on the far North Coast, large areas of early maize are not grown because the seasons are not so favourable as they are to late maize.

In the circumstances, it is not desirable to attempt to store the early maize crop. To store coastal maize successfully and economically for any length of time it must be stored as shelled grain. Shelled grain will not store successfully in bulk unless it contains less than about 14 per cent. of moisture, and while one is waiting for an early maize crop to dry sufficiently to shell and store safely, weevil is making rapid development and causing serious destruction.

Store the Late Maize Crop.

For these reasons, it is the late rather than the early crop which should be stored on the farm if any maize is going to be held for any time. As previously mentioned, maize crops maturing in winter are practically free from visible weevil life and remain so until the warmer weather of spring. But by this time the maize has dried out naturally to a sufficiently low moisture content for shelling and safe storage in bulk, and it is this maize which lends itself to storage on the coastal farm.

The plan should be adopted by the coastal farmer of gaining experience by storing sufficient of this late crop in early spring for farm use to tide him over until part of the early crop comes in. Then, should the experience thus gained lead him to the belief that such maize can be stored efficiently for an assured market rise, the storage accommodation can be extended to make provision for this. Undoubtedly the best method of storing such maize is as shelled grain in galvanised-iron tanks specially constructed for the purpose, as described in detail on page 440.

Field Methods of Minimising Weevil Damage.

Methods have already been given for dealing with the early maize crop to the best advantage. This crop develops weevils so badly, however, that any further means of minimising the damage should be considered. Such maize is generally brought into the barn or shed and stored for a time until it is fit to shell. Infestation of the crop can be reduced in the field by cleaning up the barns and sheds early in the spring when the over-wintering life commences to multiply; a pair of weevils killed then will mean several hundred thousand less at the end of the season. This cleaning up of the barns and sheds is facilitated by following the recommendation previously given to thresh the maize (usually from the late crops) held on the farm at this time, and either to sell it or store it in tanks. This will leave the shed or barn ready for receiving the early maize crop in January or February. The cleaning of the sheds must be thorough if all risk of infestation from this source—in the field and when harvested—is to be removed. Weevil-infested maize or refuse about the barns and about the field from the previous season's crop constitutes the greatest menace, being the first source of infestation of the early crops in the field in summer.

Sheds for holding maize are best constructed with a concrete or tight wooden floor, but in many cases (by design, or because of the rudeness of their construction) the sheds have an open floor through which much refuse falls, and the shed floor is so close to the ground that there are no easy means of removing this refuse, which is literally full of weevil life. In such sheds, the best that can be done is to get some sort of deterrent, such as a mixture of naphthalene and slaked lime (1 part to 20), and heavily dust it through the floor to cover the refuse.

Clean harvesting in the field and good deep ploughing soon after harvest also deprive the weevil of cover and breeding ground or material, and assist greatly in minimising the carry-over of life and subsequent field-infestation of the early crops.

The continued selection, especially in early maize, of ears which are effectively covered with a long, close fitting husk that keeps out weevil is another means of minimising damage, and should receive attention from every coastal farmer. Unfortunately little or no attention is being paid to this possible phase of improvement. With the advent of combined husking and shelling machines, seed maize selection has largely become a lost art with many farmers, but, from the standpoint of lessening weevil injury alone, coastal farmers will find continued selection for the improvement of the husk covering well worth while.

The question arises whether it is better to harvest maize in the husk or to husk it from the standing stalks. The usual method on the North Coast is to pull the ears in the husk and store in the shed until fit to shell or until required. On the larger farms contract or private husker-shellers are used, but on the smaller farms hand-husking is resorted to, followed by shelling with a small machine by the farmer himself.

On the South Coast and in the cooler tableland districts, where weevils are not very injurious or are altogether absent, and where the winters are colder and the maize takes longer to dry out, it is advisable or necessary that the ears should be husked before storing. On the average North Coast farm, maize in the ear, either husked or unhusked, cannot be successfully fumigated in the usual type of shed, and the question is, how does maize keep best—husked or unhusked? It has been mentioned that in the case of early maize on the North Coast, it is better on reasonably small areas to husk from the standing stalks, thus ridding the ears of a large number of weevils, and reducing the number carried into the storage sheds. For it is better, as previously stated, that this early maize should not be kept long. Even late maize should not be kept too long in the cob; it is better shelled and stored as shelled grain. But where there are no facilities on the farm for storing as shelled grain, and where late maize has perforce to be kept on the cob, it will be found best on the North Coast to keep it in the husk. Such late maize is not greatly infested at harvest (in the winter), and if it were husked it would be at once exposed to weevil which had been breeding in the shed from the early crops. Unhusked, only those ears which are not well covered with husk are infested for the most part, and with a variety which has been well improved in respect to its husk covering, late maize stored in the husk will keep very well for some time. It has been suggested that, in average varieties, it would be a good plan to separate at harvest the well covered ears from those poorly covered with husk, and that the former could then be kept for a very long time, but this is not quite a practical suggestion. Moreover, detection of infested ears from the appearance of the husk in every case is scarcely possible, while earworms and rodents lessen the protective value of the husk covering in storage, so that apparently resistant ears may become infested.

Summing up, it appears that the North Coast farmer would be best advised to husk the early maize at harvesting if the area is not too large and if hand-husking is the usual practice on the farm, and to harvest and store the late crop in the husk. At present, for the most part, the whole of the maize crop is harvested and stored in the husk.

Treatment of Ear Maize in Storage.

Maize sheds on the North Coast are generally of open batten or slab construction, allowing the air to enter freely so as to facilitate drying of the ear corn. These sheds cannot be made sufficiently airtight for effective fumigation without much trouble, and even if they could be temporarily closed for fumigation of the maize, they would have to be opened soon afterwards to allow the maize to dry, and it would then become again infested with weevil. This is because fumigation does not kill weevil in all its stages, the egg stage (and probably the pupal stage) escaping the effects of the gas, and when fresh air is admitted these stages of the insect pursue their development if other conditions (warmth, moisture, &c.) are favourable. In some quarters it has been suggested that a small specially-built, airtight chamber or room might be added to the shed, and that all maize which is to be stored in the open shed be first fumigated in this chamber in small batches, as it is brought in from the field. But, as previously mentioned, re-infestation may take place in the shed after fumigation, and it does not seem to be worth while fumigating maize in this way. As it is so difficult to do anything in the way of treating maize in the ear in the storage sheds, storage of any quantity for any length of time in this form is not advisable. There is an impression current that maize in storage requires to be aerated to be kept properly, but this does not apply to maize that is sufficiently dry.

As soon as storage in the ear has gone on long enough to dry the maize down to a safe moisture content for shelling and storing in bulk the programme should be proceeded with. As already stated, this will be about September or October on the North Coast.

Tank Storage of Shelled Grain.

There are two essentials for the safe storage of maize grain in bulk—

(1) A moisture content sufficiently low to prevent heating or mould.

(2) Reliable precautionary measures and effective treatment against insect pests in storage.

In tank storage it must be borne in mind that the maize has no means of getting rid of any surplus moisture, and that once it is in the tank if it begins to heat the whole mass may be totally spoiled. Great care must be exercised in seeing that the maize has dried out sufficiently if such loss is to be avoided. It may be reckoned that maize grain is safe for bulk storage when its moisture content is below 14 per cent. Innumerable instances of the safe storage of maize in tanks in different parts of Australia can be given, and there need be no fear of damage from heating, provided the moisture content is sufficiently low. If any farmer is in doubt as to the moisture his maize contains, a sample sent to the Department of Agriculture in an airtight tin or bottle will be examined and an opinion given as to whether its storage would be safe.

The remaining essential for safe tank storage of maize is the treatment for weevil. On the North Coast, or, for that matter, in many other parts of the State, it must not be taken for granted that weevil is not present in

the maize because it is not visible. The grain may be quite sound and yet may carry the eggs which later hatch out and develop the larvæ. So that even when apparently weevil-free maize is put into an airtight tank, it must be remembered that weevil in some form is introduced into that tank.

Now the weevil is a very hardy insect, and will find most conditions favourable for its life, if not for its active development; but there is one thing that it cannot withstand—an absolute depletion of oxygen for any length of time. It can live on a very small amount of oxygen, but if totally deprived of it for long it will succumb.

There are two methods of displacing the oxygen in an air-tight tank, and each has proved eminently successful in killing weevil and in preventing any further damage by it in any of its forms:—

(1) The tank is filled *absolutely* full of maize to the extent of ramming down the last bit put in, so that there is no space in the tank unoccupied. If the tank is airtight and the lid is then sealed on, any weevil present will soon be killed; the vital processes going on in the grain probably use up the oxygen in the tank, and produce carbonic acid gas. The maize can be stored thus indefinitely. This has been amply proved by tests at Grafton Experiment Farm with maize which was badly infested with weevil when tanked. Thus, without fumigation of any kind, maize can be kept sound in a tank.

(2) After nearly filling the tank with grain, a lighted candle is placed on top and the tank sealed. The burning of the candle exhausts the oxygen, and the atmosphere in the tank mainly consists of carbonic acid gas, which kills the weevil.

In these two methods the efficacy of the treatment depends on the complete sealing of the tank, a nail hole or crack being sufficient to jeopardise success.

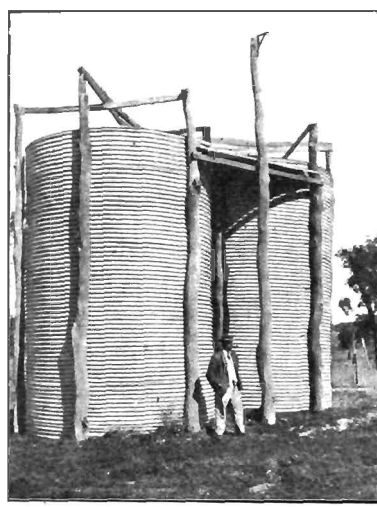
Fumigation is a satisfactory method of killing weevil in stored grain, and is essential when the tank is not absolutely airtight or cannot be made so. For this purpose nothing is better than carbon bisulphide, a heavy liquid which is completely volatile, evaporating on exposure to the air. It must, therefore, be kept in a tightly-stopped container. When carbon bisulphide evaporates it forms a rather foul-smelling gas which is about two and a half times heavier than air, and thus, if the liquid is poured on to the maize at the top of the tank, the gas at once diffuses and penetrates the mass of grain completely. There is no danger of the largest mass of grain not being fully penetrated by the gas if sufficient is used to saturate the air space. Carbon bisulphide is a very inflammable liquid or gas and will explode like benzine if a naked light is brought near it.

If the tank is absolutely airtight, 4 or 5 lb. of liquid carbon bisulphide are sufficient for 1,000 cubic feet of air space. Where the tank is even questionably not airtight this quantity must be increased fourfold or more. A well-constructed tank can, however, be made quite gas-proof, and this will ensure greater success in keeping the maize, as well as lowering the cost of fumigation. A tank of 1,000 gallons capacity will contain 160 cubic feet and will hold about 128 bushels of shelled maize. With a gas-proof tank less than 1 lb. of liquid carbon bisulphide would be required for this cubic content if it were free, but as much of the space is taken up by the maize,

about ¼ lb. will suffice. With a tank not gas-proof this quantity would need to be increased to 1 lb. or more. In the large concrete silos at Atherton, North Queensland, 700 tons of maize is satisfactorily fumigated in one bin 70 feet high, with 2½ gallons of carbon bisulphide with the bin tightly closed.

The cost of fumigating grain with carbon bisulphide as above is about one-thirtieth of a penny per bushel. No other fumigant is as cheap.

Fumigation is best done in the warmer part of the day if in winter. Not only are the weevils more active under the warmer conditions, but they are more susceptible to the effects of the gas.



Tanks used for Storing Maize on the Farm of Mr. J. Kozmlosky, Cootamundra.

The liquid should be poured straight on top of the maize in the tank and the lid put on and sealed at once. If the tank is quite airtight no more fumigation is needed, but if the gas can escape even slowly, or if the tank is opened up at any time, it will require another fumigation.

Fumigation with carbon bisulphide does not injure the grain for food, the disagreeable odour passing off on exposure to the air. Neither does fumigation with this substance injure the seed for germination, providing the maize does not contain any excess moisture. A common practice among Clarence River farmers is to keep seed of the early crop by sealing down in a can with carbon bisulphide until planting time, about nine months later.

If the moisture content is excessive and the seed is subjected to the gas too long, the viability or germinating power of the seed will be injured, so that if there is any doubt about the moisture content of seed maize it should be fumigated for twenty-four hours and then aerated, with another treatment in two or three weeks' time.

The tank should not be filled with maize, nor should fumigation of seed maize take place on a very humid day, as the grain may take up sufficient moisture to cause trouble from heating, or from injury by the gas in the case of seed maize.

Type of Tank for Storage.

The ordinary corrugated galvanised-iron container is the most efficient and economical for the storing of maize on the farm. The storage may be done in one large tank or several small ones, as desired, though the large specially-constructed tank will be found cheaper. Provided the maize is quite dry and safe for storage in bulk, it can be bulked in any quantity without danger from heating without any turning, stirring, or aeration. It is only when its moisture content is doubtful or over the safe margin that such treatment is necessary. Facilities for these treatments are usually provided for in large-scale silo storage, but as they must necessarily be dispensed with in individual tank storage on the farm, it can be seen how important it is to have the maize of sufficiently low moisture content. It may be thought by some that several small tanks are safer than one large tank for storage on the farm, because if a portion of the maize is unexpectedly high in moisture and begins to heat the loss is confined to one tank, but it must be reiterated that with the proper safeguards as to moisture content, no trouble is likely to arise from this quarter. Several small tanks in place of one large one may, however, be preferred for convenience in filling and emptying.

The tank (or tanks) must be made absolutely impervious to rain, and it is necessary either to have a well-constructed and soldered top, or else to put the tank under cover. For efficient and economical fumigation, and to keep out moisture and air, the sides must be riveted and soldered where the iron joins or fits together, and the bottom of each higher ring should fit outside the top of the lower so as to prevent water finding its way into the tank. If not covered, the top of the tank should be constructed in such a way, and a method of filling devised, that will not allow the top to become dished and hold water. A scaffolding and small platform used for the operation of filling such a tank is essential in the absence of a firm, raised top, and a specially-constructed porthole for filling.

A tank of 1,500 gallons capacity will contain about 240 cubic feet, and will hold about 196 bushels of maize. Large galvanised-iron tanks of about 1,200 bushels capacity, with timber stand, have been built in New South Wales at a cost of about £40, and smaller tanks with the necessary stand would not cost more than 1s. per bushel capacity. Such tanks are not subject to rust like water tanks, and therefore have a much longer life, and the interest charge on the cost of construction of tanks for storing

maize may be reckoned to be less than 1d. per bushel. This should put them within the reach of every farmer, and within the range of ambition of every coastal maize-grower who wishes to make more profit from his crop.

Sweet Corn.

Though the culture of sweet corn is chiefly confined at present to small patches in a few market gardens and to a few stalks in home vegetable plots, its use as a green vegetable is slowly gaining ground in New South Wales, and seed of many varieties can now be obtained from local seedsmen. The local canning of the product might also develop into a profitable industry, as we at present import the whole of our canned sweet corn from the United States and Canada.

Sweet corn differs markedly from field maize not only in its better flavour —due to a higher sugar content—but also in the appearance of the seed and the growth of the plant. Hickory King—a well-known white field variety—is often put on the market as sweet corn; but there is a great difference in flavour between it and good sweet corn. The seed of the latter is translucent, of waxy appearance, and wrinkled over its whole surface. Sweet corn does not grow very tall, and, besides suckering profusely, often bears two or more ears per stalk, which seldom attain the size of the hardy dent or field maize.

It is even more imperative than for the field crop that sweet corn should be grown on rich soil well supplied with organic matter and humus to retain the moisture in the soil during growth. The addition of stable manure is the best way of increasing the humus content, and this needs to be supplemented by 1 to 2 cwt. of superphosphate to supply the phosphoric acid in which stable manure is deficient. A top-dressing of ½ to ¾ cwt. of nitrate of soda about six weeks after planting will hasten the growth, especially where nitrogen is deficient in the soil.

Sweet corn should not be planted too early, as the seed rots more quickly in cold soil than field maize, and the young plants are also more sensitive to the cold. In order to have sweet corn during the whole of the season, successive plantings should be made about every three weeks. At least two (better three) rows should be sown at one time, as with single rows the cobs are not properly filled with grain, the result of poor fertilisation at flowering time. It is best to sow the corn in "hills" 3 feet or 3½ feet apart each way; and better results will always be obtained by sowing about six grains per hill and thinning out to two or three plants per hill when they have attained a height of 6 or 8 inches. In this way the strongest-looking plants can be left in each hill and the weakest removed. In the Sydney district, planting can commence towards the end of September and continue until February.

The cultivator should be kept going between the rows to conserve the moisture in the soil, but this cultivation should never be deeper than 3 inches, especially when the plants are well up, otherwise a lot of valuable feeding roots will be destroyed.

The usual practice is to remove the suckers, but this should not be done too early. It is better left until after flowering has finished.

The correct stage to harvest is only recognised after some practice. If pulled too young and before being fully developed the quality is poor, and the elapse of two or three days after the proper stage renders the corn too

hard and flavourless. The proper stage is when the grains are in full milk and just about to turn to dough. Outside indications are when the ear is plump, the silk changing from brown to black in colour, and the tassel brown or changing from brown to white.

As sweet corn rapidly loses its flavour after picking, especially in hot weather, it is advisable to leave the harvesting until as late as possible before marketing, cooking or canning; a few hours makes an appreciable difference in the quality.

As a rule, the late varieties, like Stowell's Evergreen, Country Gentleman, and White Evergreen give the largest and the greatest percentage of marketable ears, but some of the early varieties, like Golden Bantam and White Cory, are suitable for the home garden on account of their excellent flavour.

A fair yield is from 300 to 500 dozen marketable ears per acre, and the market price is usually about 3s. per half-bushel case or crate, which generally holds just over two dozen cobs.

In saving seed the corn should be allowed to ripen thoroughly on the stalk, and it should be husked and harvested from the stalk in the field on a warm, dry day, as it moulds very easily. The husked ears should be left in small piles in the sun for an hour or so, and then hung in a well-ventilated barn to cure thoroughly.

The ear-worm is the worst pest the grower of this crop has to contend with, and no methods have been devised to deal with it on a large scale, although in the home garden a lot of damage can be prevented by hand-picking the grubs and destroying them.

Sweet corn may be eaten fresh or cooked in the ordinary manner as a vegetable. One of the most appetising forms in which it can be served is by boiling it on the cob with corned meat. If it is desired to remove the grain from the cob, it should be given a preliminary boiling for ten or fifteen minutes, then dipped suddenly into cold water, and the grain scraped from the cob with a sharp knife. With the removal of the cob before proper cooking, however, it appears that much of the flavour is lost.

There are many districts in this State that are too early to mature ordinary maize where sweet corn can be successfully grown. It grows well wherever field maize is grown, and is becoming more popular in the home vegetable gardens in the city.

Pop Corn.

Pop corn is another distinct type of maize which has recently come into prominence in this State owing to the failure of supplies from America and to the greater demand which is apparently springing up for the manufactured article in the confectionery trade.

There are two varieties most favoured by the manufacturers—White Rice and Black Beauty, the latter being slightly the better for confectioners' purposes.

The districts which produce the best samples of pop corn for manufacturing purposes are the tablelands; good crops of White Rice have been grown in the Bathurst district, and of Black Beauty (which is about three or four weeks earlier in maturing) in the Tenterfield district.

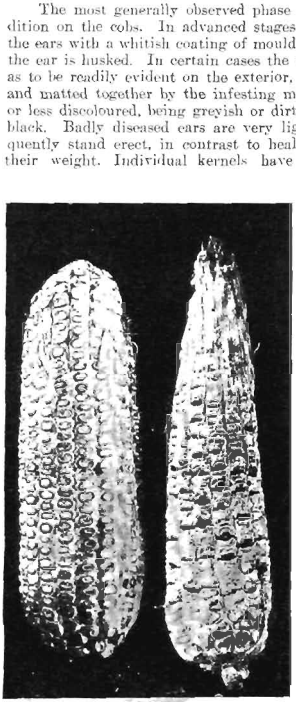
The yields obtained are usually about one-third or half that of ordinary dent maize.

Fungous Diseases of Maize.

Dry Rot (*Diplodia zeæ*).

Dry Rot or Ear Rot of maize is a fungous disease which causes a moulding or rotting of the cobs and reddish discolourations of the leaf sheaths and stalks of maturing plants. The disease may also interfere with germination.

The most generally observed phase of the disease is the dry rot condition on the cobs. In advanced stages the fungus may completely cover the ears with a whitish coating of mould which may not be noticeable until the ear is husked. In certain cases the mould may penetrate the husks, so as to be readily evident on the exterior, and the husks may be discoloured and matted together by the infesting mould. Moulded ears may be more or less discoloured, being greyish or dirty-looking or even brown or almost black. Badly diseased ears are very light in weight, shrivelled, and frequently stand erect, in contrast to healthy ears, which are pendent from their weight. Individual kernels have a dried, brown appearance, and are loosely attached to the cob; or minute, black fruiting bodies of the causal fungus may be found embedded in the flaky masses of mould between the kernels, or even upon the husks or shanks of badly diseased ears. Grain from Dry Rot cobs is useless for seed purposes. Seedlings are rarely attacked by the fungus, but the sowing of diseased seed may lead to defective germination or the development of weak plants.



Maize Cobs affected with Dry Rot (*Diplodia zeæ*).
[*After Heald, Wilcox and Pool.*

The fungus *Diplodia zeæ* causes infection by entering the silks, tips of ears, ear shanks and nodes—the last two being considered the chief points of attack. Infection may be initiated by spores which lodge in the leaf sheath cavities, germinate, and invade the host tissues, causing spots and blotches on the sheaths. The fungus may spread through the tissues from its point of entrance, and thus ears may be invaded by fungus threads that have grown upward from the node or from the shank, or downward from the silks or ear tip.

Infection occurs after flowering, and the fungus continues to grow more rapidly in the tissues of the plant parts as they

mature. The fungus overwinters in either the vegetative or fruiting condition on the old stalks or discarded ears. The minute black fruiting bodies referred to above are known as *pycnidia*, and develop from the whitish mould on affected tissue. These *pycnidia* contain numerous spores which, under favourable conditions, serve to bring about infection in other plants. These spores, which may remain viable on stalks for as long as three years, are disseminated by wind. It is of interest to note that the fungus can live also in soil in a purely saprophytic manner, independent of old host remains. The development of the disease in the field appears to be greatly favoured by warm weather and heavy rains during the period when the maize plant is approaching maturity.

In view of the facts presented above, the measures recommended for the control of Dry Rot are as follow:—

1. Collect and burn rot-infected ears, diseased stalks, &c.
2. Practise a rotation of crops.
3. Select sound cobs from healthy plants for seed purposes.

Root, Stalk, and Ear Rot.

This composite group of maize diseases is, under certain conditions, *responsible for appreciable losses in maize production in this State*. In the 1925-26 season the losses caused by these diseases were estimated at over 5 per cent., and in some parts of the State the loss was greater than 10 per cent. of the potential yield. The reduction in yield is caused by (1) defective germination; (2) reduced vigour of growth in diseased plants; (3) loss from lodged or broken stalks; (4) loss of weight in grain from improper *filling*; and (5) *actual injury to the grain*.

In the early growth of the maize plants the more common symptoms of Root Rot are poor germination and bad stands, which mostly result from the sowing of infected seed, rather than from infection of young plants by the fungus in the soil. Many slightly infected seedlings may attempt to re-establish themselves by sending out new roots from the nodes above the infected parts.

When the crop is 2 or 3 feet in height little or no sign of the disease is evident, except that on poor soils or under dry conditions a badly affected crop appears very irregular in height and growth. The fact that scattered plants in the field wilt appreciably earlier than others on a hot day is usually *an indication that root and stem rot diseases are present*.

Later in the growth period the uppermost leaves of badly affected plants commence to die off, and leaning of individual stalks occurs throughout the crop. The injury to the plants is generally most marked in the roots, which often completely rot away owing to the fungus attack. In such cases the stalks may lodge easily, and are easily pulled from the ground. Frequently the disease makes further headway in the inner tissues of the stalk, which may be almost completely rotted for the height of a few nodes above the ground. In such cases the stalks often appear quite sound until they become so weak as to break over. Such stalks also show the effect of fungus invasion by premature dying of the top leaves, and the premature ripening of the ear, in which the grain is frequently pinched or loosely attached to the core. Brace roots are sometimes developed from the nodes above the rotted part of the stem, and thus the plant is held firmly in the ground until it secures sufficient nourishment to mature grain.

Another phase of the disease is the broken or rotted condition of the shank, which frequently hangs straight down instead of bending or turning down naturally. Such shanks appear shredded or stringy when cut open. This type of injury frequently results from infection by wind-blown spores when the tissues are young and succulent. The fungus often extends itself in the form of tiny threads from the diseased tissues of the shank into the developing grain. This often accounts for the fact that apparently normal seed sometimes germinates poorly in the field.

Diseased ears may show a characteristic splitting, or dark discolouration of the grain, at the crown or dent end. A dark or brownish discolouration or softness of the core of the ear is generally an indication of the disease also. Presence of the disease on the grain points to secondary infection through the silks from wind-blown spores.

The root, stalk, and ear rot diseases of maize are caused by various species of the fungi *Fusarium* and *Gibberella*. These organisms are related to each other in that the *Fusarium* stage, found on diseased roots, stems, and cobs, later gives rise to a *Gibberella* stage—the resistant stage of the fungus, found well developed on dead maize stalks in the form of small black bodies about the size of a small pin's head. In the spring or summer the *Gibberella* spores are liberated from their cases, and initiate infection in the tender, growing parts of the plant. The *Fusarium* spores develop later from diseased tissue, and spread infection to other plants.

The causal fungus lives over in the soil and on dead stalks; it is also carried by the seed. Thus infection of the roots and stalks may result from the fungus in the soil or from the fungus threads present in the seed. The stem may become infected direct, when young and succulent, from spores flying about in the field during the growth of the crop. As stated above, the grain on the cobs may become contaminated by secondary infection through the silks, or by systemic infection from fungus threads present in diseased shanks.

Control Measures.

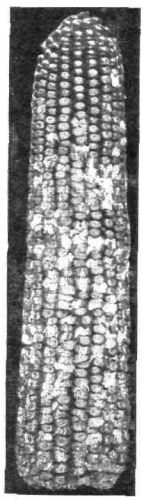
In the light of these facts the following control measures will minimise losses from these diseases:—

Field selection of seed is the most important phase of the control measures, and growers should study carefully the matter under that heading on page 406.

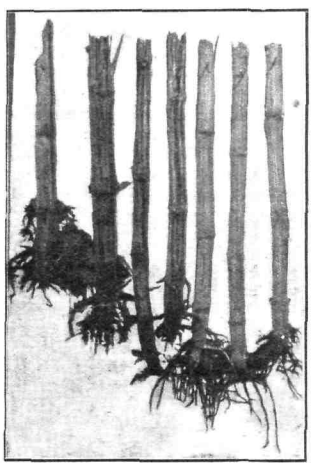
Where practicable the burning of affected maize stalks and rotation with non-susceptible crops should be carried out.

In recent years considerable attention has been devoted to the effect of seed treatment with certain fungicidal dusts and solutions for the control of seed-borne diseases of maize. Experimental results indicate that treatment with certain of the organic mercury phenol compounds largely prevents the seedling blights caused by *Gibberella saubinetii* and *Diplodia zeae*, and does not injure the seed. The beneficial effects are most marked when badly diseased grain is treated. Experimental data shows that when only diseased

seed is available for planting certain seed treatments will have distinct value. The Department is continuing the investigation of possibilities in this direction.



A Bad Case of Fusarium (splitting) disease of the grain.
Even a slight indication of this disease should be avoided in seed selection.



Root and Stalk Disease of Maize.
The three stalks on the right are sound and healthy.

Head Smut (*Sorosporium reilianum*).

This disease is widespread throughout the maize-growing districts of New South Wales. It attacks the cobs and tassels, and is usually confined to them, but, in exceptional cases, a few patches of smut may appear on the upper leaves and leaf sheaths. Head smut is usually first noticed on the tassel, sometimes converting the whole inflorescence to a mass of smut. On the other hand, single flowers may be affected. In some cases smut masses are not produced, but the affected flowers grow out into leafy structures and even into small shoots. Usually, when the tassel shows the smut all the cobs below are destroyed, though occasionally one may escape, or be only partially attacked. On the other hand, the tassel may escape when the cobs are all involved. The smut spores are enclosed at first in a pinkish membrane which soon ruptures in order to allow of the escape of the spores.

Affected plants are often stunted in growth, are brittle, and remain green longer than the rest of the crop.

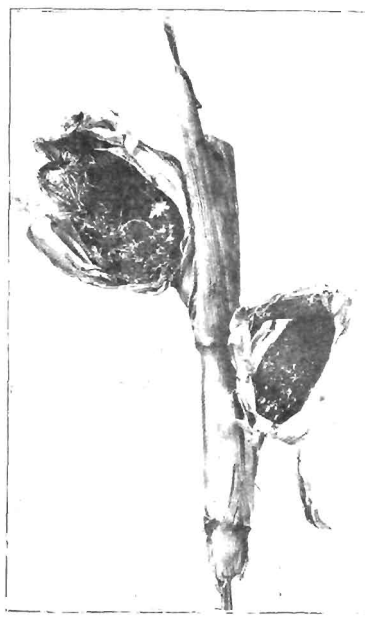
The spores of the fungus are very abundant, and drop from the smutted heads to the soil, where infection of young, germinating maize seedlings subsequently occurs. While to a certain extent the disease is spread mechanically on seed maize, the spread from a single affected plant con-

Head Smut of Maize—affected Tassel.

taminating the soil in the vicinity is probably far more important. Continuous cropping of infested land with maize or sorghum serves to increase the severity of the disease. Seed treatment for the control of the disease is not recommended.

Head Smut is to be distinguished from another smut disease of maize known as American Corn Smut. This latter disease is characterised by the soft tumours which develop on all parts of affected plants. It appeared in a

maize crop in this State some years ago, but its occurrence was promptly dealt with, and so far there has been no recurrence of the disease.



Head Smut of Maize—affected cob.

METHODS OF CONTROL.

The methods of control recommended are:—

1. Obtain seeds from uncontaminated cobs.

2. Do not grow maize continuously on the same land. Sorghum is liable to attack, and is not to be regarded as a suitable rotation crop. The spores probably persist in the soil for some years, so that, on infected land, the rotation should not include maize and sorghum too frequently.

3. Early removal of smutted heads before they have burst and scattered their spores widely. They should be collected in a tin or similar receptacle and burnt. If more care were taken in small maize crops in the collection of smutted heads, a great deal of the smut could be eliminated.

Maize Rust (*Puccinia sorghi*).

This disease is not of great economic importance in this country, but under conditions of relatively high temperature and humidity the leaves may become covered with innumerable rust pustules, lose their green colour, droop, and dry up. Under such conditions the disease would do appreciable damage.

The rust spots or pustules appear scattered, or in groups, on both surfaces of the leaf, and as they burst, disclose the reddish-brown powdery masses of uredospores, which are disseminated by the wind and initiate infection in other plants. Later in the season another type of spore—the teleutospore—develops in the form of black patches on the leaves. These teleutospores are unable to infect the maize plant direct; they infect certain species of Oxalis, and the life history of the fungus is completed by the production of another type of spore—the aecidiospore—from infected Oxalis plants. These aecidiospores are capable of reinfecting the maize plant, which, if so infected, in turn gives rise to the uredospore and teleutospore stages of the fungus. The rust on maize is a distinct species from that which occurs on sorghum.

Preliminary experiments conducted in America indicate that there are definite differences in susceptibility to rust in the different species of maize. It has been found that sweet corn is more susceptible than dent corn, and pop corn less susceptible than dent corn.

The prevention of maize rust is effected by the selection and cultivation of the most rust-resisting plants.

Leaf Stripe (*Helminthosporium turcicum*).

This disease, which under certain conditions may cause damage to maize, is found in most maize-growing countries of the world. It first appears in the form of small, yellowish, round or oval spots on the leaves. These extend along the leaf, and coalesce into longitudinal bands which may cover a great part of the leaf. The affected tissues become thin and semi-transparent, often surrounded by a lighter border, and at this stage are more or less covered with very delicate dusky patches, due to the fructifications of the fungus. The diseased leaves gradually dry up, and have a burnt or frost-bitten appearance. This has the effect of checking growth and weakening vitality, with the result that the plants often fail to mature properly.

This is a difficult disease to control, but burning of diseased stalks and rotation of crops are useful preventive measures. The selection of a resistant variety, however, is perhaps the most hopeful method of solving the problem. Departmental experience has been that there are no immune varieties, but that Fitzroy, Golden Nugget, Hickory King, and Golden Superb are resistant.

Moulds.

Upon maize which has been allowed to become and remain damp, various moulds speedily develop, the most commonly found genera being *Mucor*, *Penicillium*, *Aspergillus*, and *Fusarium*. All of these fungi rapidly produce innumerable spores, and they may give rise to disease in animals or birds in two ways—either (*a*) by direct infection from spores, or (*b*) by setting up disturbances of the digestive or nervous systems when eaten. Direct infection from spores is not very common, but fowls may become infected by the spores of *Aspergillus fumigatus*, the symptoms being listlessness, moping, and disinclination to follow the rest of the flock. When made to run they soon become exhausted and fall, and have great difficulty in breathing. There is great thirst and a diminution of appetite. The birds become rapidly emaciated, comb and wattles become quite pale, and there is intense diarrhœa. Very little can be done in the way of treatment in the case of birds. To prevent the disease, do not feed mouldy grain.

It must be admitted that experiments carried out by feeding animals with mouldy maize have given contradictory results; nevertheless, there can be little doubt that feeding mouldy maize may, and frequently does, give rise to disturbances of the digestive or nervous system more or less serious in their nature, and that mouldy maize as feed for horses, cattle, or fowls should be avoided.

Insect Pests of Maize.

About twenty-eight species of insects have been recorded attacking maize either in the field or when stored. Of these, twelve (notably beetles and moths) cause serious losses to stored grain, and sixteen attack growing maize in the field. Of the latter the Corn Ear worm, Monolepta beetle, Yellow Maize moth, Pink Corn worm, and cutworms may be regarded as major pests when prevalent. Such pests as the Corn Ear worm and the Yellow Maize moth in particular are very difficult to control, as they feed during the greater part of their lives in protected positions. Owing to the nature of the crop, and the fact that individual treatment of each plant is impracticable, control of any of the insect pests of maize is unusually difficult.

The Common Grain Weevil (*Calandra oryzæ*) and the Angoumois Grain Moth (*Sitotroga cerealella*), the most important of the pests of stored maize are discussed under the heading "The Storage of Maize" on page 432.

Maize Moth or Corn Ear Worm Moth (*Heliothis obsoleta*).

A general description of this pest appears under the heading "Insect Pests of Tomatoes," in the section on "Vegetable Crops," but on account of the different type of the crop attacked, the nature of the injury to maize is entirely different.

In the early stages of growth some damage is caused to the unfolding leaves, but when the tassels appear they are soon attacked, but are later deserted by the caterpillars for the ears. After the silks appear, eggs are

laid on them in preference to any other parts of the plant, but scattered eggs may also be found on the leaves or sheaths of the ears. Commonly the point of attack is the top of the ear or small round holes in the sheath *may mark the entrance or exit of the caterpillars. Such damage also* permits the entrance of moisture and moulds, with the result that the ears may be rendered entirely worthless.

Control Measures.—Control of this pest is very difficult. Spraying with arsenate of lead about the time the moths are laying their eggs on the silks is an effective control if properly done, but has never been considered practicable owing to the cost of such a method as compared with the value of the crop.

The cob showing a Corn Ear Worm *at site*

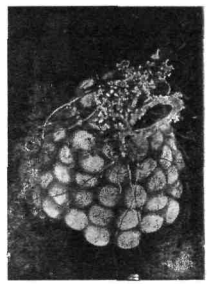
Cob showing two entrance holes bored through the sheath by Ear Worms.

The character of the husk is an important factor influencing injury to maize. Ears in which the tops are well protected by the husk closing tightly around the silk are much less subject to injury, and growers should endeavour to grow varieties having desirable husk characters.

Working the soil to break up the earthen cells containing the pupae is also advisable.

Yellow Maize Moth (*Dichocrocis punctiferalis*, Gn.).

The body and wings of this moth are bright yellow in colour, and dotted with brown, giving a definite speckled appearance to the insect. In maize the grubs are found infesting the cobs mainly, but will also bore into the stems. When infesting cobs they usually line the bore with silk, and this silken tube may extend as a pipe up through the silk and tip of the sheath to open externally. The core, the grains themselves, and the sheath and silk are eaten and damaged by this pest, which however is not as prevalent nor as serious a pest as the Maize Ear worm. This species also attacks sorghum.



Tip of Cob showing work of Yellow Maize Moth larva with pupa in situ.

The larva is narrower than that of cutworms, and in colour is palest buff or slaty-white, with pale brown spots marking the position of scattered, fine, indistinct hairs. The head and dorsal surface of the segment behind the head are brown in colour. The full-grown larva is just under an inch in length.

The pupa or chrysalis is relatively long and narrow and of dark chocolate brown colour, and not so shiny as that of the Ear Worm moth or Cutworm moth.

Cutworms.

A number of species of caterpillars of the cutworm type, such as the Army Worm (*Cirphis unipuncta*), the common Cutworm (*Agrotis radians*) and another species known as *Prodenia litura*, attack maize. The control of cutworms is discussed under the heading "Insect Pests of Tomatoes," in the section on "Vegetable Crops," to which the reader is referred for further information.

The Yellow Monolepta Beetle (*Monolepta Australis*).

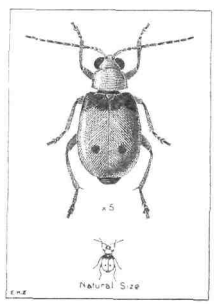
This is a native species at present confined to our North Coast river districts. The little beetle is about ¼ inch only in length, with yellow body and legs, and with a bright cerise patch on each shoulder, as well as a single cerise spot near the middle of each elytron.

This pest attacks the silks and the tassels of maize. It is also a serious pest of the orchard, attacking blossoms and foliage of citrus, stone, and pip fruits indiscriminately. The beetles also swarm on certain species of wattle, while the pepper tree (introduced) is a favourite food both in winter and summer.

Careful observation of the dates of the appearance of this beetle indicates that it has a very lengthy adult life. It is its habit of infesting fruit, wattle, and pepper trees that enables it to survive through the winter. Its absence from early October to early January indicates that the beetles are then hidden in the larval stage, probably feeding in the scrub.

In view of the above facts, attacking the beetles when on fruit trees, pepper trees, or wattles, suggests itself as a logical if indirect method of controlling the pest in the maize crop. Unfortunately, owing both to their hardiness and their extreme activity on the wing (for they rise in clouds with almost the speed of flies on being disturbed), the beetles are not readily killed.

To kill the adult beetles, the use of flares at night is recommended. A bag is wrapped round one end of a 6- or 8-foot stick or pole, dipped in kerosene, lighted, and carried up and down between the rows of fruit trees, &c., *where the swarms have settled at night. The beetles fly up into the* flare and are killed in thousands.



Yellow Monolepta Beetle
(*Monolepta Australis*).

Good results have been obtained by the use of certain sprays, applied under strong pressure, care being taken to apply them also to the ground upon which the beetles which have been brought down have fallen. If the beetles are attacked on pepper trees or on fruit trees not in bloom, kerosene and soap emulsion (1 part kerosene to 11 water) or resin and soda (1 lb. resin and $\frac{1}{2}$ lb. washing soda to 8 gallons water) are perhaps the best sprays to use. For fruit trees in blossom a miscible oil spray (1 part in, say, 40 of water) is the safest. Perhaps the best method of control, however, is dusting with arsenate of lead powder mixed with lime dust (1 lb. powdered arsenate of lead to 20 lb. lime). Such treatments are especially effective if they are used at night or in the early morning, for it is at these times that the beetles are least active.

Pink Corn Worm (*Batrachedra rileyi*).

This pest damages maize by eating out the grains, and also feeds on the core, husks, and silk of the cobs. It attacks the ears in the field and in store, but is not serious in shelled and bagged grain. It also feeds on sugar-cane, bananas, lantana, and sorghum.

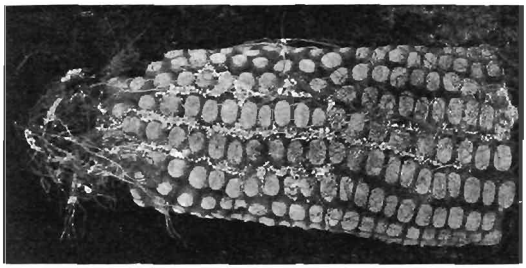
The eggs are minute and pearly white, and are laid on the cobs. The caterpillar is small (up to $\frac{3}{8}$ of an inch) and of characteristic pink colour. The pupa or chrysalis is small and brown, and is found in light silk cocoons in the husks and silks, and among the grains.

The adult moth is light greyish brown, slender, small (smaller than the common grain moth) and inconspicuous.

In late summer this insect is common on the ears, attacking the grain and top of the ear. The danger seems to be to the ripe maize grains in the field and stored cobs in the last three months of summer, but this insect is not so far a serious pest.

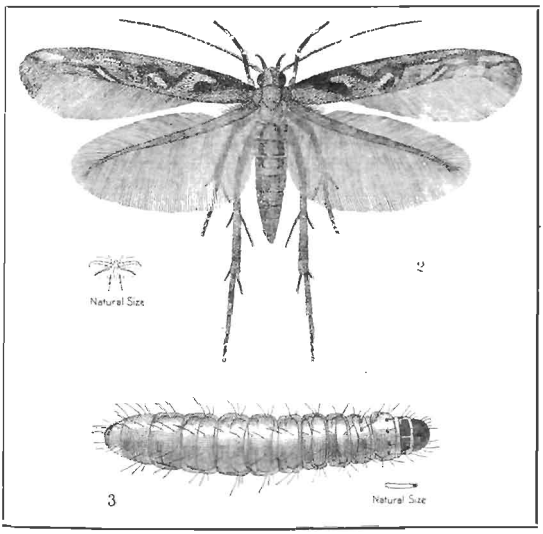
Other Insect Pests.

A number of other insects attack maize. Among these are wire worms, which feed on the roots or freshly-planted seeds, white curl grub, which also feed upon the roots, grasshoppers, aphis, &c., but these pests do slight damage only.



Cob damaged by the Pink Corn Worm.

Note the streaks of fine granules of excrement (smaller than those of the excrement of the Ear Worm or of the Yellow Maize Moth).



The Pink Corn Worm (*Batrachedra rileyi*).

2. Moth with wings expanded. 3. Pink larva, which feeds on the grains, silks, &c.

SORGHUM.

The principal groups of sorghum cultivated at the present time may be classified as follows: (*a*) Sweet or saccharine sorghums, which include such varieties as Saccaline, White African, Collier, &c., grown essentially for green fodder; (*b*) grain sorghums, such as Milo and Feterita, cultivated mainly for their heads of nutritious grain; (*c*) broom corn or broom millet, the heads of which are used in the manufacture of brooms; and (*d*) grass sorghums, such as Sudan grass. In some cases, especially in the drier parts of the State, the members of group (*b*) are used for green feed; their stalks, however, are more or less pithy. All the foregoing groups hybridise very readily, and consequently should not be grown in close proximity to one another if it is desired to keep them pure. At one time sorghum was considered as a crop for coastal districts, but it is now being grown with good results in the drier parts of the State. The grain sorghums and Sudan grass are exceptionally valuable dry-country crops, the former especially so in districts too dry for the successful cultivation of maize for grain.

The Sweet or Saccharine Sorghums.

These sorghums are specially valuable to the farmer, as they provide, when mature, a highly nutritious and bulky fodder, which is relished by all classes of stock. Although green maize is more nutritious than sorghum, the latter will withstand drought better, will grow on poorer soil, and remain green and succulent longer into the winter. Sorghum thrives best in districts having a good rainfall and a long summer season. The young plants, when well established, will withstand dry weather well, and rapidly respond to any rain that falls. Maize, on the other hand, if it receives a somewhat severe check through lack of moisture, seldom recovers, and matures in a stunted condition. If light frosts are experienced in the autumn the growth of sorghum is checked, and heavy frosts injure the crop, although the leaves and stems do not lose their succulence for some time afterwards; but sorghum stands longer into the winter than maize, and this fact ensures the crop a place on all farms requiring early winter green feed. The crop gives exceptionally high yields if planted on deep, rich, alluvial soils. It will thrive, however, on almost any class of soil if the season is favourable.

Preparation of the Soil.

The operations connected with the preparation of the soil should be thorough, as the plant roots require to develop freely, so as to provide sufficient nourishment to encourage a luxuriant growth of the stem and leaves. Plough the land deeply to commence with in the early winter, and if very lumpy break it down with heavy harrows; keep weeds down by an occasional working with the tine harrow or springtooth cultivator, leaving the second ploughing until just prior to sowing. The second ploughing should be a shallow one: if the sweetened surface is buried too deeply, the young plants are prevented from obtaining the plant-food rendered available by the agencies that have been working in it during the period of fallow. No hard and fast rule can be laid down for the amount of work necessary to bring the land into a fine state of tilth. The aim should be to prepare a fairly fine seed-bed after the second ploughing, so as to ensure rapid germination and strong, healthy plants. In districts with only a limited rainfall it will be necessary to fallow the ground for four or five months previous to sowing, thus storing up moisture for the subsequent crop.

Varieties.

The following classification shows the maturity of recommended varieties:—

Late maturers.—White African, Collier, Saccaline.

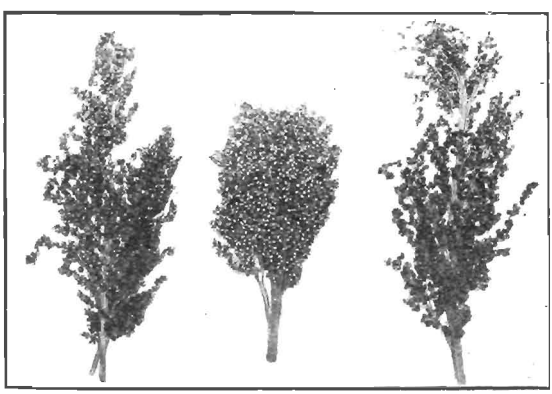
Medium late maturer.—Cowper.

Early maturer.—Sumac.

In coastal districts the late maturers are preferred, owing to the fact that they remain green and palatable longer into the winter than other varieties. With the exception of cold localities with a short summer season, very little use is found for early maturing varieties, as they do not retain their palatability and saccharine matter for any length of time, rapidly becoming dry and pithy on reaching maturity. For this reason and its light yields, other varieties are replacing Early Amber Cane.

The following are brief descriptions of the recommended varieties:—

White African.—A particularly useful type as it stands well into the winter months. The seed is white in colour, and the glumes black and nearly enclosing the grain. Should be grown in districts with a long summer season.



Sumac. White African Early Amber Cane.

Saccaline.—The most widely-grown variety in coastal districts for some years, and is still very popular. The grain is brick red in colour, and the glumes are dark brown to black, and enclose the grain by half its length.

Collier.—Another late maturer which is also becoming popular in coastal districts. It is characterised by very small, dark brown seed, enclosed by the black glumes for less than half its length.

Cowper (late No. 61).—This variety is grown extensively on the Middle and South Coast, and is particularly useful for providing late autumn feed. The grain is light brown in colour, and the glumes are dark red and enclose *the grain for two-thirds of its length.*

Sumac.—A comparatively recent introduction which matures fairly early —somewhat earlier than Cowper. The grain is reddish in colour, and the glumes, which are shorter than the grain, are dark red or black and hairy.

Cowper (late No. 61). Collier. Sweetaline.

Early Amber Cane.—A quick-growing type used to some extent in districts with a short growing season, or where conditions are somewhat dry. It is not recommended for coastal districts as the later maturing types are more suitable, giving greater yields and standing better into the winter. The grain is light brown in colour, and is almost completely enclosed by the black glumes.

Improvement by Selection.

Plants exhibiting desirable characteristics such as good growth, high sugar content, and resistance to disease should be marked in the field with pieces of coloured rags, and have their heads bagged (with a light calico bag) as soon as they begin to form in order to prevent cross-pollination taking place, the bags being removed, to prevent the formation of mould, when the pollen has fertilised its own seed and is "dead." The heads should be harvested when the grain is fully mature.

Each of these heads should be threshed separately, and the seed used for planting a single row in a head-to-row test. A convenient length for the rows in this test is about 1 chain, with 3 feet between the rows. Selections should again be made, from plants conforming to the desired type, for the next year's head-to-row test. The packets containing remnant seed from the

highest-yielding rows of the previous year's head-to-row test should be looked up, and the seed used for planting breeding plots. Selections of seed made from these plots at the end of the season will then be useful for planting large areas on the farm for stock feed, and leave, perhaps, a balance of seed for sale to neighbouring farmers. No two varieties or types should be grown in close proximity to one another, or cross-pollination, resulting in an impure type, will take place. Care must also be taken to see that Sudan grass, broom millet, or grain sorghum are not grown close to a plot of sweet sorghum intended for seed, as crossing with these will result in seed which, if sown, will produce pithy stalks deficient in sugar content.

Manuring.

Beneficial results are obtained from applications of fertilisers, such as superphosphate at the rate of 1 to 2 cwt. per acre, or a mixture of equal parts of superphosphate and bonedust at the rate of 1½ cwt. per acre. If the nitrogen content of the soil is low, or humus is deficient, a mixture of 1½ cwt. superphosphate and ½ cwt. sulphate of ammonia should be used. As superphosphate is a manure that is readily available for the use of the young plant, it promotes vigorous growth and induces the plant to develop an extensive root system.

Sacsaline at Wollongbar Experiment Farm.

Sowing.

Sorghum is generally sown in rows 3 feet apart, with a maize planter fitted with a sorghum planting plate; on large areas a wheat drill may be used. *Fertiliser should be sown in the drills at the time the seed is being planted.*

There are two methods of drilling. By the first method the seed is sown with a maize planter, or dropped by hand, in furrows 4 or 5 inches deep, previously opened out by a single-furrow mouldboard plough or special drill

plough. The drill plough is so constructed as to throw the soil on each side of the furrow that is being opened out. If the seed is dropped by hand a light harrow should be used to cover it, the implement being driven in the direction in which the drills run. By the second method the seed is planted with a maize planter or wheat drill on the flat (no furrows are opened out). A certain number of the grain runs of the wheat drill should be blocked up in order that the rows may be made the required distance apart.

When planted in rows 3 feet apart 6 to 8 lb. of seed will give a sufficiently thick stand in coastal districts, and 4 or 5 lb. in the drier parts of the State.

In dry localities and where weeds are plentiful broadcasting is not recommended, as cultivation cannot be carried out to keep down weeds and create a mulch to preserve moisture.

Cultivation.

If the crop has been planted on the flat, the spaces between the rows should be lightly worked with a one-horse cultivator when the young plants are from 4 to 6 inches high. If the seed has been planted in furrows the first working of the ground should be carried out when the young plants are 3 inches high, by lightly harrowing the area in the direction in which the drills run. This work kills a considerable amount of weed growth, and at the same time works some fine soil around the young plants. Another harrowing should be given when the plants reach the top of the drill, in order to finally level off the ground and check weed-growth.

Frequent workings with the cultivator are necessary during the growth of the crop to keep down weeds and check evaporation of soil moisture. On large areas, a handy implement to use is a two-horse springtooth cultivator: this straddles the rows and covers a lot of ground in a day. This machine can be used until the crop is 3 or 4 feet in height; if subsequent workings are necessary, the single-horse machine has to be resorted to.

Shallow cultivation is necessary, as the sorghum roots come to within 3 or 4 inches of the surface of the ground.

Harvesting for Green Fodder.

Sorghum should not be fed to stock until it comes into head; if fed prior to this stage there is a danger of what is commonly known as sorghum poisoning. The greatest yield of green fodder is obtained when the seed has formed, but is still in the milky stage; at this stage the crop is very palatable and digestible.

Harvesting large areas for silage is generally carried out with a maize binder. This machine deals with a single row of crop at a time, and ties the material into bundles, thus facilitating handling in the field and at the silo chaffcutter or silo stack. If the sorghum crop is not too high and bulky, and the stalks are fine, a reaper and binder will do effective work.

On small areas the crop is cut with sickles or hoes. A handy implement for cutting maize or sorghum stalks is a weighted sledge with scythe blade attached; it is drawn by a single horse, and will cut a large amount of material in a day.

Sorghum Silage.

Maize and sorghum are two of the best crops that can be grown for silage purposes. Sorghum should be harvested when the grain is in the dough stage. Like all bulky fodders, it makes the best silage when chaffed, as then it packs well in the tub or pit silo. Surplus material should be placed in a silage stack, this being built with the heads of the material towards the centre and butts to the outside. Care should be taken to see that the stack is built evenly, otherwise one side may slip and the stack collapse.

Sorghum Poisoning.

Sorghum poisoning is of fairly common occurrence in Australia, and has also been reported from other countries. The latest investigations in the prussic acid content of sorghum have led to the following conclusions:—

(1) During the first three or four weeks of the plant's life the prussic acid is concentrated in the stalks. Then it rapidly disappears from there, but apparently persists in the leaves in decreasing percentages until maturity.

(2) Climate and variety may be more important factors than soil nitrogen in determining the amount of the acid in the plant.

(3) When sorghum is grown on poor, infertile soil, added nitrogen may slightly increase the amount of hydrocyanic acid in the plant. With a fertile soil and abundant nitrogen this effect may not be produced.

(4) Complete hydrolysis of the glucocide is obtained by digesting the macerated tissue for two hours at 40 to 45 degrees Cent.; that is, the steaming of the crushed tissue as stated will remove the effects of the poison.

In feeding sorghum to stock it is only necessary to adopt certain precautions to avoid loss. The poisonous substance gradually diminishes as the plants become old, and entirely disappears by the time the seed is formed. Stock should not be allowed to eat young sorghum, especially if it is wilted through dry, hot weather. Stunted sorghum may also cause death, and immature sorghum which has been frosted is dangerous. The mature sorghum is harmless, and can be fed with perfect safety.

The Grain Sorghums.

These sorghums are adapted to warm, dry conditions, and are specially useful in districts where maize for grain or green feed cannot be successfully grown. In early times the seed of these sorghums formed one of the chief sources of food for mankind, and was grown largely in India, China, and Egypt; but as the use of the grain as an article of man's diet diminished, the cultivation of these sorghums, the stems of which are pithy, became less extensive, farmers turning to the sweet or saccharine varieties for providing green feed for stock.

The chief characteristics of these sorghums are:—

1. They set grain freely, even under somewhat adverse conditions.
2. They are remarkably hardy and withstand drought well.
3. The stalks are valuable as roughage for feeding to stock.
4. The nutritive value of the grain is only slightly lower than that of maize grain.

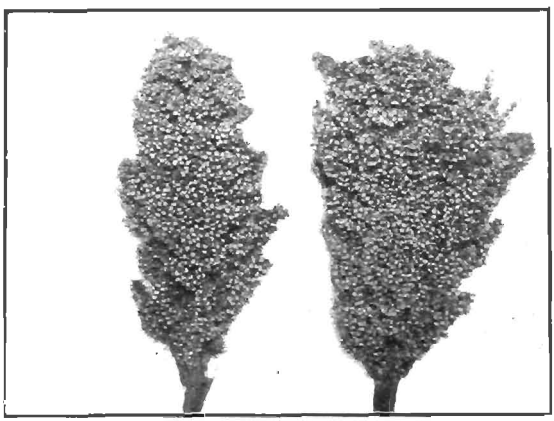
Feeding tests carried out in America showed that the grain sorghums had 90 per cent. of the feeding value of maize for fattening cattle and pigs, and from 90 to 95 per cent. for fattening lambs. The feeding value of maize, Milo, and Kafir, varied but slightly, ranking in the order named. Feterita and Kaoliang gave satisfactory results but did not equal the other grains. Sweet sorghum seed proved inferior to maize and the grain sorghums.

Soil and Soil Preparation.

Friable loams which will produce good crops of wheat are eminently suitable for the growing of grain sorghums. In dry districts the best results will be obtained on fallowed land, as sufficient moisture should be present in the soil to ensure a rapid germination and vigorous growth of the young plant. The final working of the ground before planting may be similar to that for wheat.

Varieties.

The most suitable varieties to grow are Standard Milo and Feterita. These two types give the best results, either for growing in dry localities or under irrigation.



Blackhull Kafir. White Milo

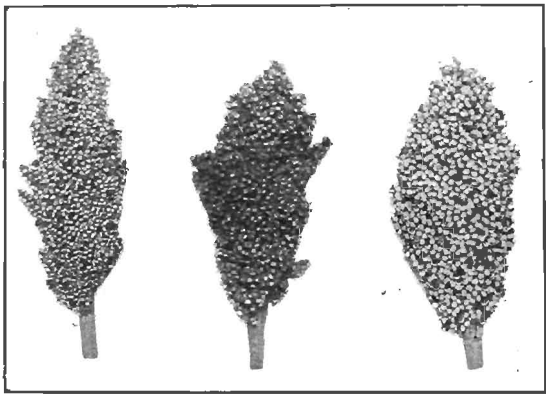
The following are brief notes on the varieties commonly grown:—

Standard Milo.— Leaves numerous; stems fairly stout; heads very heavy and compact; glumes reddish-brown and hairy; grain yellowish-brown.

Feterita.—Leaves fairly numerous; stems stout; heads erect, dense, but not so compact as Milo. Grain bluish-white; glumes black and shiny, hairy on the margins.

White Milo.—Plants similar to standard Milo, but grain is white in colour.

White Yolo.—A slender-stemmed variety of rather dwarf habit. Fairly leafy, and readily eaten by stock. Heads erect and compact, grain white.



White Yolo. Milo. Feterita.

Blackhull Kafir.—Leaves broad and numerous; stems short-jointed and stout; *head dense, cylindrical, and erect; grain, white, oval in shape and* half-covered by its black glumes (hulls).

The table given below shows the time usually taken by a number of varieties to mature:—

	Average period between sowing and flowering.	Average period between sowing and maturity of seed.
Kafir	90 days.	112 days.
Standard Milo	75 ,,	98 ,,
White Yolo	75 ,,	95 ,,
Feterita	70 ,,	91 ,,
White Milo	70 ,,	90 ,,
Manchu Kaoliang	55 ,,	75 ,,

Sowing.

Large areas are planted with the wheat drill, blocking up sufficient grain runs to have the rows about 3 feet apart. Set the drill to sow about 25 lb. dry wheat per acre (fine side of grain hoppers up); this will work out at about 4 to 5 lb. of grain sorghum seed per acre. If the seed is small, or the grain runs of the drills are worn, the seed will pass through the machine too

quickly. If the drill cannot be set to sow less seed per acre, reduce the size of the seed hoppers with pieces of board or mix some sawdust or bran with the seed at the rate of one-half to 1 pint to every 4 pints of seed. Superphosphate should be sown through the corresponding feeders of the fertiliser box at the rate of ½ to ¾ hundredweight per acre. The fertiliser stars not required should be removed and the holes out of which they have been taken blocked up with corks, the runs not required to sow fertiliser being blocked up with pieces of tin cut to shape. The maize-dropper fitted with special planting plate is a useful implement to use where small areas are being planted.

Early sowing is recommended. The seed should be planted as soon as danger of frost is over, so that the young plants will benefit from the moisture stored in the soil, and thus become well established before the hot summer weather occurs.

The bushel weights of sorghums given hereunder give some indication of the average weights that could be expected in a fairly good season. For purposes of comparison the weights of the sweet sorghums collected at the same time are also given :—

Grain Sorghums.	lb. per bushel.	Sweet Sorghums	lb. per bushel.
Milo	57	Saccaline	56
Feterita	56	Cowper...	50
Manchu Kaoliang	56	Early Amber Cane	47

The plants will be considerably assisted in their growth if occasional cultivations are given to keep down weeds and conserve moisture.

As Green Fodder and as Silage.

The methods of handling the crop for green fodder when it is in head are (1) to turn the stock in on it ; or (2) to cut and cart the material off the field. The first method is rather wasteful, especially if the crop is a tall and heavy one, as the stock tramp down a considerable amount and it is wasted. Stock are often turned in on the field after the heads have been harvested and the stalks left standing in the field, a large amount of feed being obtained by the animals in this manner. It is not safe to turn stock on young growth, or on a field of mature sorghum which has young growth showing at the base of the stems, as there is danger of prussic acid poisoning resulting.

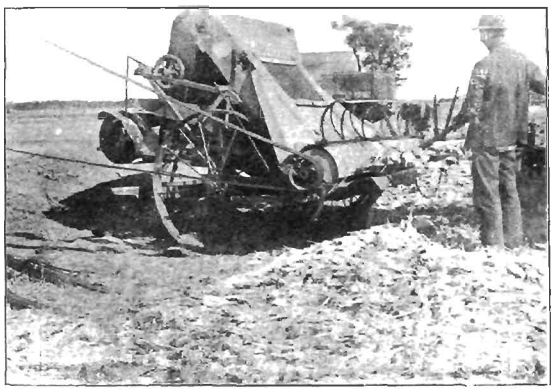
In an experiment carried out in the western district with three varieties of grain sorghum and one of sweet sorghum, the varieties were cleaned up by stock in the following order :—

Green stage.	*Dry stage.*
1. Early Amber Cane.	1. Early Amber Cane.
2. Feterita.	2. Feterita.
3. Milo.	2. Milo.
4. Manchu Kaoliang.	3. Manchu Kaoliang.

Although silage made from grain sorghum is not as nutritious as that made from either maize or sweet sorghum, the material will be found of considerable value in droughty periods. The seeds of grain sorghums become somewhat softened during the fermentation period, and consequently are more easily digested by the animals. The crop should be harvested when the seeds are fully formed, but in the dough stage, and the stalks still green and sappy.

Harvesting and Threshing.

The grain may be harvested by hand-cutting the heads from the stalks with a sharp knife, but by this method the cost of production is considerably increased. Where a maize binder is available, the crop should be cut



A Combined Harvester Threshing Feterita Seed.

A Crop of Feterita before Harvest.

and stooked in the field until the grain is ready for threshing; but if the crop is not too heavy, a reaper and binder can be used for harvesting, the material then being dealt with as just described. A header, with every

alternate finger of the comb removed, does good work where the grain ripens evenly and rapidly on the stalk. The grain must be thoroughly dry before being harvested with this machine, otherwise it will not thresh well and may heat when stored; the crop must not be more than 5 feet in height or the header will fail to deal effectively with it.

Small quantities of the grain can be threshed with a flail, but large amounts should be put through a grain thresher, or a harvester set up as a stationary thresher. If the whole plant has been harvested, only the heads should be put into the threshing drum, as it will be found difficult for the machine to deal with the stalks and leaves if they are allowed to pass through. The threshing apparatus should not be closely set for this grain if a minimum

The Same Crop after the Reaper-thresher had been through it.

amount of crushed grain is to be obtained. Cracked grain packs together very closely, and thus reduces the circulation of air in the bags or storage bins, and heats very readily. A method often adopted where the crop is harvested in bundles is to use an axe to cut off the heads and either put them through the thresher or feed the heads of grain to stock. If they are cut with stems 1 foot to 18 inches long the proportion of cracked grain will be in some degree lessened, as a fair amount of stalk goes through at the same time.

It is very important that the grain be thoroughly dry before threshing. If the seed is stored in bins, the depth of the layer should not be greater than 2 or 3 feet, so that stirring of the grain if it shows any signs of heating is facilitated.

Selecting Seed.

Seed should be selected in the field from plants exhibiting sturdy characteristics, such as well-filled and upright heads, strong stalks, and a fair amount of leaf growth; weak and hybrid plants should be discarded. Like the sweet types, the grain sorghums cross-pollinate freely, and to obtain pure seed no other variety of sorghum or Sudan grass or broom millet should be grown in close proximity to the variety under trial.

Improvement work is carried out on similar lines to those described for sweet sorghums; that is, by planting seed from selected plants in head-to-row tests and breeding plots.

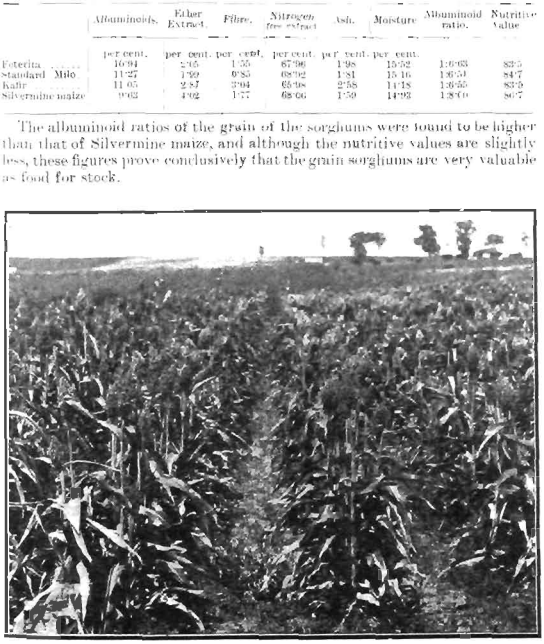
Feeding the Grain to Stock.

Before being fed to stock, the grain is best crushed, so that the material may be easily digested by the animal. If fed whole, especially to pigs, a considerable amount of the grain will pass through the animal undigested. In this State the grain has proved to be an excellent substitute for maize, and at such centres as Coonamble, Narrabri, Wee Waa, Gunnedah, Cowra, and Nyngan has been fed to horses, cattle, sheep and pigs with good results.

The following analyses of grain sorghums and of maize give some indication of the value of the grain grown in the State:—

	Albuminoids.	Ether Extract.	*Fibre.*	*Nitrogen free extract*	Ash.	Moisture	Albuminoid ratio.	Nutritive Value
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.		
Feterita	10·94	2·45	1·55	67·96	1·98	15·52	1:6·63	83·5
Standard Milo	11·27	1·59	0·85	68·92	1·81	15·16	1:6·54	84·7
Kafir	11·05	2·87	2·04	65·08	2·58	14·18	1:6·55	83·5
Silvermine maize	9·03	4·02	1·27	68·66	1·50	14·92	1:8·0	86·7

The albuminoid ratios of the grain of the sorghums were found to be higher than that of Silvermine maize, and although the nutritive values are slightly less, these figures prove conclusively that the grain sorghums are very valuable as food for stock.



A crop of Feterita at Cowra Experiment Farm.

Fungous Diseases of Sorghum.

Red Stain (*Fusarium* sp.).

This disease is one of the most serious troubles in the coastal districts. Broom millet is badly attacked, the disease affecting the node of the broom, making it brittle, and some of the fodder sorghums are very liable to attack. Sudan grass and Johnson grass are also attacked. The disease appears as broad, reddish blotches on the leaf sheaths, and inside the stems of the

Red Stain of Sorghum.

plants as reddish strands or as extensive reddish colorations of the vascular tissue. The disease is known to be conveyed from plant to plant in the field. Sometimes the inside of a leaf sheath which holds water, or has been attacked by aphis, may be greatly reddened and diseased by this secondary infection. The disease is also known to be conveyed by seed, and through the soil by reason of the presence of old sorghum "trash" on which it can live.

Control Measures.—

1. Avoid a succession of sorghum or broom millet crops on the same land by adopting some form of rotation.
2. Use the cleanest seed procurable. No satisfactory seed treatment is known.
3. Harvest crops early.
4. Select the most resistant and vigorous plants available for seed purposes. While it is very difficult, if not impossible, to get seed free from contamination, it is possible to greatly improve the type of crop with respect to the disease by selecting the best plants in the field. Saccaline, though not immune, resists the disease, and other varieties are being tested.

Head Smut (*Sorosporum reilianum*).

This disease attacks sorghum and millet as well as maize. On affected plants, the entire inflorescence is usually involved, and is converted into a spore mass protected by a transient whitish membrane. As the panicles emerge from the boot the smut masses are seen to be interspersed with the stringlike remnants of the fibro-vascular bundles of the host tissue. When the membrane breaks the spores are rapidly disseminated, the vascular strands remaining intact.

Recent researches show that infection with the Head Smut fungus is favoured by relatively high soil temperatures (28 deg. C.), and that a high moisture content of the soil materially reduces the percentage of smutted plants at temperatures favourable to the development of the disease.

Infection occurs from the soil, and the control measures listed under Head Smut of Maize (page 449) also apply to the disease on sorghum and millet.

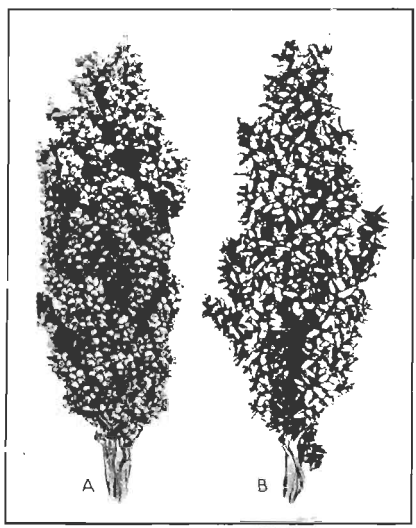
Kernel Smut (*Sphacelotheca sorghi*).

This disease occurs on sorghum and millet, and can be distinguished from Head Smut by the fact that it does not convert the whole of the panicle into a smutted mass. Individual grains only are affected, and as a rule the majority of the grains in an affected ear are involved. When the head emerges from the sheath the presence of the disease can be detected by the replacement of the grain by an oval, dirty-grey sac, which is the smut ball. This conical structure develops at the expense of the ovary in affected plants, and is surrounded at the base by the glumes which, except for a purplish tinge, appear quite normal.

Smutted millet plants generally are a total loss on account of the inferior quality of the brush. The branches are frequently of unequal length, and, furthermore, the smut spores may be scattered over good brushes during harvesting, causing a discolouration and generally lessening their value.

Infection occurs from spores which adhere to the grain at thrashing time. The infection period extends from the time of germination of the seed to the appearance of the young seedlings above ground.

The disease can be controlled by seed treatment with formalin, ½ per cent. solution for 1 to 1½ hours, or bluestone, 2 per cent. solution for 10 to 15 minutes. The grain should be dried rapidly and sown soon after treatment.



Kernel Smut of Sorghum.

A.—Healthy Head. B.—Diseased Head.

[After Reed and Melchers.

Leaf Spot, Blight, or Anthracnose (*Colletotrichum graminicolum*).

This disease causes light-coloured spots outlined with red on the leaves and stems of sorghum, and in the case of broom millet may seriously affect the broom, discolouring it and causing it to become brittle.

No methods of keeping the disease in check have been devised. It is customary to harvest broom millet sufficiently early to prevent damage by this disease, which is able to make its most rapid progress on the tissue of the broom when it is nearly mature, especially under wet conditions. As a disease in the leaves it is of little importance.

Leaf Stripe (*Helminthosporium turcicum*).

This disease attacks some varieties of sorghum, *e.g.*, Early Amber Cane, very badly, and is particularly prevalent in wet seasons. The characteristic appearance of the disease is the death of portions of the leaf in spots or in elongated areas, generally reddish or pink at the margin. The dead portions are white or brown in colour.

The disease is perpetuated by the growth of the fungus on old sorghum trash in the soil and by the spread of the spores of the fungus from plant to plant through the air.

To control it, avoid a succession of sorghum crops on the same land, and use a variety which, under the conditions of the district concerned, is normally free from the disease. Saccaline is more free from this disease than Early Amber Cane.

Rust (*Puccinia purpurea*).

This disease gives rise to reddish or purple spots on the leaves, and on these spots reddish or brown pustules occur and burst, liberating the spores. The disease sometimes reduces the yield of grain and fodder sorghums, and is known to live on Johnson grass and Sudan grass. The selection of a variety relatively resistant to attack is the only practicable method of control.

MILLET.

Millet is deserving of consideration as a quick-growing, summer catch crop. It grows easily, and does well on land from which a crop has recently been taken, or after a crop that has failed, provided conditions are fair. The cost of cultivation is low, as little is required after the crop is in.

The crop may be fed off green, and then allowed to produce growth for hay; where it is fed off the stubble should be harrowed to loosen the soil and conserve the moisture, and in this manner a good second growth is usually obtained.

Varieties.

The various millets are recognised by the distinctive colour acquired by the ripened seed, and are grouped as white, yellow, or red. They vary considerably, even under those heads, and possess peculiarities in their growth and colour of foliage. The most useful varieties are Japanese, Hungarian, Manchurian (white and yellow), White French, and Pearl: of these Japanese is by far the most grown. It is perhaps the quickest growing of all plants cultivated on the farm, providing it finds suitable weather conditions. It may be grown for hay, green fodder, or to be fed off by stock—it is useful for feeding to all classes of stock and poultry. Japanese is about the best stooler of all the millets. Hungarian is useful as a hay variety, but is not a good stooler, and will not stand a dry weather pinch like Japanese. Where grain is required the Manchurian varieties will be found the most prolific; as many as 41 bushels of seed per acre have been taken from this class. The yellow variety is the best for seed: the ripened grain may be fed to poultry and pigeons with advantage in conjunction with other grains.

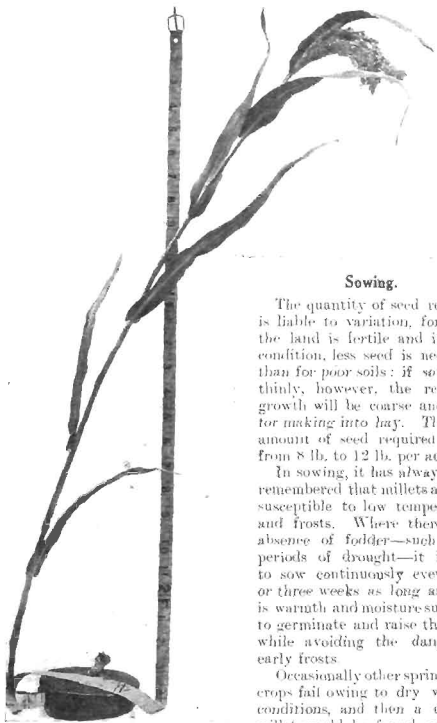
Soil.

The millets are very hardy. They require a medium quantity of moisture, grow luxuriantly on a variety of soils, and endure drought remarkably well. They do best in a mellow soil, rich in humus, but they thrive on a great variety of soils, and loams with a medium admixture of clay and sand answer well. It has to be remembered that this plant secures its nourishment chiefly from the surface soil, and it is good farm practice to stimulate that with readily assimilable fertilisers, or rotted farmyard manure, keeping in view the need for the supply of nitrogen, phosphoric acid, and potash in their most soluble forms. The fertilisers are best harrowed in, and the farmyard manure applied before ploughing.

Crop of White French Millet.

Hungarian Millet.

Owing to its sturdy habit millet has always been found a splendid crop to grow on foul land to get rid of the weeds. It will give good returns on higher and drier soils than most grasses. Poor land will often produce a good crop providing there is a sufficient rainfall or some artificial or farmyard manure to help.



Stem of White French Millet.

Sowing.

The quantity of seed required is liable to variation, for when the land is fertile and in good condition, less seed is necessary than for poor soils: if sown too thinly, however, the resultant growth will be coarse and unfit for making into hay. Thus the amount of seed required varies from 8 lb. to 12 lb. per acre.

In sowing, it has always to be remembered that millets are very susceptible to low temperatures and frosts. Where there is an absence of fodder—such as in periods of drought—it is best to sow continuously every two or three weeks as long as there is warmth and moisture sufficient to germinate and raise the crop, while avoiding the danger of early frosts.

Occasionally other spring-sown crops fail owing to dry weather conditions, and then a crop of millet would be found suitable, as it may be taken off early enough to admit of the ground being prepared for autumn-sown crops. Under such conditions, there being little or no plant growth on the ground, the millet seed may be broadcasted and disced or springtooth cultivated in.

Millet can be used for forage, hay, or silage with equally good results. It may be sown to the end of January, and even later. Some advocate drilling the seed as against the usual method used of broadcasting. It is claimed that less seed need be used, and, further, that if the soil cakes, it can be cultivated between the rows to conserve moisture. If for grain

production or silage then drilling would be advantageous. Where possible sowing should be carried out after rains, or when the soil is moist, in order to give the crop a start.

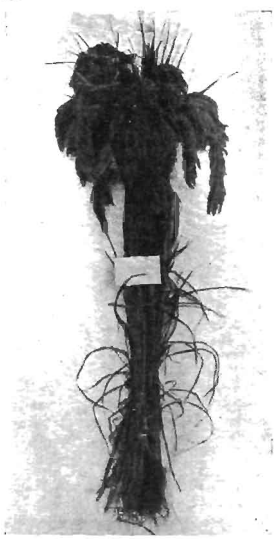
Harvesting.

Judgment must be exercised in deciding the time at which to cut for forage, and for all purposes care must be taken to harvest at the correct period. This should be the stage at which the crop is richest in nutrients, and most palatable and digestible.

When the majority of the seed-heads or panicles have formed in the green pendulous stage is the correct time to cut for green fodder. It is better to err on the side of greenness, though millet cut too green has a laxative effect on stock; if too ripe there is a possibility of the feed becoming unpalatable.

The green crop contains much moisture in both stalks and foliage, and in consequence takes longer to cure than ordinary wheaten hay. If the crop is intended for silage, it may stand a little longer after heading out, but it must be cut prior to ripening.

Manchurian Millet (Hsiao-mi White).



Manchurian Millet (Hsiao-mi Yellow).

Fodder Value.

Millet is one of the most nutritious and attractive of summer green fodders, and it is available at a time when the spring grasses may have failed, and green fodders may be scarce. As green feed, hay or silage, it is

very useful for dairy cattle, sheep, and young stock. For grazing it has been found to be excellent for sheep and cattle. Millets have no poisonous qualities, like sorghum, and may be fed when quite young. It is best, however, not to start feeding off until the crop has attained a height of at least 6 inches. After it has been well eaten down the stock should be removed until another growth is made. With suitable weather conditions, this should be only a matter of days, as the growth is rapid. Japanese is by far the best variety for feeding off.

Diseases.

The diseases of millet are common also to sorghum, and are discussed in connection with that crop on page 470.

RICE.

Rice has been grown on a commercial scale in New South Wales only since the 1924-25 season, when 157 acres were put under the crop on the Murrumbidgee Irrigation Area as a result of experimental work with lowland varieties carried out by the Department of Agriculture, independently and in conjunction with the Water Conservation and Irrigation Commission, at intervals since the year 1916. As long ago as 1891 upland sorts of rice were tried in this State under North Coast conditions, but without success, and again in 1927-28 trials were carried out in the same district. The impossibility of controlling weed growth in the crop, and the lack of suitable machinery in the districts with sufficient rainfall, have made it quite evident that upland varieties cannot be considered commercially in this State.

The area devoted to the cultivation of rice under irrigation, however, has extended considerably on the Murrumbidgee Irrigation Area, as the following figures indicate:—

Season.	Area under rice. Acres.
1924-25	157
1925-26	1,978
1926-27	4,772
1927-28	12,080
1928-29	14,319

For the year 1927-28, when 12,080 acres were grown, the yield was 19,130 tons, equal to an average yield of 83.9 bushels per acre. The total area of land suitable for rice-growing on the Murrumbidgee Irrigation Area is approximately 79,000 acres, of which about 40,000 acres could be cropped. Allowing for half this area to be under fallow, 20,000 acres would be available from the crop each year.

Rice has been grown on the poorest classes of land and has given excellent results. Throughout the Irrigation Area there is a considerable amount of heavy clay loam overlying a stiff clay subsoil, which had, prior to being utilised for growing rice, proved practically useless for any other crop. Judging from the very successful way rice crops have grown, the much improved condition of the land, and the payable yields of wheat and oats obtained on it after having grown rice, the growing of this crop seems to be the solution of the problem of these soils; it leaves the land more friable and promises a means of utilising profitably much of the once unwanted land on the area.

The annual importation of rice into Australia is between 20,000 and 25,000 tons, and reckoning on a 60-bushel crop per acre as an average, 22,000 acres would be necessary to fulfil this demand, and would mean something like £250,000 to the Area, besides a revenue of £25,000 for railway freight. America first grew rice commercially in 1912, and having met her own demands is now exporting to European countries and also to Japan. In the near future Australia will also have to look for outside markets.

The estimated loss in dressing rice (from the paddy to the uncleaned stage) is from 16 to 20 per cent. of the weight of rice. This, combined with other factors, will probably lead to the erection of mills on the Area, so opening up a new field for employment. A move in this direction has already been made, as only recently two large mouse-proof sheds for rice storage have been erected in central positions, namely, at Leeton and Murrami railway stations. The former will hold 4,000 tons, while the latter will hold between 8,000 and 9,000 tons of paddy rice.

The proportion of cleaned and polished commercial rice to paddy, ranges from one-half to two-thirds. The approximate milling out-turn of 162 lb. of paddy is:—

98 lb. commercial rice.
6 lb. polish.
28 lb. bran.
30 lb. hulls.

Rice bran contains a high percentage of protein, and is valuable as stock fodder, but owing to its excessive fat content it soon becomes rancid. This can be overcome by extracting the oil, which may be sold for various uses, leaving the residue for stock.

Polish is chiefly used in America as feed for dairy cows and pigs, having great value as a concentrate. European milled rice has less flavour and is of a lower nutritive value than Oriental rice, because the polish is not removed from the kernels of the latter in milling; the polish contains about fifteen-sixteenths of the flavour of the grain. Hulls are at present valueless, but a market may develop for the straw, which, being extremely tough and soft, may be used for stock bedding and for packing.

Cultural Methods.

Successful rice culture is dependent upon:—

1. High temperatures during the growing season.
2. A dependable water supply during the period of irrigation.
3. Soils that are comparatively flat or level, and overlying an impervious subsoil.
4. Good surface drainage.
5. Freedom from water weeds.

As rice is grown submerged (for a considerable time, if not altogether) below 6 to 12 inches of water, the soil must be capable of retaining the water on the surface; otherwise rice-growing is an impossibility. The quantity of water required to cover and maintain a depth of 6 inches over a large area of country, taking into consideration losses by seepage, evaporation and transpiration by the plants, is obviously large, so that plenty of water

must be available. Apart from the quantity of water required to maintain the correct depth, allowing for seepage, any damage that may be done to surrounding country through such seepage has to be considered.

As with other farm crops grown on irrigated land, early soil preparation and adequate check banking are amply repaid, while in the absence of such preparation the yields are diminished. It is usual to plough during the winter and follow with cultivation, which may be carried out with disc or springtooth implements, to reduce the land to a good tilth.

Grading and Making Check Banks.

If the land is uneven, having "bumps" or depressions on the surface, it must be graded to allow of even watering. Large, suitably-constructed check banks are required to retain the water on the land. The direction of these banks and their number are determined by the contour of the land—in other words, by the fall—and their solidity is dependent upon their width and height, and the length of time they have been constructed prior to sowing the crop. On the Murrumbidgee Irrigation Area some of the soils of which the check banks are made settle down very quickly, and require 6 inches to a foot of soil added to them after a few months, with the result that if this work has not been completed prior to sowing, water levels and control cannot be successfully maintained. As in America, rice lands are laid out according to the contours, the falls between the check banks usually being about 2 inches. By adopting this method of checking it is claimed that fewer banks are necessary, and the watering is also less laborious, as the water is more easily controlled and can be readily led from one bay to the other, thus gradually refreshing the water. The size of the bays is governed by the contour of the land to a marked extent; on the Area the most convenient and easily controlled bays are found to be from 4 to 6 acres. It is a big disadvantage to have long bays running the same direction as the prevailing winds, as during windy weather the water gathers speed and becomes rough over a much greater area than would be the case if they ran at right angles to the direction of prevailing winds, and in this latter case the plants are less likely to be damaged during the early growing stages.

The height and width of the check banks should be such as will successfully hold the water on the bays to the required depth. As it is usual to submerge the rice to a depth of 6 inches to 1 foot, the banks should be at least 18 inches to 2 feet when first erected, as they usually drop when the water is put on. During the past few years it has been found advisable to make them at least 10 feet to 12 feet at the base, according to the type of the land; the higher they are and the wider on top the better can submergence and water control be governed. Furthermore, they are then more suitable for carrying a number of sheep to keep down the weed growth which invariably grows on them during the submergence period of the rice crop. These matters are worthy of careful consideration, as maturity and high yields are governed by the depth of submergence and the successful control of water on the rice bays. Any loss of ground by having large check banks is handsomely repaid by heavier yields per acre, by less labour being required to attend to the banks, and by the knowledge that nothing can go wrong with them during the growing of the crop.

To make the check banks, parallel furrows are struck out several feet apart on each side of an unploughed area (4 to 8 feet wide, according to the size of the bank required), which forms a solid foundation. The

ploughed soil is then thrown in from either side with a delver, and the process of alternately ploughing, either wider or deeper, and delving, is continued until a sufficiently strong bank has been erected. A heavy single-furrow mouldboard plough or a road plough is usually required to do this work, on account of the heavy clay and the depth it is necessary to plough to obtain sufficient soil to add height to the banks.

Varieties.

It is advisable to sow only pure seed, so as to have an even ripening of the grain, and the necessity for pure seed plots is becoming very evident. Only two varieties are largely grown in New South Wales at the present time, viz., Caloro and Colusa, and the following descriptions indicate how they may be distinguished.

Caloro.—A variety developed in California from Wataribune, which had been introduced there from Japan. It is erect and vigorous in habit, attaining a height of about 3 feet 6 inches; a fair stooler, with strong, fairly coarse stems, generally lighter in colour than the leaves; not apt to lodge. The leaves are dark green, medium in length, narrow, and more or less erect and rigid, forming an acute angle with the stem. The terminal or boot "leaf" is shorter than the others, and its tip usually does not extend beyond the end of the head or panicle.

The heads are well filled, with few empty spikelets; fairly dense, of medium length, curved, having typically nine to twelve nodes, each bearing at least one primary branch, and some of the lower nodes two branches.

Rough, persistent awns are present, but these are not constant, varying in length both on different parts of the one head, and on different heads of the one plant; they are most strongly developed on the terminal grains of each branchlet and towards the tip of the head as a whole. Some grains may be completely awnless, while others on the same head may have awns up to 2 inches in length.

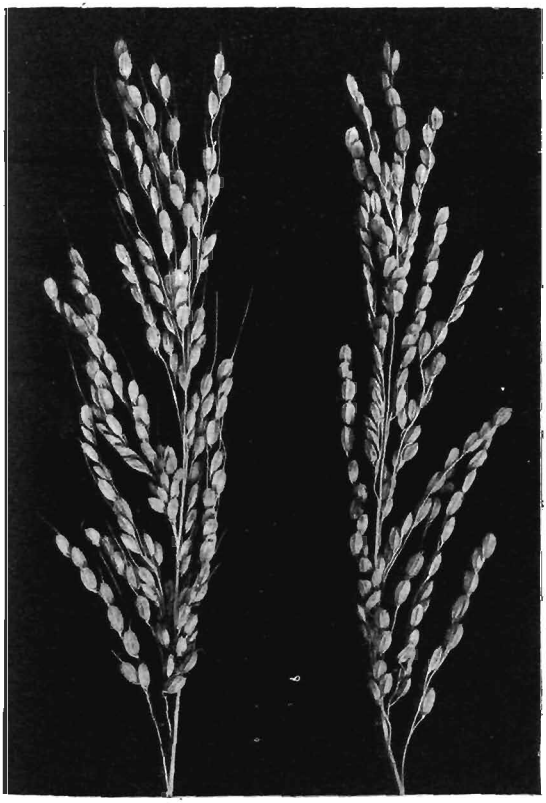
The grain is plump, flinty and bright; it is classified as short, medium-round. The two glumes (lemma and palet) forming the husk are convex, but the larger, outer glume (lemma) to which the awn is attached, if present, shows a more or less distinct "shoulder" near the tip, when viewed sideways; both glumes are downy.

Caloro is the standard variety grown on the Irrigation Area; it is a good yielder, does not shatter easily when ripe, and appears to do well under a wide range of soil conditions. It matures in 180 to 185 days.

Colusa.—The prevalence of red rice and its variants, and the reversion from type shown by Colusa in recent years, suggest that it should be temporarily eliminated from future bulk sowings. It is an early-maturing variety obtained from California, to which State it was imported from Italy, but probably its origin was China. The growth is erect, but not very vigorous, and rather short, reaching a height of about 3 feet. It is a poor stooler, with weaker stems than Caloro, and is apt to lodge, particularly if allowed to stand for any length of time after ripening. The leaves are dark green, fairly short and narrow, coarse in texture and stiff. The stems are stout and lighter in colour than the leaves at maturity.

The mature heads are completely awnless, of medium length, curved, with usually eight to eleven nodes.

The grain is plump, and, like Caloro, belongs to the short, medium-round class; there is usually a greater proportion of starchy to flinty material in each grain than in Caloro, and the general appearance is more opaque.



Heads of Rice Varieties.
Caloro on the left; and Colusa on the right.

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though still bright. The enclosing glumes are both convex, with an even curve, and they are downy. The heads are well filled, with few sterile spikelets, but are not very dense and are subject to shattering as they pass maturity.

Colusa is seven to ten days earlier than Caloro. In California it is considered a poor yielder on old land.

Points of Difference in Caloro and Colusa.—The chief points of distinction between Caloro and Colusa are:—

Caloro always has a variable amount of awn; Colusa is awnless at all stages.

The panicle is long and curved in both, but that of Colusa generally has fewer nodes and primary branches.

The "keel" of the unhusked Colusa grain is smoothly and evenly rounded, while that of Caloro is generally "shouldered" near the tip.

Colusa grain is more starchy and opaque than Caloro. The growing period of Caloro is 180 to 185 days; Colusa 175 to 180 days.

Caloro is higher than Colusa under the same conditions.

Caloro is a better stooler than Colusa.

Colusa heads shatter more than Caloro if left standing after the crop is ripe.

Colusa has a weaker stem and tends to lodge more readily than Caloro

Wataribune.—Wataribune, of which there are both early and late maturing varieties (the latter came originally from Japan) has grown well on the Irrigation Area, but has been practically eliminated from bulk sowings for the time being on account of the prevalence of red rice and its variants. It is possibly the best variety for old land, stools well and is a good milling rice.

Fertilisers.

The rice-growers on the Area are well advised to give every consideration to the likelihood of beneficial results being obtained from the use of fertilisers, as the crop is an exhausting feeder, and a big decrease in yield takes place on land sown to rice two years in succession.

The Weed Problem.

The most serious pest that the rice-grower has to fight is weed growth, for the soil and climatic conditions of the Area are very favourable to excessive weed growth in the form of cumbungi, water or barnyard grass, slender or wild aster, rushes, and reeds, and these render the land practically useless in a very short period, not only for rice, but for other crops as well, if thorough methods for their control are not adopted in the early stages of rice-growing.

Overcropping of the land, with a lack of good working, will soon cripple the industry. The growing of this crop calls for more and better "nursing" of the land than for any other crop under cultivation in New South Wales, and the best returns will be obtained over a lengthy period, if only areas are planted that can be properly handled, and the land cropped no more than once every three years. A rotation with winter cereals for fodder crops should be carried out.

It is much better to try to prevent weeds than to have to eradicate them from a rice field. Good farming with fallowing tends to keep the weeds down, and hand pulling, especially along ditches and check banks, can be of great assistance. Rice crops have been satisfactorily grown on land more or less infested with weed seeds by either sowing the rice on the surface of the dry soil by hand or through the drill, and submerging it immediately, or by sowing the rice seed broadcast in the water. The rice seed germinates and grows well, while most, and in some cases all, of the weed seeds and the weed growth is killed if the heads of these plants are kept under water. The former method has many advantages over the latter as regards labour, time occupied in the work (which is very important on large areas) and cost. Sowing broadcast in the water on small areas when unsatisfactory germination or growth of rice plants occurs through unforeseen circumstances, is adopted as a last resort by rice-growers throughout the Area. The water is not allowed to drain off rice grown in this way, and the depth is increased after the growing rice plants have reached a suitable height, the treatment being similar in every way to that given seed sown under the ground.

Soil Problems.

Reports from America state that it is found to be practically impossible to grow other crops on land that has been under rice for a number of years, but with a mixed farming proposition of 500 acres or more, by not over-cropping from the start and with systematic working, it should be possible to grow profitable fodder crops of wheat, oats, or barley.

The following rotation is recommended for rice-growing on the Murrumbidgee Irrigation Area:—Rice, winter fallow, wheat, short fallow, winter legume, short fallow.

The rice is sown in October and harvested the following April. The land is then winter fallowed and an early maturing variety of wheat sown in April or May. The wheat is harvested in December and the land is short fallowed and a crop of winter legumes, such as (*a*) barley and vetches or (*b*) field peas, sown in March to be grazed off by sheep. The aftermath is ploughed under in August and the land given a short fallow in preparation for planting with rice again in October.

Sheep kept with the object of raising small lots of lambs should be a profitable mixed farming proposition in conjunction with rice. An area of not less than 500 acres would be required to enable 100 acres to be cropped each year and 100 acres fallowed for the following season. A certain amount of grain will always be lost on the ground at harvesting, and this can be turned to profit by running pigs or turkeys on the stubble. Sheep should provide a means of keeping weed growth under control. Fallowing will be necessary, and the fallow will need to be worked well, and probably watered several times, to germinate the weed seeds, the growth from which can then be eaten off by the sheep. Good drainage facilities will be necessary, especially on farms without any high land, as trouble may be experienced with fluke and footrot in the sheep. Though weed growth, particularly water grasses, can be largely controlled by early and deep submergence, this in no way lessens the necessity for early well-worked fallows.

With the continual submergence of the land for three or four months of the year the soil will have a tendency to become "washed out." A large percentage of fine soil particles, along with organic matter, &c., will be carried down and deposited on the underlying clay band. The extensive and

fibrous root system of the rice plants has the effect of keeping the top few inches of soil loose and friable, especially on the heavier clay soils, and occasional deep ploughings will be necessary to secure the best results. Heavy clay land becomes loamy in the top few inches after being cropped with rice, probably due to a large percentage of fine clay particles being washed down.

While periodical deep ploughings may be considered the best method of thoroughly working these stiff clay soils after a crop of rice, the deep ploughing of land which has become infested with weed seeds of the barnyard varieties is possibly a dangerous practice and is not recommended; shallow ploughings are considered safest at the present time. The seeds of these weeds may not be destroyed by deep ploughing (they may be long-lived, as is the case with wild oat), and deep ploughing may result in their continually coming to the surface and proving a menace for a long period. Even though land may be ploughed deeply it must not be imagined that all the barnyard seed will be put at the bottom of the furrow. It will lie at all depths from the bottom to the surface, and the weed will be found much more difficult to control than if the seeds are kept near the surface of the land where germination may be encouraged at suitable periods and the plants destroyed by being either fed off or cultivated out.

Sowing.

It is usual to sow when all danger of frost is past and the water is becoming warmer. It should be the aim of the grower to sow as early as practicable, as this will allow of the growing of long season varieties, these being better yielders than the shorter season sorts. On the Murrumbidgee *Irrigation Areas it is usual to sow about the end of September or the* beginning of October, using seed at the rate of 90 to 110 lb. per acre, according to the variety, preparation of the land, method of sowing, and number of rice crops taken off the land. The late or long season varieties, being more profuse stoolers than the early-maturing varieties, do not need to be sown with as much seed as the latter. The better the seed-bed the less seed is required, germination and subsequent growth both being better. *If the seed be drilled, less is required than if broadcasted.*

The method usually adopted to date is to sow the seed as if it were wheat or oats, the ordinary wheat drill being used, and the seed being covered by the soil in the ordinary way. Immediately after seeding the land is irrigated to assist germination, and this is usually followed, in about a week's time, with a second application of water. The grower should keep a careful watch, so that, if necessary, a watering may be given as the young *plants begin to come through the soil and further waterings given if required* to keep the soil moist, for if the land is allowed to cake or set hard on the surface at this stage an unsatisfactory stand may result, from the young plants being unable to break through the hard surface.

The young plants are now irrigated in the usual way as often as required to keep the land in a moist state until the plants are about 6 inches high (usually about thirty days after emerging), when the water should be allowed to remain on the crop, leaving the heads above water, and the depth gradually increased as the plants grow, until it has reached a depth of at least 6 inches over the whole bay. The depth of submergence may be gradually increased with the growth of the plants until about 1 foot of water covers the whole bay, the depth being governed by the strength of the check bank system.

Whether the depth be 6 inches or greater, the water must be retained at that level until time to drain off, as frequent altering of the water levels interferes with the very necessary even and quick growth required to be made by the rice plants, and will be found to ripen the crop unevenly, reduce the yield, and lengthen the growing period of the crop.

From trials on the Murrumbidgee Irrigation Area it has been found unnecessary constantly to change the water, but if renewal be frequently made to replace water lost by evaporation and to bring the water back to the necessary level, satisfactory results follow. While this practice may hold good on the Murrumbidgee Area, the composition of the water and of the soil should be considered before it is adopted in other parts, for harmful salts may be present in either.

To obtain the heaviest yields and best quality rice it is necessary to keep the water on the crop until the last few grains towards the base of the head are out of the milk stage and in the dough stage, and the panicles of the varieties at present recommended for these areas are well turned down. Otherwise loss of weight will occur through the grain not being fully filled, and there is a greater possibility of the grain cracking when being taken off with the header. Care must be taken in draining off the water not to carry out the operation too quickly, but to extend it over a few days at least, as otherwise the plants are likely to fall and much of the crop thus be lost.

Harvesting Troubles.

Harvesting has been a problem, and it is possible that trouble may be experienced any year from an early break in the weather, which will prevent the use of ordinary machinery. Although wet conditions handicapped harvesting operations to a large extent in the 1925-26 season, no damage was done to the standing crops; a loss of grain occurred wherever the binder was used in the late harvested crops, due to the over-ripe grain being easily knocked off. The risk of a wet harvest is lessened by early sowings—as soon as danger of frost is over, and the soil has commenced to warm, being the best time.

The 1926-27 harvesting season tried the growers out, but most of the difficulties were overcome by auxiliary-driven machinery. Binding and threshing was the general method adopted, and to overcome wet conditions small 3½-h.p. engines were built on to the binders, the drive wheel then only being used to take the weight of the machine. A header, such as is ordinarily used for wheat, was tried out, and after several alterations and the attaching of a 7-h.p. engine for auxiliary power, it handled a crop of 160 bushels per acre very successfully, despite adverse conditions.

The auxiliary-driven header seems to be the machine most suited to harvesting rice, as time is the main consideration once the grain is ripe. Although it is possible to cut with a binder a week before a header could be used, the sheaves have to be stooked for at least fourteen days, then carted, and either stacked or threshed. A considerable loss of grain occurs at each handling, whereas with the header the grain is ready for bagging in one operation. Beside the loss of grain and the chance of being caught by rain, binding and threshing is more expensive. The bagging of wet rice is to be avoided, as it is subject to mould and is then objected to by the millers. Caloro, being a softer-grained variety than either Colusa or Wataribune, is likely to hold more moisture, and so is more liable to damage in this way.

SECTION VI

Root Crops.

THE POTATO.

Though largely grown in New South Wales, the potato as a crop has not received the attention from farmers that is due to it, and for a number of years this State has had to import largely from Tasmania and Victoria to make up the deficiency in our production, the importations being almost *equal to the quantity grown within the boundaries of the State.* There is no reason why local potatoes should not realise the same prices as those imported from other States. Previous to the grading regulations being introduced there was at times a big variation between local and imported consignments, which, no doubt, led to greater confidence being placed by buyers in the graded interstate product. If local growers would put up produce of reliable grade, in good, sound, clean bags, they would soon gain the confidence of buyers. In-so-far as cooking quality is concerned, the average householder cannot discriminate between the local and the usually higher priced imported potato. A strong potato-growers' organisation could do much in effecting improvements in the marketing of the local produce.

For the purposes of this crop the State is divided into two sections as regards season, viz., coastal and tableland, the time of planting varying in different parts of the State, and growers must be guided largely by local conditions.

In the warm coastal districts two crops of potatoes can be grown each season. The first crop is planted in July or August, and is called the "spring crop"; *the second, in January or February, is designated the "autumn* crop."

The weather conditions generally prevailing throughout the growth of the spring crop are such as to be unfavourable to the development of Irish blight, and consequently damage is very rarely caused. This crop usually meets with a big demand, owing to the market being bare, and it realises high prices. The autumn crop meets with conditions favourable to the rapid spread of the blight fungus, and in addition the tubers are marketed at a time when potatoes from the tableland districts are available, and prices are consequently low. The growing of the autumn crop on the coastal area is only recommended on a small scale sufficient to meet local requirements.

Soils.

Potatoes can be grown successfully on many soils. Sandy loams, loams, or friable clay loams are most suitable. Light sands and heavy clays are unsuitable, but not impossible. Sandy soils are earlier than clay ones. Small areas worked properly will give better quality potatoes and higher returns than large ones farmed "anyhow." It is true that good crops are sometimes obtained even when planted under the sod; it is also true that the same methods on cropped lands will spell failure.

The main trouble with our potato soils is the lack of organic matter. In new land there is always a good supply of humus, and the land when broken up is in good physical condition, but after a few years of cultivation all the organic matter becomes exhausted, and unless additional supplies are provided, either in the form of farmyard manure or green manure, the soil soon becomes compacted and consequently cannot produce a maximum crop; as farmyard manure encourages "scab" it is advisable to apply it some time before planting.

The presence of humus in the soil improves its texture, lightening and loosening it, and preventing the compaction of the surface, so that it is of special value in the preparation of potato soils. The humus in the soil is the ingredient which is most subject to alteration and destruction, and under dry conditions it is more or less rapidly destroyed. As soon as it has lost its moisture and become dry, it is rapidly burnt out by the combined action of sun and air. As its presence is most essential where it is most liable to destruction, the necessity for renewing it is apparent.

In order to maintain this supply of humus, the following rotation is recommended:—

(1) Potatoes.
(2) Oats or wheat.
(3) Clover, peas or rape.

The cultivation of the potato crop prepares the soil for the cereal crop, which in potato districts is usually oats for hay. After the hay crop is harvested the land should be ploughed as soon as possible so as to participate in the usual February rainfall, after which rape (February sowing) or field peas or clover (March sowing) should be planted. Of the three, clover is recommended. These crops can be utilised as sheep-feed during the winter, but they should not be completely eaten off, and care should be taken that the soil is not trampled out of condition by grazing heavily during wet weather. In the case of clover crops it is desirable to allow these crops to remain for several years before breaking up and planting to potatoes. Red clover is particularly suitable for the purpose, and in certain areas Subterranean clover has proved its suitability for restoring "worn out" potato soils. Clover crops will produce much feed on which sheep will do well, and will amply repay any expenditure incurred in the sowing down of the crop. Such a method of farming will usually restore land to a fertility standard only to be compared with virgin land. The crop residues should be turned under during late winter, and not later than August, the ploughing being fairly deep. The soil should occasionally be harrowed to conserve moisture, and should be in a fit condition for planting with potatoes during November.

Preparation of the Soil.

Although the potato as a pioneer crop may be sometimes relied upon to yield good returns with little cultivation, it is usually found that the crop requires the best of attention in every detail.

On the coastal areas the extensive culture of potatoes during the autumn is not recommended, because the conditions favour Irish blight, and growers should confine their attention during this period of the year to the preparation of the soil for the spring crop by planting a preparation crop. It is good practice to fallow between the maize and potato crops, even though the

period is short. When maize is harvested in June the land should be ploughed at once, the stalks being turned under and allowed to decay, forming the humus that is so essential to fertility.

On the tablelands the preparation of the soil should be commenced during the winter months. There are many advantages attached to early and thorough working of the soil, some of them being direct and others indirect, but all are quite important in relation to the final result.

The first direct advantage is the exposure of the soil for three or four months to the sweetening influences of sun, air, and frost, and the second the increased capacity of the soil for the absorption and retention of any rain that may fall. If this early ploughing is followed with cultivation by means of the springtooth cultivator, the effects are to preserve a surface mulch which conserves moisture, and at the same time to bring sorrel (which infests most of our potato soils) to the surface, so that the roots are exposed to the sun.

The early ploughing should be at least 8 to 10 inches deep, in order to ensure that when the seed is planted it will have a good depth of worked soil beneath it. The practice of many farmers of ploughing only 4 inches deep, and then putting the seed on the hard bottom, is the reason for many of the yields that compare so unfavourably with those obtained where better methods have been employed. Towards the end of the winter the land should be cultivated with the springtooth cultivator, and this should be repeated occasionally to conserve the moisture. If heavy rains have occurred during the period of preparation, it will be necessary to plough the land again; but in this case a shallow working will be sufficient. The effect is to open up and aerate the soil which has been hardened down by the rain, to give it a better physical condition, and to turn under any weeds that have grown. The aim in all operations should be to loosen the soil, as any rain which falls after the potatoes are planted will soon compact the seed-bed.

The result of this treatment is that the soil is in such good condition when sowing time arrives that it is unnecessary to wait for rain to plant the seed. The farmer can start operations with the knowledge that he is sowing at the right time, and that he can go through with the business to the finish without delay. Again, the grower can plant cut seed; but it is well known that if cut seed is planted in a dry seed-bed a poor germination and a patchy crop is the result. If, however, preparations have been made in the way advised, there is ample moisture in the soil, and a large area can be sown with cut seed, and no delay for rain will be necessary at any stage.

The same reserve of moisture has an important influence on fertilisers, if they have been used. Soil moisture is essential for best results from fertilisers. If the soil is dry at the time of planting, the young plant derives no advantage at the start. It is true that wet weather at a later stage will have an effect upon the fertilisers, and the crop will benefit to some extent then, but one of the greatest advantages of these manures is the vigorous start they may give when first the seed puts forth leaf and root. This is lost if the land is dry at seeding time. Ensure moisture by early working if you want to use fertilisers with confidence as to the results.

Besides the benefits which thus attach to early ploughing and working of the soil, a large amount of plant-food is also released and made available for the needs of the crop. Analysis has shown that the bulk of our soils contain sufficient plant-food to produce potato crops for hundreds of years, but the trouble is that this plant-food is not in an available form, and on continuously cultivated soils it is only by a proper system of cultivation that a sufficiency of plant-food is secured for the crop.

Varieties.

The number of varieties grown in this State is large, but some of them are not of first-rate value. The following are the varieties recommended for various districts:—

North, Central, and South Coast.—Factor, Up-to-date, Early Manhattan, Satisfaction, and Early Manistee in the South Coast district.

North Coast Plateau (Dorrigo and Comboyne).—Factor, Satisfaction, Up-to-date.

Northern Tableland.—Coronation, Factor, Satisfaction, and Queen of the Valley. (For second-quality soils—Surprise or Symington.)

Central Tableland.—Factor, Up-to-date, Early Manhattan, and, in addition, for Oberon, Early Rose and Satisfaction. (For second-quality soils—Surprise.)

Southern Tableland.—Factor, Up-to-date, and Early Manhattan. (For second-quality soils—Surprise.)

South-west Tableland (Bathow, Tumbarumba).—Factor, Up-to-date, Satisfaction.

Murrumbidgee Irrigation Area.—Up-to-date, Early Manhattan, Factor.

Descriptions of Recommended Varieties.

The following are brief notes on the varieties recommended or commonly grown:—

Up-to-date.—A main crop variety. The tubers vary in shape from nearly round to long oval; the skin is white, usually smooth, but sometimes slightly rough; eyes shallow; a fairly reliable cropper.

Satisfaction.—A red-skinned variety of good shape. Being an early sort it is suitable for spring planting on coastal areas.

Early Manhattan.—A dark purple-skinned potato, mottled with white; flesh very white. Usually a good cropper, with a large percentage of marketable tubers.

Factor.—A white-skinned variety, very similar to Up-to-date, but has proved a better yielder in many districts. One of the best of the white-skinned varieties; eyes shallow, and tubers of good appearance and good cooking quality.

Early Manistee.—An early red skin. Tubers somewhat flattened; table quality excellent; shallow eyes.

Coronation.—A late-maturing variety; blue skin, mottled white, somewhat resembling Early Manhattan. Synonymous with New England Blue Skin or Guyra Blue. A heavy yielder under good conditions, but if the season is dry the proportion of small potatoes is very high. Particularly suited to New England. Tubers of good shape.

Surprise.—A late-maturing variety, suited to the tableland districts. The tubers are rounded in shape, light-pink in colour, with deeper pink in the eyes. Wrongly known by some farmers under the name of Freeman. The large tubers have a tendency to become hollow, and are not the best of keepers. It is a splendid table variety, and the bulk of the tubers produced are of a marketable size. Little skill is required in grading to make an attractive sample. Very rich soils are not suitable to the growth of this variety, as overlarge hollow tubers are frequently produced.

Carman No. 1.—An early white-skinned tuber of good appearance; somewhat inclined to second growth. One of the best varieties on granite soils.

Late Manhattan.—A purple-skinned variety without white blotches. Grown fairly extensively in the Orange district as the main-crop variety. Flesh very white. This variety is degenerating fast, and will require much work in the way of selection if it is to remain profitable in commercial areas.

Queen of the Valley.—A red-skinned variety which is still largely grown. Certain strains are an improvement on the deep-eyed tuber which is usually looked upon as the typical Queen of the Valley. The improved strains are more commonly known now under the local name of Brownell Beauty or Big Top Brownell—apparently no true type of the one time well-known Brownell's Beauty is cultivated in this State.

Seed Potatoes.

On the quality of the seed planted much of the success of the potato crop depends, and when selecting seed the utmost care should be taken to see that the variety is true to type and perfectly free from disease. Continual selection will increase the yield.

A good whole Tuber Set, about 3 oz. in weight.

In the tableland districts during past years seed potatoes have been picked in a haphazard manner, and have generally consisted of the grade between the "pig" and marketable sizes; in fact, anything that was left at the end of the season after all marketable tubers had been sold. With all other varieties of crops the seed is carefully selected from the best available, and it is apparent that some change should be made in the method of selecting seed potatoes.

The best way to secure good potato seed is to raise it on the farm under one's own observation. Farmers who have large areas to plant should maintain a seed plot. To commence this, each grower should select and mark in some way those plants that are quite free from leaf roll, mosaic and other virus diseases, and which are not in proximity to affected plants. At digging time these plants should be subjected to a further process of selection, tubers being kept for seed from those that have borne in greatest measure potatoes of good type.

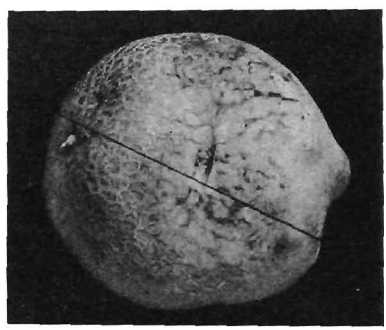
These seed tubers should then be planted in a seed plot situated some little distance from the main or other potato crops, and in the following season all plants in this plot which show virus disease or any sign of degeneration should be removed as soon as they are recognised. The remaining tubers will provide the seed for the main crop in the following year, with the exception of the small number necessary again to maintain the seed plot.

If this system of two-year selection of the seed potatoes was practised, or a known disease-free strain were propagated in the seed plot, and rogued only one year, it is certain that much higher yields would be obtained. The method would not be costly, but would involve attention to that most vital of all potato-growing problems—the selection of the best seed. The present haphazard methods of securing seed from the crop without any knowledge as to whether the tubers come from degenerate plants or not will only result in further depression of the yield.

On coastal areas seed from cool districts should be obtained at least once a year. Immature seed is considered better than mature, and to this fact is attributed some of the superiority of cold country seed.

Cut or Whole Seed.

There is considerable diversity of opinion as to which is the best size of tuber to use as seed. Small potatoes can be divided into two classes—(1) the late-formed tubers of a strong, robust plant; (2) the produce of a plant of low vitality. The former would probably yield as well as its parent, but the latter could only be expected to produce a crop of poor quality. When small potatoes, selected from the pit, are used year after year, reduction in yield must follow, since every year the produce of weakly plants would be on the increase.



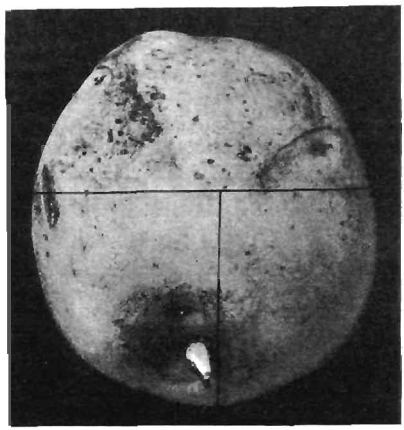
Tuber cut for two sets.

Experiments carried out by this Department with whole and cut seed have not produced results more favourable to one than to the other. If the season should be dry at planting time, it would be preferable to use whole potatoes, as the cut seed would dry out considerably before shooting, and consequently would not be able to give the young plant the same start in life as a whole tuber. When cutting is resorted to, it is advisable that the planting should be done as soon as possible after cutting. The cut surface may be hardened by sprinkling with ashes or slacked lime.

In cutting the seed, the sets should be made as even in size as possible, with the least possible cut surface.

For autumn planting on the coast only whole tubers should be used, as under humid conditions cut seed is liable to rot.

The practice of storing seed in large pits without providing ventilation has been the cause of a good deal of fermentation and consequent injury to the germ, with the result that the eyes of such seed fail to develop or the shoots are small and spindly, eventually dying off. In order to obtain seed with strong vegetative power, it is essential that all heating and fermentation be avoided from the time the potatoes are taken out of the ground until planted.



Tuber cut for three sets.

As the condition of the seed has a big influence upon the yield, the following methods of treatment are recommended:—(1) Place the seed tubers in shallow boxes or trays, and store in a well ventilated and lighted room. The trays should be made with the ends higher than the sides; this will admit light and allow of a proper ventilation. By this method it will be found that the buds are short, dense, full of colour, and sturdy enough to resist fairly rough handling. Potatoes stored in this manner are not so liable to rot, and any diseased tubers can readily be removed, together with any that have produced weak shoots. The chief advantages of this system are that the sets produce fine, healthy plants, and are in readiness for an early planting. As early crops are more likely to escape blight, this is in itself a big argument in its favour. (2) A modification of the above method.

which would involve less labour, would be to spread the seed as shallow as possible on the floor of a shed; or (3) store in a rick made of saplings, the floor of which should be about 6 to 12 inches above the ground level—the spaces between the saplings would allow plenty of ventilation; or (4) spread out thinly in early spring under trees or in bush scrub.

The amount of seed required to plant an acre varies according to the size of the seed and distance apart, ranging from 7 cwt. to 13 cwt. per acre.

Treatment of Seed.

Dipping of seed for "scab" should be more general. The standard dip is a solution made of corrosive sublimate, in which the seed is soaked for 1½ to 2 hours. Details of this treatment are given on page 508 in connection with scab diseases.

Manurial Recommendations.

If the organic content of the soil is satisfactory and the land properly worked, the use of artificial fertilisers can confidently be recommended.

Experiments which have been carried out by the Department in various districts of the State indicate that a dressing of 2½ cwt. of superphosphate per acre dusted along the furrow in which the sets are planted nearly always results in a profitable increased yield. In districts of heavy rainfall, such as Dorrigo, a heavier dressing (5 cwt. per acre) usually gives the most profitable increase, but the lighter dressing is to be recommended in most other parts. In the cooler tableland districts of the State the addition of 2 to 3 qrs. of sulphate of ammonia to the 2½ cwt. of superphosphate has been productive of the best yields in recent tests.

Planting and Cultivation.

Where potatoes are grown for early market the aim is to plant as early as possible—that is, as soon as danger from frosts is over—provided there is an ample supply of moisture. Nothing will be gained by planting in a soil that is excessively cold and wet. Covering with litter, such as straw, when the plants are breaking above ground, will often ward off the effects of frost. The covering of the land with litter immediately after planting is not recommended, as it reduces the soil temperature, and germination is slower and sometimes hindered.

The time of planting varies with the district. On the coast two crops are grown, the first being sown from June in the far north to September in the south. This crop usually realises high prices, because it generally comes on a bare market. The second crop is usually planted in February and harvested during the winter, when potatoes are cheaper. Seed for this crop is obtained from the spring crop.

On the tablelands, potatoes are planted most extensively during October, November, and early December—November being the month of heaviest planting. During October planting is always associated with a certain amount of risk, as the occurrence of frosts during early November is not uncommon. Although the haulms may be cut back by frosts, it is only very heavy frosts which entirely destroy the crop. Usually with late frosts the tops are at the most cut back to the surface of the soil, and fresh shoots are produced from dormant buds lower down the stem.

The best depth to plant is 4 inches; it should not be more than 5 inches. The most common method of planting is by dropping at every third or fourth furrow during ploughing, according to the width of furrow cut and class of plough used. The rows should not be less than 27 inches apart, and a distance of 30 to 32 inches is preferred; on poorer soils this should be increased to 3 feet apart.

When the dropping of the potatoes is done by hand, the sets should be placed on the ploughed side of the furrow, reducing the possibility of their being damaged or knocked out of position by the furrow horse when being covered. The tubers are dropped from 12 to 18 inches apart, a good average being 15 inches.

On small areas the single furrow is in general use, but on the larger areas where the acreage under potatoes runs to or approaches three figures, multiple ploughs are used. On these ploughs the dropping is made lighter by having a box fastened on the plough to hold the seed, and a galvanised iron pipe, into which a man or boy, sitting on the plough, can feed the seed with his hands, the potatoes being dropped in the second furrow, and covered by the third sod.

Another system is to open out furrows with the plough at the required distance, covering the sets with plough or harrows. The drills should be covered as soon as possible to prevent drying out.

Of recent years the use of planting machines has been on the increase. Some of these machines are for use on multiple ploughs, being worked by chain-drive from off the land wheel. Another class includes those of American make, which are complete machines on their own wheels, and fitted with fertiliser attachment. These machines open out the furrow, plant the seed, and manure and cover in the one operation, and they tend, too, toward better farming methods. The potatoes are planted in straight rows, and the manure is placed in close proximity to the sets, even on windy days. Planting can be carried on in the hot weather with little loss of soil moisture, as the necessity of ploughing at this time is dispensed with. Experience, however, has proved that these machines are more suited to the lighter types of soil; on the heavy basalt soil it is difficult to plant to a satisfactory depth. For these machines the land is prepared early in the year, being fallowed and cultivated until planting time. Planting on these lines is the ideal method if mechanical diggers are to be used for harvesting.

Soon after planting, the field should be lightly harrowed to break down the furrow ridge, thereby reducing evaporation. Just as the young plants are showing through, the field should be again harrowed, this being the last opportunity of killing young weeds between the plants, as all future cultivation is between the rows. When the haulms have grown sufficiently to distinguish the rows, the cultivator should be used to loosen the soil, keep down weeds, and retain the earth mulch so essential in retaining moisture. A cultivator of the Planet Jr. type is the most suitable, because when the tops become at all large the width of the cultivator can be narrowed, so that there is less damage to the haulms and the young roots in close proximity to the stem. Cultivate frequently in the early stages of growth, as the destruction of weeds at this time is easier, and means a clean crop later on. Towards flowering time the rows should be slightly hilled to protect the tubers from sun-scald, frosts, and potato moth. The hilling can be effected by using the moulboard attachment during the last working with the cultivator.

The new tubers always develop over the old set, and as they become large may even be half out of the ground, and unless the crop has been hilled the newly-formed tubers become exposed.

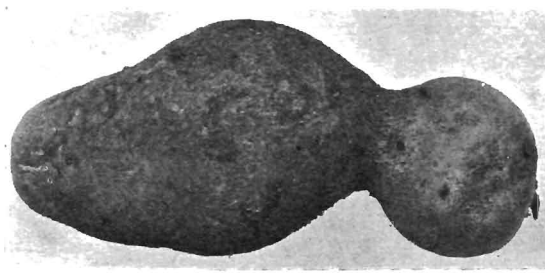
Hilling is also a preventive of rot during outbreaks of Irish blight, inasmuch as the greater thickness of earth over the tubers to a large extent prevents the washing of the spores from off the foliage on to the tubers.

Excessive hilling is not recommended, as it intensifies the injurious effects of dry weather, and also results in damage to the roots between the rows.

Potatoes under Irrigation.

Work the land well, and if it be dry, irrigate just before ploughing. Plough deeply as soon as the land is dry enough, and plant immediately. Keep the ground well harrowed until the young plants are well up. One good irrigation (or at the most two) is all that is required for spring crops, and these should be given before the young potatoes are any size, as later watering will induce a second growth, which spoils the tubers.

The secret in potato-growing is good cultivation, combined with as little water as is necessary to keep the plants in good growing condition.



Tuber showing second growth.

The spring crop should be planted as soon as the severe frosts are over, which is usually from July to September, and the fall crop in February. They should be planted in drills 3 feet apart, and when it is found necessary to irrigate, furrows may be drawn midway between the rows and water allowed to run until the ground is well soaked. As before stated, two waterings, with good cultivation, should be sufficient for any spring crop of potatoes. The autumn crop will naturally require more waterings during its earlier stages, as the ground at this time of the year is drier and the heat more intense.

Second growth mostly occurs when rain follows a very dry period, and a similar condition often occurs when potatoes are irrigated after a dry spell.

Harvesting.

The spring crop on the coast is grown for earliness, and the tubers are harvested when considered large enough to market and firm enough to carry. At this stage the haulms are green, and the young tubers are very soft. Very often the potatoes could be profitably left for another week or so, because being nearer maturity they arrive in a much better condition on the market, and the additional weight, even in this short time, is considerable. Some of the potatoes dug very early present a very poor appearance on arrival at market; being devoid of skin, they are much bruised and black in colour.

Other than the spring crop, the time to harvest is determined by the dying-off of the tops and the maturity of the tubers, and the sooner the tubers can be dug after the tops reach this stage the better. If left until midwinter the weather is disagreeable and much time is lost, while digging is heavier and the tubers do not clean. If the tops have been destroyed by frost, it will be necessary to allow the tubers to remain in the ground until the skin is firm and does not peel on handling.

The most common method of harvesting is digging with the pronged digging fork, but digging machines have been increasingly popular in recent years.

One form of Potato Digger. Rear view, showing tubers leaving revolving apron and falling on riddle.

Digging machines are of two types—(*a*) English, in which the principle is that a share passes under the row of potatoes, the earth and tubers being thrown to one side by revolving arms at the back, so that the tubers are left exposed, ready for picking up. The machines are light in draught, but the large spread given the tubers is one of their worst faults. (*b*) American.—The principle in this case is for a share to pass under the rows, the tubers, together with the earth, then being carried on to a revolving apron. This apron, which is of cross bars, arranged up and down alternately, revolves rapidly, being given a sifting action by elliptical sprockets. The earth

passes through the bars and falls back into the furrow already dug, the tubers passing over the back and being deposited in a row on the loose earth recently dug. These machines are not satisfactory on basalt soils that have become wet with winter rain.

Marketing.

The tubers after digging are treated in different ways. A large percentage of the growers have of recent years been sending their produce to market straight from the paddock. In this case the large potatoes are first picked up and bagged and carted immediately to the station, and the smaller tubers bagged separately and stored for future use for seed and pig-feed.

Growers should realise that intimately bound up with the whole matter of profitable potato-raising is the demand of the market. It is essential to success to send the product to market in a condition acceptable to the buyer. In these days of keen competition buyers pick and choose to an extent not realised by one who has not witnessed the disposal of goods put on the market. Growers should note that potatoes must be marketed according to grade.

Before bagging, care should be taken to remove all soil that might be attached to the tubers, and the bags should be shaken down to ensure tight packing—but not too tight, for either too loose or too tight packing results in bruising, and decay follows. The tubers should be left exposed to the sun for a little time before bagging. This will allow them to dry thoroughly, and there will be less adhering earth. Second-hand bags are frequently the medium of carrying diseases that attack the potato, and they should certainly not be used unless they are clean wheat or flour bags, or have been obtained through agents who can offer some guarantee that they have been disinfected by boiling or steaming at a sufficient temperature before despatch to the farm. New bags may, perhaps, be a little more expensive in the initial cost, but they well repay the extra outlay. Each grower must brand bags according to grading regulations.

Storing.

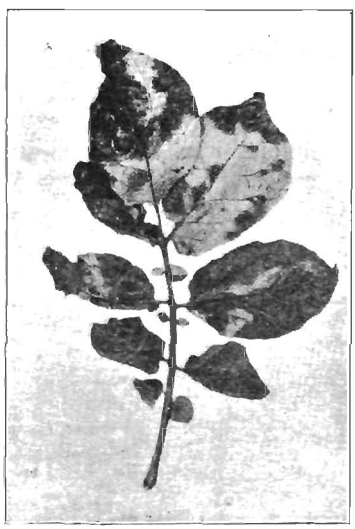
When storing potatoes intended for culinary purposes it must be remembered that light causes a yellowing of the flesh, and produces bad boiling qualities; consequently, it is necessary that the light should be excluded. In order to prevent the spread of rot, the potatoes should be perfectly dry, no matter which method of storage is adopted. Pitting is not recommended where it can be possibly avoided owing to the cost of a second handling. It is preferable that the storing be carried out in sheds which are well ventilated, the potatoes being covered with straw or hessian to exclude light.

Where large areas are grown and pitting must be resorted to, a system of ventilation should be provided by leaving openings and filling them with straw, covering in such a manner as to keep out the rain, and at the same time allow a free passage of air.

Diseases of the Potato.

Late Blight.

Late blight, or "Irish" blight as it sometimes is called, frequently causes very serious losses in potato and tomato crops. The disease is caused by a parasitic fungus, *Phytophthora infestans*, and during a period of moist weather with cool nights and relatively warm humid days, it may be responsible for considerable damage. A warm dry spell will frequently check its progress.



Potato leaf affected with Late Blight.

[*After McAlpine.*]

All parts of the potato plant may become affected, and the disease may also develop on the tubers in storage. The first symptoms usually appear in the form of brown or black areas on the edges of the leaves. These discolorations have, at first, a somewhat water-soaked appearance, but with the further development of the fungus the foliage blackens and wilts. The fungus itself may be observed on the under-surface as a delicate, downy growth. Blackened, elongated, discoloured areas may develop on the stems. These often commence at the junction of the leaf-stalk and stem.

The disease is spread from plant to plant by means of small spores which serve to propagate the fungus. Tubers may become infected in the field by means of spores which are washed down from diseased plants or through contact with diseased foliage at harvesting.

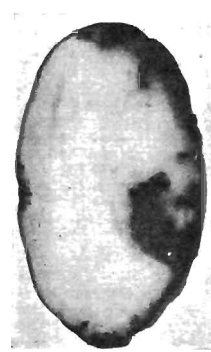
Affected areas on the tubers become depressed and show a brown or purplish discoloration at the surface. The late blight fungus, acting alone, causes a decay which is brownish in colour and which extends irregularly into the flesh of the tuber. More frequently, however, the symptoms are complicated by the presence of secondary bacteria which result in the development of a soft, evil-smelling rot.

CONTROL MEASURES.

The following methods of control are recommended:—

1. Use only healthy tubers for seed purposes. It is preferable to obtain seed potatoes from a crop which has not been affected by the disease.

2. Spray the crop with Bordeaux mixture 1-1-10, or if good stone lime is not easily obtainable, spray with Burgundy mixture. Lime-sulphur or sulphur dust is of no value in control of the disease. The spray should be applied when the plants are from 6 to 9 inches high, and subsequently at fortnightly intervals if weather conditions warrant it. The spray should be applied at high pressure through fine nozzles, and should be directed on to all portions of the plant.



Section of Potato affected with Late or Irish Blight (*Phytophthora infestans*).

If a late attack has caused serious damage to the plants at the close of the growth period, it has been found that some loss may be prevented by spraying the plants and the soil with copper sulphate (1 lb. to 4 gallons). The spray kills the plants and prevents further development of the fungus. Under general conditions, however, when the disease has developed in a crop, allow the vines to die and dry completely before digging is commenced. The tubers should be picked up as soon as they are dug, and should never be covered with the dead vines.

3. It is sometimes suggested that hilling will protect the tubers from infection, but unless the hilling is done so as to form a ridge the effect is rather to form a funnel which may facilitate the washing of spores on to the tubers.

4. Sort out visibly affected tubers before shipping or placing remainder in storage. Tubers should be kept in a dry place, and at a temperature of 38 deg. Fah. or less, to prevent development of the disease in storage.

Diseased tubers should be boiled before feeding to stock.

5. Practise rotation of crops. Do not sow potatoes in the same area year after year. As far as practicable, remove and destroy diseased foliage and tubers.

To make Bordeaux Mixture.

The formula recommended by the Department for use in connection with potatoes is as follows:—

Copper sulphate (bluestone)	4 lb.
Freshly-burnt lime..	4 lb.
Water	40 gallons.

Two or three fairly large wooden vessels are required to make the mixture. If, for instance, it is intended to make 40 gallons of spray, two tubs or barrels capable of holding 20 to 25 gallons of water are needed and one of a capacity of 40 to 45 gallons.

For the copper solution, wooden vessels are preferable, though copper ones may be used. Iron should be avoided. For the lime, use wooden tubs or barrels.

Purity of the Ingredients.

Samples of bluestone sometimes come on the market which contain a quantity of sulphate of iron, and it is as well that the grower should know the difference. Bluestone proper should be in the form of dark blue crystals, while the adulterated mixture is a lighter blue; indeed, the characteristic colour of sulphate of iron is a light green. The bluestone may be tested by dissolving a few crystals in water and adding a little ammonia. A pale blue precipitate is formed which dissolves to an intense blue colour, and the solution remains perfectly clear and free from sediment if allowed to stand for a while. If a reddish sediment settles, it is due to the presence of iron.

It will be found as we proceed that it is of importance that the lime should be freshly burnt. To test whether it is so, a few lumps should be placed in a heap and sprinkled with water, when it will gradually fall to pieces, becoming very hot in the process, giving off a quantity of steam, and crumbling to a fine, white powder. Some lime may not crumble readily with cold water, but may do so with hot water. If it does not get hot enough to give off steam even with hot water, then the lime is unsuitable.

Dissolving the Copper Sulphate.

The first operation in making Bordeaux mixture is to dissolve the copper sulphate and to make the milk of lime separately. It is for this that the smaller vessels are required.

The common practice is to crush the bluestone crystals and then to pour boiling water over the powder. To dissolve the 4 lb. recommended in the above formula, one gallon and a half of hot water should be sufficient. When it is seen that the bluestone is dissolved, cold water should be added to bring up the quantity to half the total quantity of spray to be made.

Many growers omit this last point, simply obtaining the solutions and mixing them before adding the requisite quantity of water; but the practice has a distinct effect upon the quality of the spray mixture, lowering its efficiency and increasing the probabilities of the nozzles becoming clogged.

It is not essential to dissolve the bluestone in hot water. If the spray is not required for immediate use, half the water can be put in the cask, and the bluestone suspended in a porous sack, as near the surface as possible. If thrown loose into the bottom of a tub of cold water, bluestone will not dissolve in a week.

If large quantities of Bordeaux mixture are being used, it is handy to make a concentrated solution of copper sulphate and to use it as required. Such a stock solution of copper sulphate (bluestone) can be made in a large cask, of a strength, say, of 1 lb. to 1 gallon of water. This can be done by weighing out the desired quantity of copper sulphate, and suspending it in a piece of bag or hessian in the upper part of a measured quantity of water. *When mixing the spray, a gallon of this solution is used for every pound of* copper sulphate required. A mark should be made at the level of the liquid after removing any of the stock solution, so that if evaporation occurs it can be compensated for by the addition of more water before the next quantity is measured out.

Lime and Water.

The lime, which as stated above should be freshly burnt, is slaked by the addition of about half a gallon of warm water. Sufficient water must be used to ensure the whole of the lime being slaked, and it should be added from time to time in small quantities, to keep the action even and ensure perfect slaking. It is a common mistake to add too little water at this stage, with the result that too much heat is developed and the lime is burned, in which case there are many small lumps that do not slake down properly, and they have to be thrown out in the straining to prevent the nozzle becoming clogged.

The lime being reduced to a fine powder, water is added to produce a thin whitewash, and the whole should then be strained through coarse sacking to remove any lumps that may cause trouble in the nozzle. Enough water is then added to bring the quantity of milk of lime up to half the total quantity of Bordeaux mixture that is to be made.

Just as a concentrated solution of bluestone may be prepared, so, in a similar manner a weighed quantity of lime can be slaked beforehand in a large receptacle, measuring the quantity of water used (which should be sufficient to reduce the lime to a cream) or, if the lime has been stored under water (see below) it can be measured out, and a measured quantity of water added to bring it to a cream. The lime can then be measured out from the stock mixture and the right quantity of water added at time of mixing the spray as described for the bluestone, but great care must be taken before measuring out the lime that the stock mixture of lime cream is very thoroughly stirred. When stock solutions or mixtures are held for considerable periods, allowance should be made for loss of water through evaporation when brought into use.

A Note on Lime.

It is essential that the lime used should be that known as "quicklime," "stone lime," or "building lime." It should slake readily with water, becoming hot in the process, and crumbling to a powder free from rocks or stones.

Freshly slaked lime can be used, provided it really is freshly slaked. Old slaked lime in which the calcium hydrate has been converted wholly or in part into calcium carbonate is of no use in the manufacture of Bordeaux mixture. When carbonated lime is used in spray mixture, the chemical actions which take place are different from those when fresh-burnt lime is used. Air-slaked lime, provided that it has not become carbonated, is as suitable as quicklime, though, of course, more would have to be used. A parcel of 100 lb. of quicklime on becoming slaked would weigh about 132 lb., and when it has become completely carbonated would weigh 178 lb.

Not only is a certain difficulty sometimes experienced by growers in obtaining lime of good quality for the preparation of such sprays as lime-sulphur and Bordeaux mixture, but even when a suitable lime has been procured and has given satisfactory results, there remains the problem of efficient storage. Quicklime becomes first air-slaked, and is then converted into carbonate of lime, with the consequence that the resultant proportion of effective lime after storage constitutes a variable quantity, according to the quality of the original article and the conditions of storage. The preparation of sprays with the accuracy necessary for consistent good results becomes (in the absence of a knowledge of the article's exact constitution) almost impossible.

As the result of a series of experiments, the Department has devised a method of getting over this difficulty, and it is now established that—

1. Lime may be stored under water even for periods of twelve months.
2. There is a slight decrease in the effective lime, amounting to about ¾ per cent., but this decrease is so slight as to be negligible.

It is therefore recommended that growers should first of all procure lime of good quality for the preparation of sprays; and that the lime obtained should be kept under water, and used as required. Each aliquot then drawn will contain a definite quantity of lime, the amount of which can be simply and readily calculated.

Mixing the Milk of Lime and the Bluestone Solution.

The bluestone solution and the milk of lime are now ready to be brought together. This must be done in such a way as to ensure their being thoroughly mixed. Pouring one into the other is not satisfactory. They should both be poured at the same time into the large vessel mentioned above. The operation can be best performed by two men, each with a bucket, one handling the bluestone solution and the other the milk of lime, and both pouring in together and stirring frequently. The sulphate of copper (bluestone) solution or the lime and water mixture can be kept separately for a long period—a thin scum or crust of calcium carbonate will probably form on the surface of the latter and should preferably be removed before use, but when mixed the resultant spray should be used immediately.

Testing Bordeaux Mixture.

The object in using Bordeaux mixture is to apply a basic copper sulphate from which ordinary or normal copper sulphate will be re-formed in small quantities only at a time, but yet in sufficient quantity to kill harmful fungous spores. If normal copper sulphate was applied as such, even in very weak solution, it would seriously injure the leaves and plant tissues, and the lime is added to produce the insoluble basic sulphate. The proportions mentioned in the above formula supply ample lime to more than neutralise all the copper sulphate, but through inaccuracy in weighing or measuring, it may happen that the copper sulphate may not be entirely decomposed and that some of it may exist in solution in a free state. While this is extremely unlikely with ordinary care, it is as well to test for the presence of soluble copper.

A rough but useful test consists in placing a clean knife blade in the mixture for a few minutes. If copper sulphate that has not been neutralised is present, a reddish stain will be left on the steel, and it will be necessary to add more milk of lime, and then test again.

A second test as to whether or not the copper sulphate has been neutralised consists of adding a few drops of a solution of ferrocyanide of potassium (in the proportion of 4 oz. dissolved in 1 pint of water) to a small quantity of the Bordeaux mixture, acidified with acetic acid, preferably in a test tube. If any brown or black discoloration takes place more lime is needed.

If, however, the proportions recommended above, and the methods of handling described are carefully followed, there should be no reason to fear the burning that free copper sulphate causes.

Burgundy Mixture.

In this mixture copper sulphate is again the most important constituent, but its corrosive action upon the plant is prevented by the use of common washing soda as the neutraliser instead of lime, a larger quantity being necessary.

It often happens that it is difficult to obtain freshly burnt lime for Bordeaux mixture, and the washing soda may then be used to produce Burgundy mixture.

The formula recommended is as follows:—

Copper sulphate (bluestone)	4 lb.
Common washing soda	6 lb.
Water	40 gallons.

The copper sulphate is dissolved in the same way as in the case of Bordeaux mixture, but the Irish Department recommends that the bulk of the water should be used for this purpose when making Burgundy mixture. If 40 gallons of spray is being made, 36 or 38 gallons of water should be poured into a clean barrel and the bluestone suspended in it in a bag.

The balance of the water should be put in another vessel and the washing soda dissolved in it in the same way.

When both the materials are fully dissolved, the soda solution should be poured slowly into the bluestone water, stirring continuously. The bluestone solution should never be poured into the soda solution.

Burgundy mixture should be regarded as a substitute for Bordeaux mixture, and should be used at the same times as recommended for it.

Even when the above conditions are accurately carried out the mixture may not give the best results, owing to differences in the strength of the sulphate of copper and of the washing soda. Those who wish to get the best results should dip a piece of blue litmus paper in the prepared mixture. If the paper becomes red, more washing soda should be dissolved and added in small quantities at a time to the preparation, and with continuous stirring, until a fresh piece of paper dipped in the mixture remains blue. One pennyworth of litmus paper, which may be obtained from any chemist, is sufficient for a large number of tests.

Early Blight.

This disease does not usually occur in epidemic form, although occasionally it may be almost as severe as Late Blight. Early Blight is caused by the fungus *Macrosporium solani*, which also attacks the tomato, egg plant and a number of weeds belonging to the potato family (*Solanaceae*).

The disease is characterised by the development of dark-brown, circular or oval spots on the foliage, but rarely on the stem. The tubers are not affected. The first spots commonly occur on the lower, shaded, and consequently weaker foliage; in fact, healthy, vigorously-growing leaves possess considerable resistance. Under favourable conditions the spots enlarge rapidly until in extreme cases a single spot involves half the leaf. It is more usual, however, to find the leaf covered with many small spots, which often assume a target effect owing to the concentric nature of the rings which have developed. Affected leaves lose their healthy green colour and become yellowish. In severe cases most of the leaves are destroyed, and often only the defoliated stem remains.

Early Blight on Potato Leaf.
[*After Chupp.*]

The causal organism is carried over from season to season on old potato leaves or on the susceptible weeds, or possibly in the soil itself. The spores of the fungus may then be splashed by rains or thrown with fragments of soil by cultivation implements on to the growing leaves, where infection occurs. On the target-like spots which subsequently develop, numerous spores are produced, and these serve to spread the disease to other plants through the agency of wind or insects. Frequent rains with heavy dews, together with hot weather, favour the development of Early Blight.

CONTROL MEASURES.

Control measures are briefly:—

1. Eradicate all solanaceous weeds.
2. Spray with Bordeaux mixture as for Late Blight.
3. Practise rotation of crops.

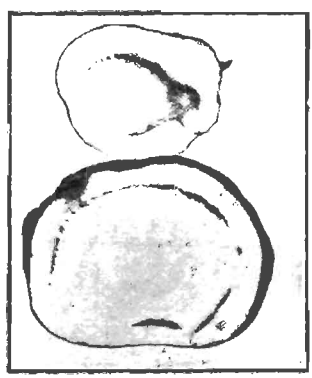
Fusarium Wilt and Dry Rot.

Wilt, caused by the fungus *Fusarium oxysporum*, is one of the minor troubles of the potato in this State. It is also known as Fusarium Blight, Stem-end Browning, Brown-ring, &c., and the causal fungus may also attack tomatoes, sweet potatoes, and other plants.

When about a foot high affected plants may appear dwarfed, but the more striking symptom of yellowing generally appears later after a period of warm weather in summer. The lower leaves may die, and when the roots and base of the stem have become thoroughly invaded by the fungus, the plant wilts and later dies—first one stalk and then the others in succession. The tubers from diseased plants may appear quite sound externally, but when cut open they frequently show a brownish, discoloured ring near the stem end, but occasionally the discolouration may appear as a network. Agencies other than *Fusarium* sometimes cause similar discolorations.

When diseased tubers are stored they sometimes contract a stem-end rot or dry rot. This may be caused by the wilt parasite, but may also be caused by other species of *Fusarium* which may develop after infection with the wilt fungus, or after entering through bruises, lenticels, or the eyes of the tubers. Potatoes which have developed dry rot appear shrunken and wrinkled, and later produce small white tufts of the fungus on the surface of affected parts. The rot is typically firm, dry to cheesy in consistency, and greyish white in colour, but the tissues may later become invaded by other fungi and bacteria, when a soft evil-smelling rot often develops.

The causal fungus lives over in the soil and in diseased tubers. Infection with the wilt fungus may occur from the seed tuber into the new plant, from the soil into the seed piece and then into the sprout, or directly from the soil into the roots. Usually when the plant is diseased the fungus grows down through the stolons into the young tubers. The disease is favoured by prevalence of high temperature.



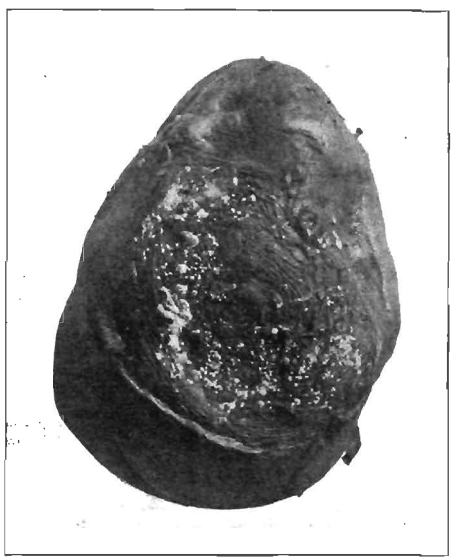
Section of Potato showing Brown Ring caused by Dry Rot Fungus.
[*After McAlpine.*]

CONTROL MEASURES.

Since wilt and dry rot infection originates mainly from the soil, control is difficult, but the following measures will help to minimise losses:—

1. Use care in digging and handling the tubers to avoid injury to the surface. This specially applies when the crop is to be stored or shipped.
2. Secure, if possible, seed from a clean crop.
3. If it is suspected that the seed may be diseased, cut the stem-end of the tubers before planting and reject any showing a brown discolouration of the vascular ring.

4. Land known to be infected should not be sown to potatoes for a number of years.
5. All diseased material should be burnt. Tubers should be boiled before being fed to pigs.
6. When the potatoes are to be stored, all injured or diseased tubers should be rejected, and the remainder placed in a dry, cool, well-ventilated building.



Potato affected with Dry Rot

Bacterial Brown Rot.

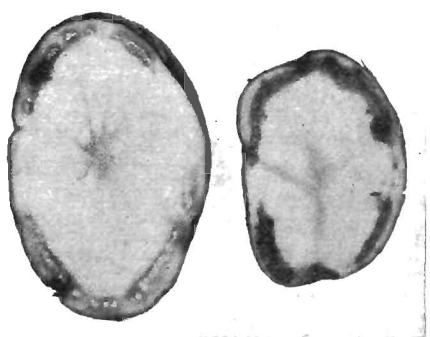
This disease, caused by *Bacillus solanacearum*, also occurs in the form of a wilt or blight on such important crops as tomato, tobacco, &c. Affected plants show at first a slight wilting of the vines, which gradually becomes so pronounced that eventually the plants die. Such vines are water-soaked and flabby, and if the stems are cut open the water ducts will be found to be discoloured brown. This feature develops also in the leaves and leaf stalks. The bacteria travel down through the stem tissues into the stolons,

and thence to the young tubers, which develop a brownish discolouration in the vascular ring, followed by an extension of the disease outward until the surface is reached. The invaded tissue gradually becomes soft and mushy. In severe cases of the disease large cavities lined by evil-smelling mushy tissue are found in the tubers.

The causal organism, a bacterium, lives over in affected tubers, in potato refuse, and on other crop and weed hosts. Infection occurs through wounds in the roots or above ground parts of the plant. Insect punctures often furnish an avenue of entrance for the pathogene. The disease is favoured by high temperature and wet weather.

Control measures consist of—

1. Selection of seed from sound plants.
2. Rotation with non-susceptible crops



Brown Rot, or Bacterial Rot.

Scab Diseases.

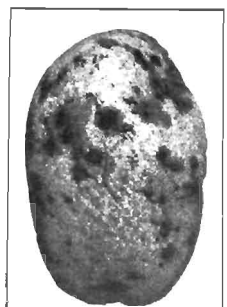
There are four common causes of scab in potatoes; three distinct types result from the action of fungous parasites, and the fourth is caused by eelworms. The skin of the potato tuber is of a corky nature which, so long as it is intact, is highly protective, but when it is injured, as from parasitic invasion, the potato endeavours to repair the damage by producing an extra amount of corky cell substance around the seat of injury. It is in this way that a scab is produced.

Rhizoctonia Scab.

This disease receives its name from the causal fungus *Rhizoctonia solani*. It is also known as Black Scurf, Black Speck, Russet Scab, &c. The fungus attacks many plants besides the potato, including lucerne, peas, cabbage, carnations, violets, and others.

The presence of the Rhizoctonia fungus on affected tubers is readily detected in the form of small black lumps, varying greatly in size (up to about one-third of an inch in diameter), and in shape. These structures represent the resting stage of the fungus, and whilst they somewhat resemble lumps of soil, they appear distinctly black when wetted and do not easily wash off. The superficial position of the fungus on the tubers sometimes leads growers to think that the disease is of little importance, but when affected potatoes are planted these black resting bodies become active, and under cool, moist conditions considerable damage may result.

Often the sprouts from affected tubers develop a brownish rot, and when dug up they often present the appearance of having been chewed off by insects. Then again brownish-coloured cankers may girdle the base of the sprout and seriously impair its vitality. New shoots frequently develop below the girdled region, and these in turn may become diseased, and be followed by the growth of another shoot. This process of girdling and renewed growth may continue until the sprout is finally killed. This is often the explanation for "misses" in potato crops in this State. Occasionally also, affected sprouts break through the soil some time after the healthy plants have come up, but these poorly developed individuals are decidedly unprofitable.



Tuber showing scab due to *Rhizoctonia solani*.

In some instances cankered areas do not develop on the base of the stems until the plant has developed considerably, and the effect then is to affect the leaf growth so that the top leaves become massed together, giving the plants a rosetted appearance. The vines of these plants are often abnormally large, and produce as many as fifty small knobby tubers which always remain in an undeveloped condition. Occasionally small tubers may be produced on the stem in the axils of the leaves.

In rare instances a tuber-canker type of injury may develop, but the most common symptom on the tubers is the development of the black resting bodies or sclerotia described above. A jelly-end rot condition of elongated pointed-end tubers is also an occasional symptom attributable to *Rhizoctonia solani*.

The causal organism lives over in the soil and on the tuber in the form of fungus threads and sclerotia. These sclerotia consist of closely-woven masses of threads which become active under the same conditions which favour the growth of the host. When the tubers sprout, the sclerotial threads penetrate the tender shoots and cause the girdling and cankering described above. Later in the season the fungus spreads over the immature tubers, and at certain points forms the characteristic sclerotial masses.

While the causal agent lives in the soil, it is considered that in most instances the disease arises from the use of untreated, diseased tubers. In heavy, poorly drained soils the disease is likely to become serious.

Control measures are as follows:—

1. Use clean selected seed whenever possible.
2. Steep seed tubers before planting in a fungicidal solution of either corrosive sublimate or formaldehyde. The former material is, generally speaking, more effective than the latter. The solution consists of 1 oz. of corrosive sublimate (mercuric chloride), and 6¼ gallons of water. Dissolve the crystalline material in about a quart of warm water, and then dilute to the required amount. A wooden or earthenware vessel should be used, since the chemical will attack metal. Immerse the seed potatoes (which should not be cut and preferably not sprouted) in the solution for from one and a half to two hours, and do not use the solution for more than three batches. It is advisable to place the tubers directly in the solution or else to use a small wooden crate. Avoid the use of bags as this weakens the solution.

   It is wise to keep the tubers moist for twenty-four hours before treatment to loosen the dirt and soften the fungous material which is then more readily killed by the treatment.

   Corrosive sublimate is a deadly poison if taken internally by stock or human beings. The solution, however, is quite harmless on the hands. Treated potatoes are unfit for domestic use or for feeding to stock.
3. Practise rotation of crops.

Common Scab.

This disease is caused by the fungus *Actinomyces scabies*, and occurs also on turnips, mangels, beets, radishes, carrots, and other fleshy roots. Common scab does not impair germination, but it reduces the yield and prejudices the keeping qualities of the tubers. It does not in any way impair the edible quality.

The scab begins as a minute brown speck at a breathing pore of the young tuber, and with enlargement of the potato the scab also increases in size. Frequently several spots develop on affected tubers, and these may coalesce to form a more or less continuous scabbing of the potato surface. In individual scabs the corky ridges of the lesion are arranged fairly plainly in concentric circles. This character is caused by the attempt of the host to shut out the parasite by a barrier of cork, each successive layer of which is killed, and a new one begun a little farther from the centre of infection.

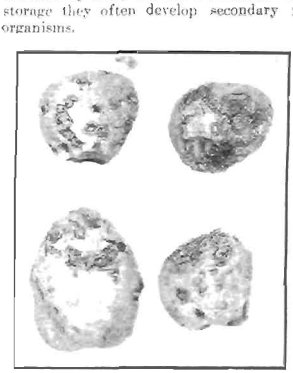
The causal fungus lives over in the soil as well as on affected tubers. The disease may also be distributed by manure from stock fed with diseased potatoes. A number of factors apparently are involved in the development of common scab, but so far investigations indicate that a combination of medium temperature, and an alkaline type of soil which is dry, favours an increase in scab formation.

Control measures are as follows:—

1. Use only sound tubers for seed purposes.
2. Disinfect seed tubers prior to sowing as suggested for Rhizoctonia Scab.
3. Practise rotation with non-susceptible crops.
4. Where possible grow and plough in cover crops. This not only increases the fertility of the soil, but also tends to reduce the amount of common scab in subsequent crops of potatoes.

Powdery Scab.

This disease, sometimes known also as Corky Scab, has been recorded from isolated localities in this State, but is not of great economic significance. It is caused by a slime-mould, *Spongospora subterranea*, and is favoured by cold, wet soil conditions. When affected tubers are placed in storage they often develop secondary rots from infection by various organisms.



Potatoes affected with Powdery Scab.

The disease first appears on very young tubers in the form of small pimply swellings which are of a brownish colour with a faintly purplish tinge below the skin. As the pimple enlarges, the epidermis breaks and curls backwards around the spot. The ruptured pustules are almost circular or oval, and may occur singly or in clumps on the tuber. Each pustule is filled with a brownish powder consisting of the spores of the causal organism. In some instances the parasite may extend its invasion into the deeper tissue and thus give rise to the canker form of the disease. The stolons and roots are also subject to attack, when small galls are frequently produced upon them.

The slime-mould or myxomycete which causes Powdery Scab lives over on affected tubers, and will remain alive in the soil for many years. The incidence of the disease is increased by cool, wet soil conditions; lime also favours the trouble and mechanical injury tends to increase infection.

Control measures are as follows:—

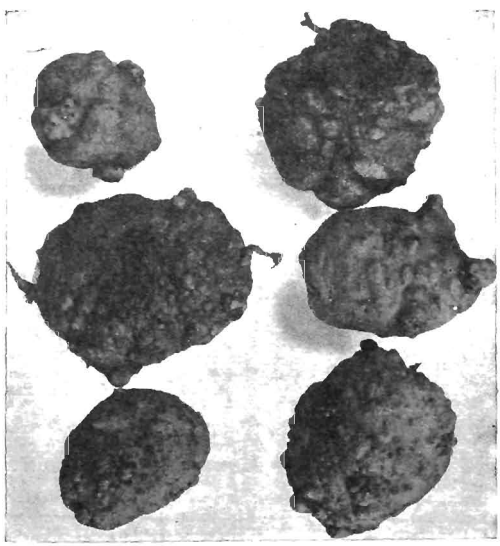
1. Use clean seed and disinfect, prior to sowing, as for Rhizoctonia Scab.
2. Cultivate carefully and attend to drainage of soil.
3. Avoid the use of contaminated manure.
4. Adopt long crop rotations.

Eelworm Scab.

Tubers affected with eelworms usually show a large number of small pimple-like outgrowths on the surface with a slight depression round each pimple. Just below the pimple there is a darkened ring in the flesh which can be seen when the tuber is cut open. In the centre of the discoloured area a small glistening body about the size of a pin point may sometimes be observed. This is the female eelworm. There is usually very little change in colour of affected tubers, but in severe cases of infection the tubers may become quite warty, roughened and discoloured, necessitating considerable wastage in peeling for table use.

The disease is sometimes known as Root-knot or Root-gall, and is known to occur on a large number of different plants including many field crops, ornamental plants, flowers and vegetables, fruit-trees, nursery stock, and a number of weeds.

The causal agent is a minute parasitic nematode or threadworm, *Heterodera radicicola*. The young eelworm larvae move through the soil with considerable activity, and on finding a root or young tuber, bore their way into it. Once inside, they commence to feed on the tissues by means of a



Potatoes infested with Eelworms.

spear-like organ within the mouth. The presence of the worm irritates the tissues and stimulates them to enlarge, thus forming the gall. Generally speaking, the eelworm diseases are most serious in light soils and in crops which are grown during the warmer months of the year.

Control measures are as follows—

1. Avoid the use of tubers showing pimply outgrowths for seed purposes. If affected potatoes are to be fed to stock the eelworms should first be destroyed by boiling the tubers.

2. Practise rotation of crops and avoid growing susceptible plants continuously on the same land. There are a few crops resistant to eelworm, and these include the cereals and grasses, certain American varieties of cowpeas and velvet beans. Onions and peanuts are also fairly resistant.
3. Avoid spread of the disease by contaminated implements, flood waters, &c. Always cultivate clean areas before proceeding to areas which are known to be infested with nematodes.

Young eelworms are not very resistant to unfavourable weather conditions. Drying out of the soil or flooding the soil is usually fatal to them in a comparatively short time. Soil kept free from vegetation for about two years usually results in the killing off of the nematodes.

Brown Fleck.

This disease is generally known as Brown Fleck, but is also referred to as Internal Brown Spot and Sprain. Affected tubers may appear externally healthy and sound, but when cut across show rusty-brown blotches on the cut surface, the surrounding parts of the tuber being sound. The markings may vary in size and shape, in some cases appearing in the form of spots, in others as streaks. Plants which bear affected tubers may show no signs of disease on the stems and foliage.

Brown Fleck.

The rusty-brown blotches result from the death of the tissues in isolated areas, with subsequent discolouration of the cell walls.

The disease is of non-parasitic origin, no causal organism having, so far, been isolated from diseased tubers.

The disease appears to be most prevalent on soils of a light, gravelly nature, and is most generally observed in dry seasons.

It is possible that the death of the cells in the blotched areas results from a curtailment in the supply of water to the tuber.

Control.—There is no evidence to support the view that "fleeked" seed potatoes will always give rise to a diseased crop. At the same time it is not advisable to plant such seed, as it is an indication that the variety is susceptible.

This would especially apply in the case of soils of a sandy or gravelly nature.

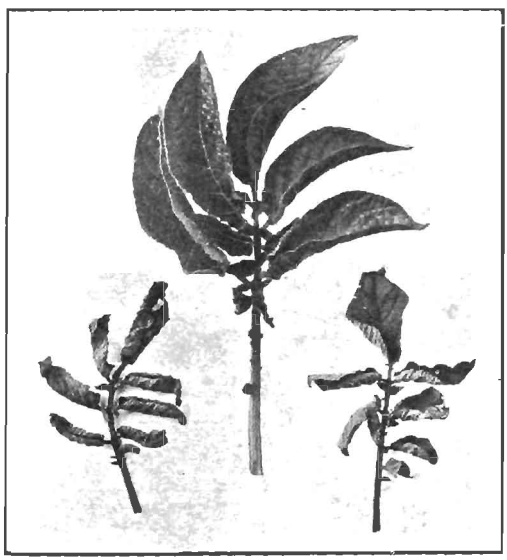
Virus Diseases.

Virus or "degeneration" diseases of the potato constitute one of the most important problems in potato growing in New South Wales. This group of diseases is mainly responsible for the "running out" of varieties. The

economic significance of virus trouble is appreciated from the fact that instances of infection amounting from 30 to 62 per cent. have been observed within recent years in potato crops in this State.

Affected plants may show varying symptoms, but in general stunted growth and crinkled or mottled foliage may be regarded as sure indications that the plant is suffering from one or another type of the degenerative or virus diseases. Some of these types are as follows:—

Mosaic is so called because of the mottled foliage of affected plants, which exhibit light and dark green patches with more or less vaguely defined outlines. Dwarfing, wrinkling, and some ruffling of the leaves are characteristic symptoms.



b *c*

Potato Foliage showing Leaf Roll.

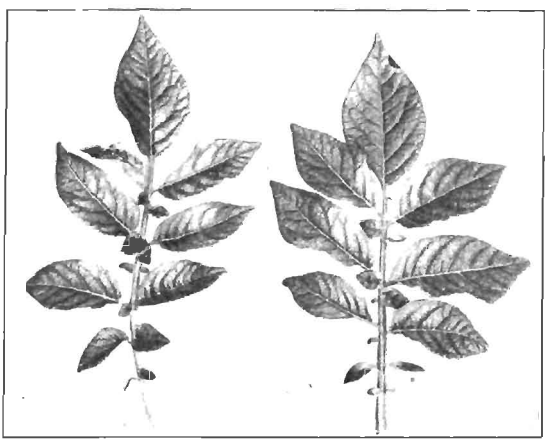
(*a*). Initial stage of disease (variety—Surprise).
(*b*) and (*c*). Advanced stages (variety—Satisfaction).

Leaf Roll is distinguished by the upward curling over of the leaves towards the mid-rib. This curling or rolling is evident first on the lower leaves, progressing upwards as the infection advances.

Spindle Tuber is often defined as "running out," "running long," "off shape," or "poor shape." Characteristic features are more or less spindling upright stalks and smaller leaves of a somewhat darker green than on healthy plants. Besides being spindle-shaped (as compared with the flat oblong shape of healthy potatoes), the tubers often have unusually deep eyes.

Curly Dwarf shows itself by very distinct dwarfing, uprightness, spindling, curling, wrinkling, brittleness, and burning, and by premature dying of the foliage.

Most growers are familiar with the appearance of such debilitated plants, but few, perhaps, appreciate the menace they present. The causal agent in each case is the infectious virus, an extremely minute germ which is carried over in tubers from affected plants, and may be spread in the field from diseased to healthy plants by any means in which sap is transferred, as by sucking insects, bruising, diseased leaves, &c.



Potato Leaves showing Yellowing or Chlorosis caused by Virus Disease.

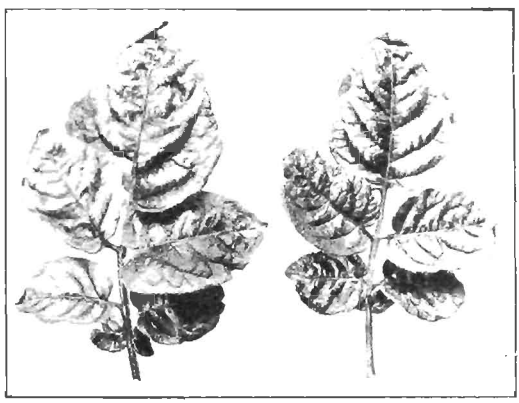
Control Measures.

The most important point in the control of potato virus diseases is the selection of seed tubers from healthy plants only, and this selection should be carried out in the field, where the appearance of the foliage serves as a guide to the nature of the plants from which tubers might be selected. Yield and size of seed must also be considered—small tubers do not necessarily denote that the seed is of poor quality, but certainly a very large percentage of these small potatoes is the product of plants suffering from the above mentioned classes of disease. In most instances the number and

size of tubers from plants affected with any of these diseases are materially reduced. In some cases, however, although the yield may not be so great, the individual tubers from a diseased plant may be as large and appear as perfect as those from a normal plant. For this reason it is impossible by bin selection alone to pick out seed tubers that will produce a healthy crop.

The utilisation of a stud seed plot is particularly valuable for purposes of ensuring sufficient disease-free seed for the planting of the main crop. In this way it is possible to appreciably improve the quality and quantity of the tubers produced.

The "rogueing" or eradication of diseased plants as soon as they are detected is very important. Such plants should be destroyed by burning.



Potato Leaves showing Crinkling or Malformation caused by Virus Disease.

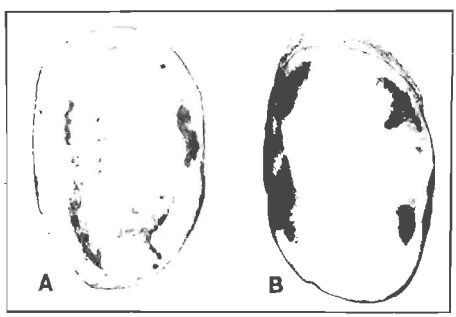
Frost Injury.

The occurrence of frosts during the period when potatoes are lying in the ground frequently causes considerable injury. Exposure of tubers to freezing temperatures after digging also may lead to serious effects. Sometimes the effect of sudden dropping of temperature may cause damage to the foliage in the form of small, brownish, dead areas on the basal portions of the tender leaflets, but the most serious injury from frost is observed on the tubers.

Frozen tubers show symptoms which vary from mere spots of greyish, drier-appearing flesh cells slightly below the skin to a complete collapse and blackening of the inner tissues. If frozen solid the tuber becomes soft and watery on thawing. Later, putrefaction sets in and disagreeable odours are given off.

When the tuber is not frozen hard, but chilled to a certain stage, its external appearance is quite similar to that of the normal, but when cut open a typical discoloured network of darkened blotches is evident in the region of the vascular ring, about ¼ inch below the skin. Another symptom sometimes observed is the shrivelling of the tuber until it becomes leathery in texture. The flesh when sliced appears almost normal in colour, but is drier. After a brief exposure to the air the tissue becomes greyish, then a pinkish tinge which gradually becomes more intense and darker until it is red, then purple, and finally coal-black.

The freezing of potato tubers occurs at different temperatures, depending on the period of exposure, treatment during exposure, and the variety. Normally the tuber is injured at a temperature of 28 to 29 deg. Fah. Temperatures lower than 28 deg. may not cause serious results if the tuber is undisturbed, but when handled or jarred in any way ice particles begin to form and injury soon follows.



Blotch Type of Frost Injury.

A.—Longitudinal section of tuber exposed to freezing temperatures for nine hours.
B.—Cross section of stem end of tuber affected with frost injury.

[*After Jones, Miller, and Bailey.*

Control Measures.

Control consists mostly of preventive measures:—

1. Tubers should not be allowed to remain in the soil any longer than necessary.
2. Potatoes for table use should not be exposed long to any temperatures below 38 deg. Fah., but tubers kept for seed purposes may be subjected to a temperature of 33 or 34 deg. Fah. without affecting their capacity to germinate.
3. Where potatoes are stored adequate precautions should be taken against any possible damage through the occurrence of low temperatures, and provision made for ventilation.

Insect Pests of the Potato.

The potato is subject to attack by a number of insect pests, nearly all of which can be definitely controlled if growers are equipped with a knowledge of the various species of insects which attack his crops, and if the preventives and remedies recommended by the Department are applied. Farmers only too frequently are ignorant of the cause of damage, and are at a loss to know what to do to prevent or control it.

The principal insect pests of the potato are:—The Potato Moth (*Phthorimaea operculella*), the Brown Vegetable Weevil (*Listroderes obliquus*), the 28-spotted Ladybird (*Epilachna 28-punctata*), Rutherglen Bug (*Nysius vinitor*), and the Green Vegetable Bug (*Nezara viridula*).

Potato Moth (*Phthorimaea operculella*).

The potato moth is present to a more or less extent in every potato-growing district in the State; it causes two distinct forms of injury (1) to the growing plant, and (2) to the tuber.

The injury to the plant is manifested by the larvae mining into the leaf and tunnelling in the stem. The eggs are generally laid on the under surface of the leaf, and as soon as the larva hatches it begins to mine in the leaf. As it grows it makes its way into the petiole of the leaf, and eventually works into the main stem. The larva generally works downwards in the stem causing the terminal section of the stem to die. The pest does considerable damage in the field, especially when the plants are young.

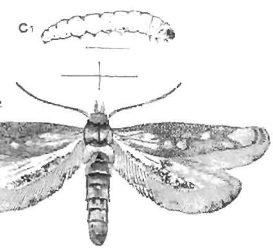
Damage to the tubers may also occur in the field if the tubers become exposed while growing, or if the tubers are allowed to remain in the field any length of time after harvesting. Serious infestation of the tubers may also occur after the tubers have been stored in a shed, bin, or stack. When the tubers are infested the eggs are usually deposited in the eye or scars or cracks in the potato. The egg hatches in about five days during the summer months, and the young larva enters the tuber where the egg was deposited. Because of this the damage to the potato is first noticed in the eyes. The larvae injure the potatoes by tunnelling through them, filling the tunnels with excrement and permitting the invasion of the organisms of decay. The market value of the potatoes is thus considerably reduced.

The larva, when fully developed, is about half an inch in length, the body being whitish with sometimes a tinge of pink, and has a dark-brown head. It later becomes greenish in colour, spins a loosely woven cocoon, and transforms to the pupal condition in any suitable place, such as the eyes of the potato, folds in a sack, cracks in the walls, or in debris.

The adult is a small, grey moth, having a wing expanse of about half an inch. The hind wings are both narrower and shorter than the fore wings, but both bear a fringe of light-grey or buff hairs. The average minimum period of life of the moth, from egg to adult, is about twenty-seven days, but this may be considerably prolonged under cold conditions. Owing to the protective colouring of the moth it is not readily seen in the field, where it hides amongst rubbish and clods of earth.

Control Measures.

Control measures should be commenced during cultivation. Where hilling is the practice it should be done with care, so that all tubers are well covered with well-pulverised soil, and no clods should be permitted, as they form crevices and permit the moth to reach the tubers. Where flat cultivation is practised, plant deeply and keep the soil well stirred. When the potatoes are dug they should be bagged without delay; if they are exposed even for a short while infestation is almost sure to follow. It will be particularly



C1

C2

The Potato Moth.

—A potato showing races of moth infestation on one side.

—The same potato cut open, showing how the larvæ affect the flesh.

C1—The larva.

C2—The adult Potato Moth.

The lines indicate natural size.

noticeable in a season when showers are frequent that the percentage of infected tubers when dug is considerably smaller than in a comparatively dry one. This is mainly owing to the rain breaking down the clods and compacting the soil, thus preventing the moth from gaining an entrance to the tubers.

Many growers, after filling the bags, and before sewing them up, cover the mouth of the bag with stalks and leaves, probably to shade them from the sun. This practice cannot be too strongly condemned, as the moth may be

lurking in the haulms, and will immediately leave them to attack the potatoes. All stalks and foliage should be removed and completely destroyed as soon as possible. The bags should be sewn up immediately after filling and removed without delay to suitable storage. If it is not convenient to remove them for some time they should be placed in stacks and closely covered with some cloth or tarpaulin. Extreme care and watchfulness all along the line are necessary, particularly in storage. Many growers think that there the tubers are immune from attack. This is not the case; more damage is done while in store than elsewhere. But if suitable storage is provided, the ravages of the moth can be better controlled than in the field.

Frequently potatoes are stacked in the open shed on the farm, and no precautions taken in the way of securely covering them. To prevent infestation they should be stacked in a tight room or bin or sealed in a galvanised-iron tank to prevent the moths gaining access to them. If the tubers are infested, they should be fumigated with carbon bisulphide before storing. On top of the stack place a shallow vessel, and into this pour some carbon bisulphide, and close the door tightly. This liquid becomes a gas when exposed to the air, and being heavier than air the fumes diffuse among the potatoes and destroy any moths and larvae. This should be repeated every ten to fourteen days, in order to kill any larvae or moths that might emerge from the egg or pupal stages. Four or five charges should be sufficient. About 5 lb. of liquid carbon bisulphide to every 1,000 cubic feet of space should be used. As the gas is *highly inflammable*, the greatest care should be exercised. No lights of any kind should be near, or disastrous results will follow.

Of course it is recognised that many growers may not, perhaps, be in a position to provide themselves with bins, tanks, or a suitably-closed room, but every effort should be made to do so, and to adopt the treatment recommended. It will be found that the potatoes, being free from infestation, will realise better prices, and the trouble and expense will be warranted. In the absence of storage facilities, the potatoes should be drawn into a heap, a saucer containing a strong charge of carbon bisulphide placed on top, and the whole covered closely with a cloth, tent or tarpaulin.

Covering with grass from some place remote from the potato crop, or hay, and occasionally sprinkling with water, is a primitive method, but is found to check somewhat the attack of moth.

The prevention and control of the potato moth may be, therefore, briefly summarised as follows:—

(1) Plant deeply, cultivate properly, and do not allow the tubers to become exposed.

(2) Plant seed free from moth infestation.

(3) After filling the bags do not cover the mouths with potato tops or other debris.

(4) Remove the potatoes from the field as soon as possible after harvesting.

(5) If the potatoes are to be kept for seed or held before marketing, store in tight-fitting rooms, bins, or tanks to prevent the access of moths.

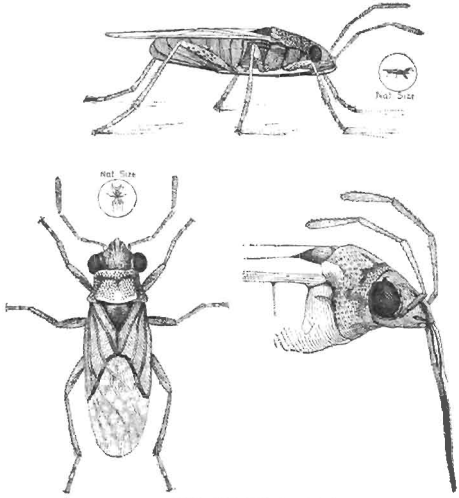
(6) If the potatoes have to be stored in a loosely fitted shed they should be covered as securely as possible with some suitable closely woven material and examined at intervals for moth infestation.

(7) Should the tubers become infested they should be fumigated when necessary, preferably in a gas-tight bin, tank, or room with carbon bisulphide at the rate of 5 lb. to every 1,000 cubic feet of space, not taking into consideration the space occupied by the potatoes.

(8) If a gas-tight receptacle is not available, the potatoes may be fumigated under canvas or "duck" sheeting, the edges of which must be securely fastened down.

Rutherglen Bug (*Nysius vinitor*).

These plant-bugs are small brown insects with silvery-grey wings, and measure about one-sixth of an inch in length. They suck up the sap with their beaks, and, where numerous, soon cause the plants to shrivel. They



Rutherglen Bug (*Nysius vinitor*).

appear in summer from eggs that have been deposited on the grass and weeds by the autumn brood of the previous season, and are particularly fond of potato and tomato plants, though they infest many other crops and fruit trees. They fly well, and in the warmer part of the day are very active, and for this reason are difficult to destroy by a contact spray when in the adult stage: and, again, those that do not rise on the wing frequently shelter on the under surfaces of the foliage, and thus escape the spray.

CONTROL MEASURES.

The younger or immature stages of the bug are more readily killed by contact sprays. Benzol emulsion, miscible red oil, or nicotine sulphate, are the most satisfactory, but the miscible red oil cannot be used on delicate plants or fruit-trees in foliage, as injury will result.

The difficulties of control when once this pest has entered a crop suggests the need for measures of clean cultivation, and also the prevention of the bugs from entering the cultivation areas, in the first instance, where possible. Such preventive measures include spraying infested weeds with strong oil and soap emulsions of either crude oil or kerosene (one part to eight or ten parts of water), or with miscible red oil sprays; or the infested weeds may be burnt over.

Another method of preventing Rutherglen bugs from crawling into cultivation paddocks is to cut a deep straight-sided furrow or trench with holes sunk at intervals of about 15 feet along the bottom of the furrow or trench. The bugs crawl and fall into the furrow and accumulate, and many collect in the holes. Thus their further progress into the crop is arrested, but they should be sprayed with an oil spray every few days to destroy them and to prevent any eventually struggling across this barrier trench. Even many winged bugs are trapped in such a trench.

In lieu of the trench a narrow band of crude creosote oil or wood preserving oil, or of thin tar run along the ground or across roads or the edge of cultivation areas, will arrest and turn any advancing bugs, and perhaps save the crop. Later, however, the winged forms become so numerous and such active flyers that it is impossible to prevent them entering crops and orchards.

Smoke fires, to produce a maximum of smoke, placed at intervals along the windward side of an infested area have been used with some success in driving the bugs out of an orchard. On the whole the pest is difficult to cope with, and these various methods are only sometimes applicable.

Leaf-eating Ladybird (*Epilachna 28-punctata*).

Known also as the Twenty-eight Spotted Ladybird Beetle, this insect is capable of causing severe injury to potatoes and tomatoes, and to a lesser extent to pumpkins, melons, cucumbers, and other similar plants. The injury is caused both by the larval and adult stages of the insect, although that done by the former is probably the greater. Large patches are to be found eaten away on one surface of the leaves, while the epidermis on the side opposite to the one on which the insect is feeding is left intact.

The eggs, which are pale yellow, are laid side by side in patches on the surface of the leaves of the food plant. The larvae on hatching are very small, but when full-grown are about half an inch in length. They are thick, fleshy grubs, yellow in colour, with light brown patches on the upper surface which is also thickly covered with black branched spines. As soon as they are full grown they congregate in masses on the leaves and pupate.

The adult insect or beetle is ovate in form, with the under surface flat and the upper surface strongly convex. It is dull orange-yellow in colour, with the wing covers bearing as many as twenty-eight spots, but frequently this number is reduced owing to the merging of some of the spots.

It should be remembered that although this species is destructive, the family to which it belongs consists almost exclusively of useful predaceous beetles which feed upon destructive scale insects and aphids. This species must not be confused, therefore, with other and useful species, such as the Aphid-eating Ladybird (*Leis conformis*), which has a general resemblance to the leaf-eating species, but is smaller, has a less number of spots, and is

The 28-spotted Ladybird (*Epilachna 28-punctata*).

Portion of a Pumpkin Leaf, showing ravages of *Epilachna 28-punctata*.

bright orange-red in colour. Neither must it be confused with the destructive Banded Pumpkin Beetle (*Aulacophora olivieri*), which is elongate in shape, and has only four black spots on the wing covers.

It may be controlled by spraying with arsenate of lead (powder), 1 lb. to 40 gallons of water.

Other Pests.

The Brown Vegetable Weevil (Listroderes obliquus) is a common pest of potatoes, and feeds both in its larval and adult stages on the foliage of the plant, and the Green Vegetable Bug (*Nezara viridula*) often attacks both the foliage and stems of the plants. These pests are referred to under pests of tomatoes on pages 697 and 699 respectively.

TURNIPS AND SWEDES.

Turnips of first-class quality for sheep and for domestic use and market can be produced abundantly in many parts of this State. In the coastal and tableland districts the crop can be grown with comparative ease; and in many of the wheat districts where the rainfall does not fall below an annual average of 20 inches, turnips are well worthy of attention if sheep are kept in conjunction with cereal production: and a quick-maturing fodder crop can be thus profitably utilised in rotation.

The turnip crop may be either left in the ground to be eaten out by the sheep during winter, when greenstuff is scarce, or it may be harvested,

trimmed, and stored in pits made by stacking the roots on straw in a long, narrow, ridged heap, and then covering with a thick coating of straw and soil.

Almost all soils are suitable for the production of turnips, the governing factor being more the supply of moisture than the richness of the land. Hence it is desirable to employ a soil with a fair percentage of sand, if possible, the physical condition then favouring the retention of moisture.

Preparation of the Land.

The turnip is a shallow rooter, and every effort must be made in the cultivation of the soil and in the application of manures to retain the plant-food near the surface where it can be readily drawn upon by the crop.

The land should be ploughed deeply, if possible, a couple of months at least before sowing, and then lightly reploughed just previous to sowing. The soil should then be brought to a very fine tilth by means of the harrows and cultivator. This is essential to ensure the proper germination of the fine seed of the turnip. On very loose soils the hand-sower at times shows an inclination to run too deep, and in order to lighten the work it is advisable to use the roller to compact the seed-bed. In such cases it is necessary after sowing to break up the rolled surface between the rows by giving a light scuffling.

Time to Sow.

In most parts of the State it will be found that February and March sowings will produce the best results, but on the tablelands earlier sowings are not out of place. Swedes do not do well in New South Wales when sown early in the summer, the crop being one that is native to cool conditions, and hot weather being, therefore, unfavourable to proper development. The attacks of aphis in summer time also contribute to failure, while the heavy moisture requirements of the crop further demand that it shall be grown at a time when the rainfall is most regular. Autumn sowing avoids the hot weather and the attacks of aphis, and allows the development of the roots at a time when the rainfall is usually more regular, and the evaporation very much less. Moreover, the February-March sowings of swedes bring the crop to maturity at a time when graziers find it of greatest value. There is almost always need for succulent feed in the winter and early spring, especially for ewes approaching lambing, or with lambs at foot, and swedes sown as suggested will mature at the time required.

White turnips can be grown at almost any time of the year, except in midsummer, though in vegetable gardens where water is available there is no need to avoid even that short period. The sowings of these varieties, however, should only be sufficient to cover the immediate requirements of the season, especially in hot weather, as they readily run to seed.

Sowing.

In the coastal and tableland districts 2 lb. of seed is generally sown in drills about 2 feet 6 inches apart, and 3 lb. to 4 lb. broadcast. In the drier districts a smaller quantity of seed, say, 1½ lb. drilled per acre, would be ample.

When turnips and swedes are grown under dry conditions, the best results will be invariably obtained when they are planted on the flat, in land deeply worked and well cultivated.

Fertilisers.

The results of experiments with fertilisers for swede turnips go to show that a supply of soluble phosphoric acid is very essential to the crop, owing, not so much to the quantity taken from the soil as to the peculiar inability it appears to have, in comparison with many other crops, of utilising the supplies naturally existing in the soil. Superphosphate, applied at the rate of ½ cwt. to 1 cwt. per acre, supplies a readily available form of phosphoric acid, and the crop responds to its application with a largely increased yield. It has a marked effect upon the young plants, inducing a vigorous, healthy growth from the very start; indeed, no crop is more readily benefited by applications of this useful fertiliser, or makes more efficient and apparent use of it when the results are determined by the weight of the yield.

Treatment of the Growing Crop.

As soon as the young plants are about 1 to 2 inches in height, it is advisable to thin them out. For a field crop the plants should be left 12 to 15 inches apart in the drills. The thinning out is best done with a sharp hoe. The soil between the drills must be kept well loosened with a cultivator. This will keep down the weeds and help the soil to catch and retain moisture.

Value as a Stock Food.

The following may be taken as the average composition of a swede root:—

Water	88·6
Ash	1·2
Protein	1·2
Fibre	1·3
Carbohydrates or nitrogen-free extract ...	7·5
Fat	·2
	100·0 parts.

Although the percentage of water appears high, it must be remembered that the dry matter is practically all digestible. This cannot be said of a great many other stock foods. Succulence, bulk, palatableness, digestibility of the dry matter, and the high percentage of sugar contained, give turnips a peculiar value as a food. Sheep and goats fatten readily when fed on them alone, and they are also valuable for pigs and cattle, coming in at a time when other foods are often scarce. They should be fed to dry stock on the dairy-farm in preference to milch cows, as if given to the latter the milk will be tainted. The Swede turnip possesses good keeping qualities, and may be either stored or left in the field for a couple of months till required. If left for any considerable length of time the proportion of woody matter increases, rendering the root unpalatable and less easily digested.

Swedes should be cut in pieces before being fed to cattle, as the animals are apt to swallow the whole or a large portion of a root, and the shape of the piece may result in it becoming stuck in the gullet when it is forced back into the mouth for rumination. The choking so produced has killed more than one cow.

Sheep may be utilised for feeding off a crop without the labour of digging; when confined to limited areas by means of portable fences, they will eat out the whole of a crop, leaving only a thin shell that, together with the animal residues, will plough in to advantage.

Turnips as a Catch Crop.

The cheapness of the seed, and the ease with which a crop of swedes can be grown in the tableland areas, offer considerable inducements to those engaged in mixed farming to sow a fairly large area each season as a rotation crop. Following, for instance, a crop of hay, where the stubble is ploughed immediately after harvest with a view to sowing potatoes in the spring, it is possible for the farmer to sow, say, ½ lb. to 1 lb. of turnip seed per acre in February, or just after rain in March, and with very little extra cultivation to produce a crop that can be used either as stock feed, or, if prices warrant it, as vegetables for the market. In such a case, the preparation of the land would be little more than would be required for an early fallow after the hay crop, and the practical certainty of a good yield, together with the possibility (always present) of good prices for swedes in the vegetable market, should make the venture a good one.

The seed should be mixed with, say, 56 lb. superphosphate, and sown through the manure box of the wheat drill, certain feeders being blocked so that the mixture of seed and superphosphate shall be sown only through every fourth feeder. Care will require to be taken to maintain a proper mixture of the seed and fertiliser, or the seed will all work to the top, just as in the case of rape. The hand should be run through the manure box every now and again to mix up the contents evenly, or the drill will presently be sowing all superphosphate, and then, as it empties, all seed. No more than sufficient to sow one acre should be put in the drill at one time, and as only one-fourth of the feeders will be sowing, it will be necessary to set the cogs of the manure drive to sow at about 2 cwt. per acre.

In districts favoured with good rainfall, such as the Dorrigo and Comboyne, profitable crops have been obtained by simply broadcasting seed on the ashes after a successful "burn."

These suggestions for the use of turnips as a catch crop, however, must not be allowed to obscure those for their production on more systematic lines, whether for farm or for vegetable garden purposes, as described above.

Varieties.

For Table Use.—White Stone and Nepaul appear to be the best varieties of turnips. Orange Jelly is a first-class variety as far as quality is concerned, but it is a somewhat light cropper.

Of the Swedes, Champion Purple-top, Imperial Purple-top, and Garden Swede may be mentioned as good table sorts.

For Stock Feed.—Green-top and Purple-top, Yellow Aberdeen, and White Pomeranian Globe are fairly good croppers among the turnips.

There are a number of good varieties of Swedes suitable for feeding to stock. Imperial Purple-top, Champion Purple-top, and Skirving's Purple-top may be mentioned as good, even croppers.

Diseases and Pests of the Turnip.

The turnip, like most cruciferous plants, is subject to attack by a number of fungous diseases and insect pests. In the following paragraphs an account is given of the more important turnip troubles under local conditions.

White Rust.

This disease is world-wide in its distribution, and probably occurs on all known cruciferous plants. Among species of economic importance, cabbage, cauliflower, turnip, cress, horse-radish, and radish are quite susceptible. The disease is also well known on the common weed, Shepherd's Purse, and on wild mustard, but is generally regarded as being of minor importance under local conditions.

The disease is characterised by the development of prominent white pustules or blisters, which may appear on any part of the plant except the roots. The presence of the fungus leads to the formation of the blisters, which later rupture and liberate a powdery mass consisting of innumerable fungus spores. Distortions and other malformations of the leaves and stems may also be produced. When the flowering organs of the plant are malformed or checked in development, sterility may result, leading to appreciable losses in seed crops. Under favourable conditions seedlings may be practically destroyed, while plants less severely affected or attacked later in their development may be dwarfed.

The causal organism, *Albugo candida*, apparently exercises a selection in its host requirements, since the strain on Shepherd's Purse is distinct from that on common vegetables, and the form on mustard will not attack cabbage, nor will that on radish attack turnip.

When liberated from the pustules as a white dust, the spores are scattered by wind, rain, and insects to neighbouring plants, where fresh infections are initiated. The spore germinates in a film of moisture, and sets free eight swarm spores. These in turn germinate by sending out a tiny germ-tube, which enters the host tissues through the breathing-pores or stomata. The younger the plant the more readily does infection occur. The fungus threads spread through the tissues of the plants, and later the white fruiting pustules are produced on the surface. Another type of spore—the oospore—is sometimes produced in the invaded tissues, and the fungus lives over by means of these thick-walled resting spores, as also by means of fungus threads in plants remaining alive from one season to the next. The greatest amount of infection takes place during periods of cool, moist weather.

Control measures are as follows:—

1. Practise rotation of crops; do not plant crops of this botanical group (*Cruciferae*) continuously on the same area.
2. Destroy infected crop refuse by burning.
3. Dust plants with a mixture of equal parts of freshly-slaked lime and sulphur.

Other Diseases.

There are other diseases of turnips which occur also on cabbages and cauliflowers, as Black Rot, Club Root, Downy Mildew, Black Leg, &c. Reference to these diseases is made under cabbages and cauliflowers in the Vegetable Section of this Handbook.

Turnip Aphis (*Aphis pseudobrassicae*).

The common turnip aphis, which may be either winged or wingless, is a small greenish species covered with a bloom, and is found infesting the under-surface of the leaves in the first instance, causing them to become curled up and wrinkled. Later the whole plant may become badly infested

and a total loss may result. These aphids mature and multiply with great rapidity, so that unless precautions are taken to control them they later form colonies and spread over the plants, sucking up the sap with their piercing beaks, so that the plants soon sicken and stop growing, or at least produce only poor turnips.

The promotion of vigorous growth by surface cultivation and manuring will greatly aid the plants to withstand aphis attack, while clean cultivation is an important factor in control. Other measures that may be adopted are described in connection with melon aphis on page 718.

Turnip Flea Beetle (*Phyllotreta nemorum*).

This introduced species frequently attacks turnips. It is a small black beetle, slightly more than one-sixteenth of an inch in length with a single yellow stripe down the centre of each wing cover. The chief damage is caused by the beetles feeding upon the young plants, but they may become very abundant when the leaves are fully formed, and make numerous small holes in the leaves. As its common name implies, the beetles hop readily when disturbed.

The pest can be easily controlled by spraying the plants with arsenate of lead (1 lb. powder to 40 gallons of water).

Other Pests.

The Brown Vegetable Weevil (*Listroderes obliquus*) is capable of causing severe damage to turnips; it is discussed in connection with tomatoes on page 697. Although the Cabbage Moth (*Plutella maculipennis*) attacks turnips, it is primarily a pest of cabbage, and control is discussed in connection with that crop on page 656.

MANGOLDS.

Principally owing to our extensive systems of animal husbandry, as compared with those of more intensely populated countries, the cultivation of root crops is by no means widespread in this State. The mangold provides a very useful addition to a ration for pigs, dairy cattle, or stud sheep by reason of its ready digestibility and palatability, and as agriculture becomes more combined with dairying and stock-raising in this State, there is no doubt that it will gradually play a more important part in our crop rotations. The average yield of mangolds in New South Wales, under good soil conditions, is about 25 tons per acre.

Soil and Climate.

Mangolds do best in deep, well-drained loams, or clay loams. Poor sandy soils or shallow clay soils will not suit them, in spite even of water supply and other conditions being favourable. The costs of production are high, and to meet these a good crop must be secured. Soils which grow good maize and potatoes as a rule grow good crops of mangolds.

Although fairly drought and frost resistant, they do best in a mild climate with a good rainfall, such as that of the coast and tablelands. In cold districts they must be sown as a summer-growing crop, but in localities where the winter is mild, best results are obtained from autumn sowing, since weed competition is then at a minimum, and the crops escape the excessive heat of summer, which may induce the plants "to run to seed."

Varieties.

Mammoth Long Red, Yellow Globe and Golden Tankard are recommended where procurable.

Preparation of the Land and Sowing.

Thorough preparation of the land is absolutely necessary to ensure successful cropping. Mangolds are deep-rooting plants requiring a loose soil for proper expansion, while their large feeding-root systems cannot be utilised to best advantage unless the soil can be easily penetrated. For these reasons, and to conserve the large amount of moisture required by the crop, preparation should be commenced some months prior to planting, when a deep ploughing should be given, followed by as many harrowings as are necessary to consolidate and to fine the soil. Just before planting the land should be cross-ploughed and harrowed, care being taken not to plough quite as deep as for the first ploughing.

Best results are usually obtained with mangolds by sowing on ridges; this, particularly in clayey land, allows free expansion of the growing roots. The ridges should be 2 feet 6 inches to 3 feet apart, and are made by throwing two furrows together with a plough having a fairly long mouldboard, and then running a light roller over the ridges from end to end to firm the soil.

March and April are the best months for autumn planting, and September and October for spring sowing. Planting is carried out with a wheat-drill, all but the necessary tubes being blocked; the rate of seeding in such cases is 10 to 12 lb. per acre. When sown by hand half the above quantity of seed is sufficient, and seeds should be dropped about 6 inches apart. The seed should be covered ½ inch to 1 inch deep, according to the amount of moisture present in the soil at planting time. In this connection it is advisable to choose a time when the soil is moist, for planting in dry soil or deep planting produces slow and patchy germination.

What is commonly called the seed is a fruit containing three to five seeds, and 100 of these should give at least ninety to 100 young plants. The germination percentage will determine whether the rate of seeding should be increased beyond that stated above. A good plan is to soak the seed in warm water for some time before sowing, but care should be taken not to soak much more than is required for immediate sowing, as the keeping quality of the seed may be impaired.

Manuring.

Manurial requirements will vary according to local soil conditions, but as a general rule it may be laid down that mangolds should not be planted except in very rich soil without a liberal dressing of a phosphatic and potassic manure. Nitrogenous fertilisers will only be necessary in soils known to be very deficient in nitrogen, as they tend to stimulate leaf growth at the expense of the roots.

Cultivation and Thinning.

A seed-bed containing plenty of moisture and free from weeds will result in an early start, which is half the battle with crops of this nature. As soon as the plants can be discerned above ground (with favourable conditions usually about nine days from planting) a good cultivation should be given

to conserve the moisture, and this should be followed up by cultivation wherever required to cope with weed growth. The roots must not be injured by the cultivator, as this causes them to decay; until they have a firm hold of the ground the rows must be kept free of weeds by the use of the hoe. Care must also be taken not to destroy the ridges during working.

Thinning is a very important operation, and should be carried out when the plants show four leaves. If left until later it is more costly, and results in a considerable reduction in yield. The work is best done with a short-handled hoe, and the object is to space single plants 12 inches to 18 inches apart, according to whether the soil is rich and moist or medium dry. A clump of seedlings results from the germination of a seed ball, so that, in addition to hoeing, hand-picking is necessary to leave single plants.

Harvesting.

The ripening of the crop is indicated by the leaves turning yellow. This usually takes place seven to eight months from the time of planting. Harvesting should not take place before maturity is reached, for the maximum yield is then not obtained, and immature mangolds are likely to taint milk if fed to dairy cows. Lifting may be extended over a fairly long period to fit in with other farm work, without deterioration of the roots, but in hot districts the autumn-planted crop must not be left in the ground during the summer, as the plants are liable to run to seed.

Mangolds may as a rule be lifted from the ground with the aid of a strong digging fork.

Storing.

The tops of mangolds form splendid cattle feed. The roots may be stored by stacking in heaps about 2 feet high on a bed of straw, under shelter, with plenty of ventilation, while they may also be covered with straw and earth, as is done in the case of potatoes. In a warm climate storing cannot be carried out through the summer, owing to a high temperature favouring the development of the agencies which cause decay. Roots to be stored should be handled carefully to avoid bruising, which provides entrance for fungi causing decomposition.

Feeding Value.

Mangolds contain a very large proportion of water (more than any other root crop), and the average of a large number of analyses at various experiment farms shows the moisture content to be 92.01 per cent. Although they are a very bulky crop, containing a very small proportion of actual nutriment, a comparison of the total feeding value of the yield of an acre, with that of a crop of maize or oats cut as green fodder, shows the mangolds to a very slight advantage. Allowance must also be made for digestibility and palatability, particularly in relation to dairy cattle.

Summary.

The advantages and disadvantages of mangolds may be summarised as follows:—

Advantages.—(1) The crops form a useful supplement to a ration for cattle, pigs, or stud sheep.

(2) They stimulate the milk yield of dairy cattle.

(3) Their cultivation may be very profitably combined with the operations of a mixed farm.

(4) The thorough tillage necessary for the successful growing of these crops results in a splendid soil condition for the following cereal crop.

(5) The practice of feeding the roots on the farm means that soil fertility is maintained to a greater extent than where crops are sold off the farm.

(6) They may be easily stored and utilised in the early spring when succulent feed is scarce.

Disadvantages.—(1) The crop entails a great deal of labour, which means that it is preferable to sow a small area and give it proper attention, rather than to neglect a big area by reason of labour shortage.

(2) On account of their bulk, compared with their actual food content, the roots take much handling, and for this reason should not be fed unless supplemented by more concentrated foods, or a falling-off in condition will result.

(3) They are a soil-exhausting crop, and should not be grown on the same land more than twice in succession.

SWEET POTATOES.

The sweet potato does not receive the attention in this State that it deserves, notwithstanding that its cultivation calls for no special consideration. It may be grown in localities unsuitable for the ordinary potato, and in other parts it will do well at a time of the year when the weather is too hot for the better known crop.

Apart from the demand for the crop for culinary purposes, both for home use and for sale on the open market, the utility of the roots as feed for stock is also worthy of attention. The crop should receive special consideration, for instance, from farmers who are concerned in the raising of pigs, as the heavy yields obtained make it an important supplement to the skim-milk or other diet usually in vogue. Apart from the expense of the temporary subdivision of the land, which is essential for the economical feeding-off of the crop, no harvesting costs arise.

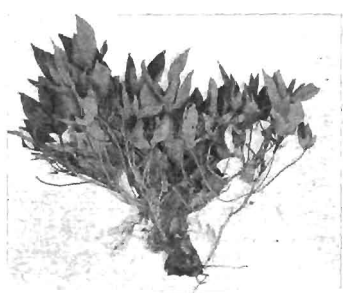
While the present market demand for sweet potatoes is not large, there are great possibilities for extension. With a well-organised effort, it should not be difficult to create a greater demand for this little-known vegetable, especially if growers are prepared to give greater attention to the cultivation of the better culinary varieties which are now becoming available. These new varieties, although perhaps giving a smaller yield than the coarser and more common types, are of a size and quality that suit the vegetable trade. A great proportion of the sweet potatoes marketed in the past consisted of large roots which often suggested coarseness by their appearance, and which would have been better suited for feeding to stock than for the vegetable market. Many of the newer varieties, however, produce even-shaped globular roots, free from ridges, which may be marketed in bags without the risk of damage that attaches to the long-root types (such as White Maltese), which are now so common in the market.

Districts and Soils.

The sweet potato crop has been grown on small areas in tableland districts, and has been considered successful, but, generally speaking, its extensive culture cannot be recommended in such parts. It should be remembered that the crop is subject to damage by frost, and as saleable roots are not produced until late in the season, the risk of total loss under cool conditions is too great.

The coastal districts of the State are particularly adapted to the cultivation of the crop. If a little attention is devoted to keeping down weeds and conserving moisture by hoeing, it is surprising how much dry weather the sweet potato will stand.

The ideal soil for this crop is a sandy one which has been well supplied with organic matter. In a soil of this character the plants possess almost the hardiness of weeds, and the roots develop well, being even in quality and of good shape. As the crop is a deep rooter, thorough preparation of the land is necessary. While roots of the best quality are developed in sandy soils, even the poorer soils of this class produce roots of size and quality suitable for the market. Heavy clay soils are not suited to the commercial cultivation of the crop, as they are inclined to produce ill-shaped roots, and it is necessary to harvest the tubers before winter rains occur or a large percentage of rot will result. The type of soil also largely affects the appearance of the tubers when harvested. Those obtained from sandy soils present a clean appearance, whereas those grown on heavier clay types may require washing before being forwarded to market.



Sweet Potato "root," with plants ready for breaking off and planting out.

Propagation.

The crop is propagated—not by planting tubers in the field—but by means of shoots or "plants" which grow from the tuber. When bedded or planted, sometimes as many as fifty "plants" will grow from a single small tuber (see accompanying illustration), and two or three pullings may be obtained in a single season.

The plants necessary for producing an early crop are obtained by placing the roots—usually small, slender tubers kept over for this purpose from the previous season—in sand in a cold frame or hot bed. The tubers should be placed close together, but not touching, and then covered with 3 or 4 inches of sand (river sand preferred); the whole bed should then be well watered and covered with a glass sash or frame of hessian. By raising a corner of the

White Maltese.

frame, enough air can be admitted to prevent rot setting in. The bed should be kept moist, but not wet, and covered until the plants show through the sand, when the covering should be removed during the daytime but replaced at night. This is done until all danger of frost is past. The "plants," when 6 or 8 inches long, are ready for planting out.

By bedding the roots early, the addition of bottom heat is unnecessary in comparatively warm districts. If tubers are set in the frame about the end of July or beginning of August, plants will be ready as early as it is safe to put them out. Plants raised on sand, and without artificial heat, are hardier than if raised in a rich compost and on a hot bed, and, in addition, the risk of introducing disease is lessened. In a cold district, or where bedding-down has been delayed, it will probably be found necessary to use some sort of bottom heat.

In mild districts, plants quite early enough for a main crop can be obtained by bedding the tubers in the open ground in a sheltered situation with an easterly aspect, or cuttings 6 or 8 inches long may be made from the vines of the early-planted crop and set out in the same way as the plants

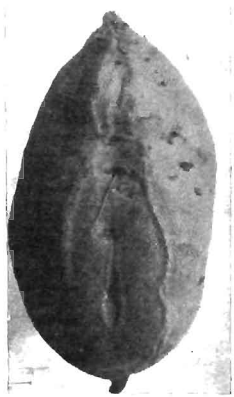
obtained by bedding. These cuttings will grow quite readily, and the crop produced by planting them seems to keep better than the early crop. Small "rubers" are the best for producing plants; 1 cwt. will produce at one "pulling" 4,000 to 5,000 plants, and will occupy 90 to 100 superficial feet in the cold frames.

Varieties.

Two or three varieties have principally been grown in the past, and a few notes on these will be of interest.

White Maltese.—This is at present the variety most largely grown, having been a favourite for many years. The roots are white in colour and long in shape, and the cooking quality is fair.

Pierson.—This is a variety of long standing, but it appears to be gradually receding in cultivation. Except for its tendency to crack, it is a desirable type, being of fairly good shape with good cooking quality: an early variety.



Yellow Strasburg.

Nancy Hall.

Pink.—This is rather a coarse variety, and although used for culinary purposes it cannot be considered a desirable type, containing as it does a large percentage of fibre. It is a heavy yielder, and is best suited for feed for stock.

Within recent years a number of varieties have been imported from the United States of America, and have given fairly satisfactory results in tests

at Grafton and Wollongbar Experiment Farms. The average yields of the best of these new varieties, ascertained over a period of four years at Grafton and three years at Wollongbar, are as follows :—

Variety.	Grafton. (4 years.)	Wollongbar (3 years).
	tons cwt.	tons. cwt.
Southern Queen	8 2	7 0
Yellow Strasburg	8 13	4 2
Porto Rico	6 6	5 0
Triumph	8 5	3 3
Nancy Hall	6 7	5 1

As a comparison in yield, it may be mentioned that at Wollongbar White Maltese averaged over the same period 5 tons 17 cwt. In other trials of one season only on farmers' experiment plots, yields of these imported varieties have compared very favourably with the better-known local types.

Southern Queen.

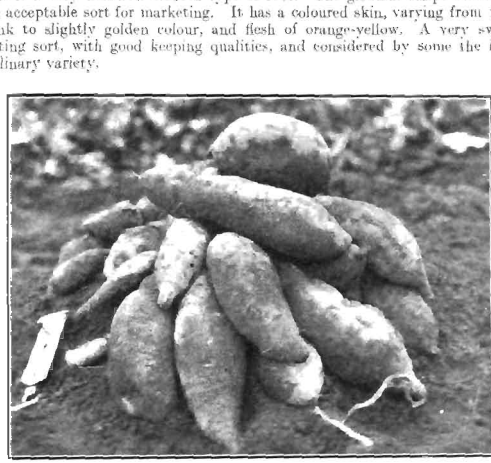
Yellow Strasburg.—This variety is classified in the United States as more suited for stock feed, but although it has produced some large type tubers here it is considered a good table sort with keeping qualities. On rich soils it will probably grow rather large, and is therefore better suited to the poorer-type sandy soils. It is round to oval in shape and veined.

Triumph.—The roots are medium long and of good cylindrical shape, with light yellow skin. It is a desirable culinary type, the flesh being somewhat drier than most other varieties in cultivation; fairly sweet, with light yellow flesh, and suitable for early marketing.

Southern Queen.—A white, roundish variety of a uniform smooth character, mid-season, and of good keeping quality. The flesh is of good texture, moist and sweet.

Nancy Hall.—This is an early variety, producing medium size, fairly round roots, which are yellow to salmon in colour, but tinged with a dark orange-yellow flesh when baked. It is a good culinary sort, very sweet, with a good textured flesh. It keeps fairly well.

Porto Rico.—While not as heavy a yielder as many of the older varieties this is a very desirable smooth type of root. The globular shape makes it an acceptable sort for marketing. It has a coloured skin, varying from rose pink to slightly golden colour, and flesh of orange-yellow. A very sweet eating sort, with good keeping qualities, and considered by some the best culinary variety.



Typical Tubers of Porto Rico.
A Good Commercial Variety.

Root Selection.

It has been noticed that in the sweet potato crop there is a big variation in types in most individual varieties. This may be due to several causes, but it becomes accentuated when no means are taken to check or rectify it. By the judicious selection of individual roots a marked improvement can be obtained in a comparatively short period. The improvement aimed at is mainly quality, although an increase in yield is also obtained. The Department of Agriculture has for some time been trying to popularise the chunky types of tuber.

In all sweet potato crops, individual plants are found which have an abundance of fibrous roots that fail to develop normally and which produce only small tubers, if any. These tubers, if lifted with the crop, are usually selected as being the right size from which to produce plants, and it naturally follows that such plants have a depressing influence on the yield and quality of the resultant crop. This type of plant should be avoided when selection is carried out. The tops should be removed and the roots lifted and left in position until a specified area is dug. The *total* plants should then be *examined and individual selections made. These selections* should be *more than the actual number required, as a further* reduction is made for keeping quality.

When making selections it should always be remembered that uniformity of type is more important than varietal characteristics. Select early-maturing plants with a medium number of roots of uniform quality, size, and appearance. From a farmer's point of view selection should be carried out along the following lines:—

1. Avoid plants of low yielding qualities.
2. Avoid plants producing one or two roots of excessive size.
3. Avoid plants with a large number of long narrow roots.
4. Avoid late maturing plants.
5. Avoid diseased plants. To do this, growers should become acquainted with the different diseases.

Manuring.

On light type soils which have a tendency to set on the surface, the addition of well-rotted farm manure is a distinct advantage.

On raw sandy soils the application of manure and fertiliser is desirable, and satisfactory results should be obtained from applications of 3 cwt. per acre of superphosphate and bonedust mixed in equal quantities. If possible, the fertiliser should be dusted along the line of planting and worked in with a cultivator before the actual planting takes place. On rich soils neither farmyard manure nor fertilisers seem to be essential.

Planting Out and Cultivation.

The planting is commenced at any time when all danger of frost is past; it can be continued in the coastal districts right up to the beginning of January with every hope of a good crop.

The shoots or plants should be carefully drawn from the bed and put root downwards in a bucket of water or a mixture of cow-dung and water. For planting they should be drawn from the bucket as required and placed 2 feet apart in rows which are 3 feet apart.

The plants may be ploughed in at the time the ground is getting its second or final ploughing. When this method is adopted, the plants are placed the required distance apart in every third or fourth furrow, the necessary covering being given by the plough as it turns the succeeding furrow.

A common plan is thoroughly to prepare the ground first and then dibble the plants in with a spade. This method is somewhat slower than ploughing in, but for ordinary conditions it has been proved the most satisfactory. A man and a boy can plant with a spade 3,500 plants in eight hours.

A point of very great importance when planting by either method is to see that the soil is thoroughly compacted around the plant; this is especially necessary in dry weather. When the plants are dibbled, this compacting is done by pressing the soil firmly against the plant with the foot, and when ploughed in a heavy roller with a large diameter should follow the planting. A roller with a small diameter will drag the plants up. Whatever method of planting is adopted, if the ground be at all moist, the plants will root without difficulty. It is the practice of some growers to plant on ridges. In cold districts this is probably beneficial, but satisfactory results have been obtained without this trouble and expense.

The subsequent cultivation given to this crop is such as will keep the weeds down and conserve moisture. Cultivation with a small-toothed scuffler may commence as soon as the plants are set out, and can be continued until the vines cover the ground.

Harvesting and Storing.

The mature stage can be determined by cutting one of the potatoes. If the cut surface dries white, and does not turn greenish-black round the edge, the potato is fit to eat. If a milky juice exudes which, on exposure to the air, turns black, the potato is not mature enough.

The potatoes will continue to grow until the first frost is experienced; this destroys the vines, and, of course, the tubers will cease to grow after this. The crop may be left in the ground until then, and if the frosts are not very severe they may be left until they are required, but the vines should be removed or they will decay and communicate rot to the tubers.

During the last two months of the growing season the yield per acre is very much increased; in some cases it almost doubles itself. Where, therefore, bulk is desired it is well to leave the tubers in the ground for as long as possible after they become fit for the table.

The harvesting is usually done by hand labour. Some diggers prefer to use a pronged hoe, others a digging fork; it is a question of use. With some varieties which produce their roots in clusters around the "plant," the labour of digging may be lessened by throwing a furrow away from each side of the potatoes. When digging, care should be taken not to bruise the roots; a bruised potato rots easily, though a clean-cut one keeps well.

No difficulty has been experienced in storing small quantities of potatoes in dry sand. The tubers on being dug should be allowed to dry in the sun for a few hours, and then placed away in sand, where they will keep through the winter perfectly.

Diseases and Pests.

Sweet potatoes are relatively free from diseases and pests in this State, but in some countries where this crop is extensively cultivated heavy losses are sustained annually through various diseases, the majority of which affect the roots.

Scurf or Soil Stain.

This disease was first recorded for this State in 1927. Under field conditions, scurf first appears in the form of small brown spots on the root, which may later coalesce to produce a uniform browning of a part or of the entire surface of the root. The discolourations only affect the surface of the tuber, but the disease may result in shrivelling of potatoes kept in storage. The injury to the skin facilitates the escape of moisture from the potatoes, which may crack, and thus permit the entry of rot-producing organisms.

The disease is caused by a fungus, *Monilochaetes infuscans*, which overwinters on the potatoes and in decaying vines in the field. Alkaline soils and heavy wet soils containing a large amount of organic matter favour the development of the disease.

Control measures may be summarised as follows :—

1. Use clean seed.
2. Treat seed in corrosive sublimate solution (1 part to 1,000 parts of water.
3. Rotate with non-susceptible crops.
4. Use clean soil in seed-bed and avoid manure containing sweet potato refuse.

Sulphur, applied at the rate of 300 to 400 lb. per acre about one month before planting out, has given beneficial results in some countries.

Sweet-potato Hawkmoth (*Herse convolvuli*).

The caterpillars of this moth feed on the leaves of sweet potatoes, convolvulvus, and other plants, and sometimes occur in sufficient numbers to cause considerable damage. The caterpillars, which hatch from eggs deposited on the foliage by the female moths, vary from brown to green in general colour, with black lines along the upper surface and a number of black spots on the sides of the body, and have a conspicuous curved spine on the upper surface of the posterior end of the body. When fully matured they may attain a length of 3½ inches, and they then bury themselves in the soil about 2 inches below the surface, and change into dark, reddish-brown pupae, with the front of the head produced into a curled, trunk-like structure.

The adult moths which emerge from these pupae are about 3½ inches across the outspread wings, and are of a general mottled grey colour with pink markings on the body. There are at least two broods during the summer, while the winter is passed in the pupal stage in the soil.

Control Measures.—Normally the caterpillars do not occur in sufficient numbers to render control measures necessary, but should they do so, spraying with arsenate of lead mixed at the rate of 1 lb. of arsenate of lead powder to 40 gallons of water, is recommended. It is necessary to have the spray pump fitted with an extension rod and an angle nozzle to enable both surfaces of the leaves to be sprayed, and where the foliage is thick the nozzle should be drawn among the leaves to ensure a thorough application.

Sweet-potato Weevil (*Cylas formicarius*).

This pest, which occurs throughout the world in countries where sweet potatoes are grown, is present on the north coast of New South Wales. The main damage is caused by the grubs of the weevil (and to a lesser extent

the adult beetles) feeding on the tubers, both in the field and in storage, though the stems and leaves are also attacked at times by the adult weevils. The weevil has also been recorded as feeding on several other plants closely related to the sweet potato.

The adult weevil is *ant-like in general appearance, about ¼ inch in length*, and of a general dark metallic blue colour, with the portion of the body just behind the head bright red. The weevils lay minute eggs in the stems or tubers of the plant, and these develop into white, legless grubs which, when full grown, are about ¾ inch in length. These grubs tunnel through the stems and tubers, reducing the latter to a decaying mass, and pupate in an oval chamber within the tuber. From these pupae the adult weevils develop and commence egg laying, thus completing the life cycle. The weevils breed actively throughout the warmer months, when transformation from egg to adult occupies about thirty days. Breeding continues throughout the winter, but is very much retarded by cold weather.

Control Measures.—Although the weevil is winged, its powers of flight are limited, and the spread of the pest is largely caused by transportation of infested tubers or plants. Growers should therefore obtain tubers for propagating purposes from localities known to be free from the weevil. The pest overwinters mainly in tubers or stems which have been left in the ground after harvesting or in "volunteer" plants, and clean cultivation between crops, burning or boiling of all infested tubers and dead vines, careful harvesting so that no tubers remain in the soil, and a regular rotation of crops are the chief control measures.

Weevils are often carried over the winter in the seed-bed; this should therefore be located as far as possible from where the main crop is to be planted, and the tubers used should be destroyed as soon as the young vines are obtained.

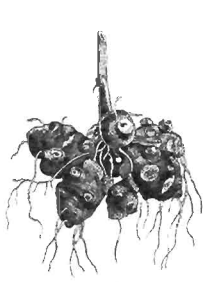
Where these methods are practised a satisfactory control of the pest may be obtained. Where sweet potatoes are grown year after year on the same ground the infestation by weevils becomes increasingly severe each year. Infested tubers which are not completely destroyed may be utilised as pig feed after they have been boiled. Where the adults are feeding on the leaves or stems, spraying with arsenate of lead mixed at the rate of 1 lb. of arsenate of lead powder to 40 gallons of water, or dipping the tops of the young plants in arsenate of lead solution, is recommended.

THE JERUSALEM ARTICHOKE.

This plant belongs to the sunflower genus and grows to a height of 6 to 9 feet, resembling closely in appearance an ordinary sunflower with a miniature flower.

It produces a large cluster of rhizomes or tubers, as shown in the illustration, useful for culinary purposes, and of special value as fodder for pigs. The leaves and stalks are of some value for sheep and conversion into silage, but it is almost invariably for the abundant crop of tubers that the plant is grown.

The Jerusalem artichoke is very persistent in growth, and, if raised in suitable soil, it is difficult of eradication. Enough tubers, as a rule, are left each year to continue the crop; hence it is wise to set apart a permanent



A cluster of rhizomes.

paddock for it, or the odd corners of a farm or waste places of little value for other crops may be used for growing artichokes.

Suitable Climate and Soil.

The plant is extremely hardy. Whilst the best crops are raised on good mellow loams, profitable yields are secured on stiff clay lands, light sandy or gravelly soils.

The land is best suited where the drainage is good. In fact, any soil suitable for potatoes will answer for artichokes. It is a crop that requires little attention when it is established.

The soil needs thorough cultivation. It should be deeply ploughed about May or June. During the winter it may be harrowed occasionally, lightly reploughed about September, and well manured as if for sweet potatoes. The tubers are then planted by dropping them into furrows 3 feet apart, with a space of 2 feet between each tuber. If the sets are small, plant whole, while large ones may be cut. Cover by turning a furrow over them. About 4 cwt. of tubers will plant an acre.

Ripening.

The crop matures in five months. Should rain fall immediately after planting, the harrow may be run over the land to fine the surface. This should be repeated when the plants are about 4 inches high to check evaporation and destroy weeds. Later on the cultivator should be kept moving between the rows about once a month.

When the crop flowers and the tops droop and die, about April or May, it is ready for harvesting.

A crop of Jerusalem Artichokes.

Fodder Values.

In feeding to pigs it is best to turn the animals into the crop to root out the tubers. It must be remembered that where it is desired to continue the crop the pigs should be removed before all the tubers are eaten out, and the only cultivation then necessary is to plough the land and keep the surface loose and free from weeds until the next growth is above ground.

Few foods are more relished by pigs. The tuber in the raw state is very nutritious, more especially for pregnant sows, and also sows reduced in weight and condition after suckling and weaning big litters.

Young growing pigs make considerable growth when fed with artichokes for a short period. The exercise obtained in harvesting or rooting up the tubers has a beneficial influence. A number of tests go to show that for fattening purposes these tubers must be given with grain.

The average composition of the artichoke is shown here in contrast with the potato:—

	Water.	Ash.	Protein.	Carbohydrates.	Fat.	Nutritive ratio.
Artichoke . ..	79·5	1·0	2·5	16·7	0·2	1 : 7
Potato . .	78·9	1·0	2·1	17·9	0·1	1 : 8·6

SECTION VII.

Leguminous Crops.

EVERY farmer is now familiar with the group of plants known as legumes (so called because their "fruit" which contains the seeds is a legume or pod). These plants are of the highest value and possess characteristics that distinguish them from all others, notably the high protein content of their seed, the excellent feeding value of their whole vegetative system, and their capacity for storing nitrogen in their roots and thereby leaving the soil actually enriched in that important item of plant-food.

In New South Wales legumes are grown for various purposes: Lucerne for hay and grazing, clovers as an important constituent of pasture mixtures, field peas, vetches, cowpeas, etc., for green fodder and hay, and also for green manuring and soil renovation, and garden peas and beans for the vegetable market and home use. Their place in our farm practice, indeed, is even larger than might be apparent at first sight, for the "herbage" that springs so abundantly on wheat lands when these are "left out," and that is so highly esteemed as pasture, consists largely of trefoils, which are as much legumes as lucerne or clover.

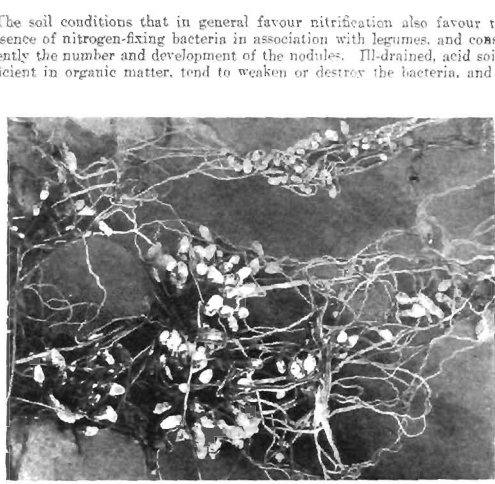
The secret of the value of these plants to the farmer is the possession of a source of plant-food that is not accessible to most other plants, particularly not to cereals. The practical experience of hundreds of years led farmers of past generations to believe that leguminous crops possessed some peculiar power of making succeeding crops grow better, and it was not till the last twenty-five or thirty years that this could be explained. It is now known that association with certain bacteria in the soil enables legumes to make use of the air in a way that other plants cannot. This association is one of mutual helpfulness, or symbiosis, the bacteria requiring considerable quantities of certain kinds of food that are generously supplied in the plant juices of legumes, while the plants derive from the bacteria, in some way not yet fully understood, a supply of nitrogen that the bacteria have taken from the air and built into nitrogen compounds within their own cells. It is supposed that the nitrogen compounds thus manufactured by the bacteria are diffused through the cell-walls and absorbed into the general circulation of the plants, where they are used for the building up of the protein compounds that are characteristic of the legumes in whatever form they are considered. The presence of these bacteria is indicated by the development on the roots of the little growths now universally known as "nodules." These little swellings vary from the size of a pin-head to the size of a small pea, and they may sometimes be seen by carefully digging up a plant with as many of the small roots as possible and then washing away the earth in a gentle stream of water.

There is unfortunately an impression amongst farmers that if the leguminous crop is removed from the land and the roots with their nodules

remain, the soil is thereby enriched in nitrogen. It must be clearly understood that the nitrogen taken from the air by the organisms does not exist in the nodules, but is made use of and distributed throughout the plant, and that the removal of the aboveground portion of the plant from the land means the removal of a large amount of nitrogen. An increase in the nitrogen content of the soil can only result from the growing of leguminous crops when they are fed off, ploughed in, or soiled to stock, and the resultant manure from the stock returned to the soil.

Soil Inoculation.

The soil conditions that in general favour nitrification also favour the presence of nitrogen-fixing bacteria in association with legumes, and consequently the number and development of the nodules. Ill-drained, acid soils, deficient in organic matter, tend to weaken or destroy the bacteria, and it



Bacterial Nodules (natural size) on roots of Tares at Hawkesbury Agricultural College Orchard.

is probable that this in part explains the failure of some leguminous crops on such soils. The introduction of cultures of bacteria into the soil has been attended with considerable success in some parts of America, and has been much advertised as a method of promoting fertility, especially where the growth of legumes is proposed. In some parts of the United States, in fact, use of such cultures appears to be advisable—even necessary. In New South Wales, however, experiments with cultures have revealed no advantage from their use, the soil and atmospheric conditions apparently favouring nitrification in a natural way.

Summer Legumes.

In this section prominence is naturally given to lucerne as the legume most in cultivation, but an increasing number of plants of this family are being utilised for a variety of purposes in the economy of the farm. Apart from lucerne and clovers, the leguminous crops may be conveniently classified according to the season of their optimum growth and climatic requirements as follows:—

Summer legumes—Cowpeas, peanuts, soybeans, and velvet beans.

Winter legumes—Field peas, vetches or tares, and tick or horse beans.

In districts with a severe winter climate, *e.g.*, the tablelands, the winter legumes given above require the summer season for their growth.

Similar advantages to those which are derived from the use of mixed pastures of grasses and clovers are obtainable from growing in combination a leguminous fodder crop and a cereal. A good deal of judgment has to be exercised in deciding on the most suitable combination. The exact time each crop takes to mature is an important factor, and it should be arranged so that they will both give their maximum yield and be ready to harvest at the one time. When grown alone many of these legumes creep along the ground, but when sown with a cereal they stand more upright, and are consequently easier to harvest. For use on the farm they can be made into excellent hay, but there seems to be no demand for such mixtures on the New South Wales market, and the presence of any foreign matter, regardless of its feeding value, will reduce the price of the chaff.

On account of their high feeding value and of their utility for soil improvement, the annual leguminous crops will always deserve a place in general farming and will yet come to be regarded as essential in any system of intensive farming in many districts of this State.

Generally speaking, these crops are not as particular in their soil requirements as many other crops, growing well on poor soils as well as on many acid soils to which clovers and lucerne are quite intolerant. These characters make them all the more valuable from a soil-improvement point of view.

Of the summer crops, velvet beans will make the best growth on poor land, though fertilisers, particularly superphosphate in small quantities, usually make a vastly increased growth of any one of them on such land. Soybeans are a little more resistant to dry weather than the other two crops, though none of them can be strictly called drought-resistant.

While not regarded as main fodder crops in any district, they have decided uses in this direction which are very little known at present. Apart from soil improvement each of these crops has its particular excelling sphere of utility—cowpeas as a purely hay crop, soybeans as a grain crop for pigs (particularly for hogging down) and also as an emergency hay crop, and velvet beans as a catch crop for winter grazing. It is the utilisation of the tops of peanuts for hay after the nuts have been threshed that makes the crop so valuable for fodder, though the whole plant may be used for hogging down.

As hay crops, cowpeas and soybeans cannot compete with lucerne where this crop can be grown, but lucerne has its soil and climatic limitations, and it is here that cowpeas or soybeans are deserving of a place. Their hay is more difficult to cure than lucerne hay owing to the thicker stems, but

has the advantage of being actually less damaged by rain during hay-making. The following analyses show how favourably the hay compares in feeding value with that of lucerne or clover:—

PERCENTAGE of Digestible Nutrients.

Crop.	Protein.	Carbohydrates.	Fat.	Nutritive ratio.
Lucerne hay.....	11·0	39·6	1·2	1 to 3·9
Soybean hay.. .	10·8	38·7	1·5	1 to 3·9
Clover hay.....	6·8	35·8	1·7	1 to 5·9
Cowpea hay.....	5·8	39·3	1·3	1 to 7·3

Soybean hay appears to be therefore about equal to lucerne hay and superior to clover hay, while cowpea hay is only slightly inferior to clover hay.

Winter Legumes.

Field peas are being more and more extensively grown for the combined purposes of soil improvement and stock feeding. In the coastal districts they are sown alone, mostly in late autumn, for late winter or early spring grazing for dairy cows, or if feed is not short at the time they are ploughed in as green manure, and then followed with a maize crop with beneficial results. They can also be sown in combination with oats or wheat for green feed of better feeding value than the cereal alone. On the tablelands, where the crop is mostly used as a fodder crop for sheep, sowing must take place in early autumn or early spring, as severe frosts cut the plants to the ground. In the more favoured wheat districts field peas could with advantage be grown with the oat crop for hay for farm use.

Vetches and tares, too, are used as a dual-purpose crop, mostly in coastal districts, the greater bulk of the growth being used as a soiling crop, and the remainder ploughed in as green manure. The vetch is also used in combination with a cereal.

Tick or horse beans have found their best development so far as a green manuring crop in orchards on the Murrumbidgee Irrigation Area. They are not a palatable fodder, though they derive their name from the popularity of the seed for horse feed.

Those legumes that are grown for the vegetable market—beans and peas—are dealt with in the vegetable section of this Handbook (page 644).

LUCERNE.

Lucerne is now the chief leguminous crop in New South Wales, and its fodder value is becoming more and more widely recognised. Its most extensive cultivation in earlier years was in the Hunter district, and at Tamworth, but it has shown itself capable of adapting itself to a variety of soils and climates, and it is now spreading over a much wider area of the State.

Suitable Soils.

It is seldom safe for a farmer to say that lucerne will not grow profitably on his land before he has tried it. It is usually associated with rich alluvial soils, but while the best results are obtained from such land, it also thrives on a wide range of soils that do not possess the depth or fertility of the rich alluvials. It is sensitive in certain respects, and disregard of its special susceptibilities will result in reduced yields, but payable results may be expected from almost any land, except that which is badly drained or exceptionally poor sandy country. The plant roots very deeply, and it is obvious that a deep, permeable subsoil contributes to maximum results.

The heaviest yields are obtained on the very best alluvial soils, found on river banks, particularly deep, free soils well supplied with plant-food, and with free water 15 to 30 feet below the surface. A farmer possessing such ground will find it hard to discover a more profitable use for it than to grow lucerne. The suitability of lucerne to such a soil is the secret of success on the Hunter River flats, where comfortable livings are made on 30-acre holdings, and where first-class lucerne land brings from £70 to £120 per acre.

Drainage is absolutely essential to success; where badly drained patches occur in the soil the lucerne soon dies out absolutely, and its place is taken by couch grass and weeds of various kinds. Flood waters do not affect it, provided it is moving, not stagnant, water; but to cover a lucerne field with water for six or seven days is a sure means of eradicating it altogether.

Preparation of the Soil.

The first matter to be considered by the farmer proposing to grow lucerne is the question of weeds. Young lucerne plants grow comparatively slowly, and are apt to be killed by weeds during their earlier stage of growth. For this reason it is generally preferable to sow lucerne in autumn, when the growth of weeds is not so great; but even then in some districts the problem is a difficult one.

If the ground be ploughed several months before sowing, and the weeds which then spring up destroyed by frequent cultivation, a large proportion of the weed seeds will have germinated and will be effectively disposed of. All land should be thoroughly cultivated and kept clear of weeds and couch grass.

A good rainfall cannot always be depended upon at seeding time, and light falls of rain may have the effect of germinating the seed without being sufficient for further growth. For dry districts, therefore, fallowing is essential, and the land should be ploughed in autumn or early winter the year before it is intended to sow the seed. The depth of the ploughing is governed by the character of the soil. Alluvial soils should be ploughed to a depth of about 7 inches, but on other classes of soil of lighter or more porous nature a depth of 3 or 4 inches is sufficient.

The ploughed land should then be allowed to lie in the rough state during winter, and be broken down in the beginning of spring with harrows. During the summer months the land must be frequently worked with harrow or cultivator, so as to allow neither growth of weeds nor the formation of a hard crust on top. If the seed-bed cannot be worked down sufficiently fine

with the harrows, a one-way disc cultivator or roller will soon do all that is necessary. If the land is rolled it should be harrowed immediately after the rolling.

The success of lucerne growing in dry districts depends almost entirely upon the thorough preparation of the soil, and the ideal conditions to be aimed at are a well-worked soil, in which the previous year's rainfall has been conserved, together with a finely worked surface as a seed-bed.

The Seed-bed.

Just before the seed is sown a light ploughing should be given, and the land well harrowed, and, if necessary, rolled to level the surface and give a firm, fine seed-bed. Generally, about three or four harrowings and one good rolling are required on alluvial soil, but it may be necessary to roll twice. If weeds or grass are still present they should be worked out with a spring-tooth cultivator and removed. Lighter soils can be brought into condition with considerably less working.

Since the surface soil undergoes the greatest change it follows that it becomes the most fertile, and it is necessary to retain it where the young plants will be benefited by the enhanced fertility. The seed is planted near the surface, and it is there that the young roots gain the sustenance required by the plant. If deep ploughing is given the second time, this improved soil is inverted and put beyond the range of the young roots. The second ploughing should, therefore, be shallow.

Varieties of Lucerne.

With regard to varieties of lucerne, it has been demonstrated that the local strains, Tamworth, Hunter River, and Mudgee, have such an advantage in acclimatisation as to make the discovery of better types a difficult matter. The Department has tested a number of lucernes from other lands, seed being obtained from time to time as the published reports appear to suggest their possible utility here, but it is still extremely doubtful if any will be recommended in preference to the local strains that have yielded so exceptionally well for so long.

Selecting Lucerne Seed.

Good lucerne seed should be sound, mature, plump, bright in colour, well saved, and reasonably even in size. It should contain no impurities or weed seeds, and should be free of dodder. It should be free also from insect pests and fungous disease, and there should not be less than 80 viable seeds in every 100.

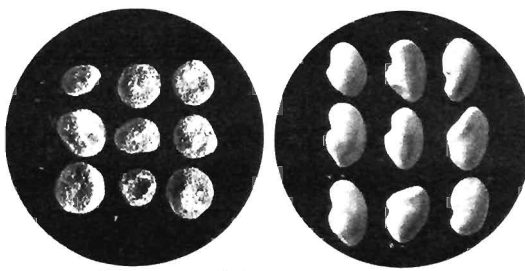
Seed grown in New South Wales gives very much higher yields than imported seed, even though the germinating powers may be alike. It is wise to test all seed for purity and vitality. To carry out the test: Take a piece of blotting paper about 6 by 8 inches in size, folded across the middle, and place on an ordinary dinner plate, moisten the blotting paper with water, and spread 100 seeds evenly over one half of the paper; turn the top flat down, and invert another dinner plate over the lower one so as to serve as a cover.

The plates should then be set in a warm place, where the temperature can be approximately maintained at about 90 degrees Fah. The blotting paper must not be allowed to become dry, and every twenty-four hours the germinated seeds should be removed and the number recorded.

To test for purity: Take a given weight, say 1oz. of the seed; spread it out on a sheet of white paper, and pick out all impurities. These may consist of sand, dirt, vegetable matter, (small twigs of the plant, for instance), mouse dung, weed seeds, or insect remains. These should be carefully weighed, and the proportion in the sample arrived at thus:—

Total weight of sample tested : weight of impurity found :: 100 : actual percentage of impurity.

The weighing can be done with very little trouble. If the individual cannot manage it no doubt the local chemist would oblige, the simplest weights to use being avoirdupois, 437½ grains to one oz., or 7,000 to the lb. The calculations are then easily made.



Dodder Seed. X 10. (*Cuscuta trifolii*). **Lucerne Seed.** X 5.

If it is found that seeds of noxious weeds exist (more especially dodder) the bulk should be sifted, using a mesh that will retain the lucerne whilst allowing the dodder and other small things to pass through. Broken and small seed may pass through also, but this will be no loss.

Time of Sowing.

In land which has previously been infested with barley grass, Cape weed, or other weeds whose seeds germinate in autumn, August and September are the best months for sowing; and under irrigation in the western districts spring sowing is preferable on account of the rapid growth which weeds make in winter, whilst lucerne is comparatively slow in germination during the cold weather. But throughout the bulk of the areas where lucerne is grown autumn sowing is preferable. For instance, on the North Coast, if lucerne is sown in spring or summer it will have but a poor chance of surviving amongst the heavy growth of weeds, and March and April are the months recommended. On the New England tableland and similar elevated districts the seed should be sown in March, so that the roots may be well down

before frosts set in; in the most important of our lucerne areas the sowing should be a little later than that. If the autumn is too dry, however, a spring sowing can be made if conditions are suitable. In the southern and south-western districts, where lucerne might be profitably grown on many farms, a little discretion should be exercised, autumn being the best time if the season has been a wet one and the soil conditions are such as favour early germination, while in the case of a dry summer and autumn the sowing should be delayed till about July or August.

The seed should be sown immediately after there has been sufficient rain to make the surface soil moist to a depth of several inches. The soil is put into condition for receiving the seed by loosening the surface with cultivators or harrows, or by lightly ploughing, following with the harrow, and, if necessary, rolling to get a firm, even surface.

Quantity of Seed.

The quantity of seed varies. In the regular lucerne districts of the State from 12 lb. to 15 lb., and even 20 lb., per acre is applied. For dry districts, such as the Riverina, 6 to 8 lb. will be found quite sufficient if evenly applied. For grazing purposes in dry districts 2 to 3 lb. seed per acre is ample.

It is not wise to run the risk of a thin crop through a little parsimony in seeding. It is all-important, with a permanent crop such as lucerne, that a good stand should be obtained at the outset. Re-seeding cannot be done without again breaking up the land, and this means that a year or more is lost. If re-seeding is not done, the yields are permanently affected through the poor stand. Attempts are sometimes made to remedy unsatisfactory stands by sowing further seed, but they are seldom successful. The soil is not in a receptive condition, and what plants do grow have to contend with established vigorous plants.

At the same time it is a mistake to endeavour to remedy defects in preparation, or in the state of the soil, by heavier seeding. Favourable conditions are required to promote germination and to help the young plant, and seeding should only be done after they have been obtained. If the ground should happen to be dry at seeding time, heavier seeding will not secure a proper stand.

Machines for Sowing.

Farmers generally prefer to broadcast the seed where the area is small, but sowing through the grass seed attachment of the wheat drill is a useful method when the area is larger.

A method of sowing that is well suited for wheat districts is to mix thoroughly just prior to sowing 70 lb. of superphosphate with the lucerne seed, and put the mixture into the manure box of an ordinary seed drill. The discs or hoes of the drill should not be set into the soil too deeply. Some drills, especially when new, cannot be set to a shallower depth than 1½ to 2 inches: in such a case a good plan to follow is not to set the lever of the drill into the first notch but to let it dangle. The cogs of the drill will be in gear, but the hoes will not go down as deeply as if the lever had been set into the first notch. In this way the seed will be sown about ¾ inch deep. Special care must be taken not to fill the manure box right up. Not more than sufficient seed and manure to sow half an acre should be put into the drill

at one time. In order that the seed may be thoroughly covered, it is advisable either to improvise a brush harrow at the back of the drill, or to harrow with light harrows after the sowing. An even distribution of the seed is required, and although some men are sufficiently expert to obtain it by hand-sowing that method is not recommended to the inexperienced. Many good machines are available which do the work satisfactorily.

If a farmer is compelled to resort to hand-broadcasting, half the seed should be sown in one direction across the paddock, and the other half at right angles across the first cast, so that strips missed the first time will receive some seed. Select a calm day or early morning as it is hard to distribute the seed evenly on a choppy, windy day.

Covering the Seed.

The seed should be covered with a light harrow, though a brush harrow is often used. Adjustable lever harrows are very effective for this work, as the depth can easily be regulated. The seed should not be covered deeply, and precautions must be taken to prevent a crust forming on the surface.

Sowing with a Cover Crop.

Owing to the slow growth of lucerne during the first year many farmers are tempted to sow it with another crop, such as wheat or oats, from which some return may be obtained. Others think that the sowing of such crops will assist the young lucerne by giving it some cover. This is not a sound practice on good lucerne land. Young lucerne is slow in growing, while the cereals are vigorous growers which take from the soil moisture and plant food and so rob the young lucerne plants, which instead of growing sturdily become stunted and weak, and are not in condition to stand the hot weather conditions when the cover crop is taken off. Careful preparation of the soil is required for lucerne, and this, with the cost of the seed, represents a good deal of expenditure, and it is not worth while risking the loss of this for the comparatively small return obtained from the cover crop.

In wheat districts, however, a mixture such as lucerne and Wimmera rye grass is sometimes sown with the last crop of wheat to be grown on areas which are to be devoted to pasture. This procedure is adopted to lessen the cost of establishing the improved pasture (see page 734).

Cultivation and Early Mowing.

Lucerne sown in autumn should receive no cultivation until the following spring at earliest. The young plants are tender, and will not stand rough handling. On friable, loose soil, especially, the effect of cultivation would be to pull many of the plants out, and consequently the harrowing must be light, and should not be attempted until the roots have a firm hold; but after the second cut, particularly on ground that sets hard, the harrow can be used.

The method of keeping early spring weeds in check is to mow frequently. The mower should be put over the crop before any of the weeds have commenced to flower, and the operation should be repeated a month or two afterwards. Two mowings will generally be sufficient. They must not be omitted if weeds are getting a foothold, even if the lucerne is not ready to cut, as the object is to destroy the weeds. If the quantity should warrant it the cut material can be raked for green feed or for silage.

Once lucerne becomes well established its vigorous growth keeps most weeds in check, but a certain amount of cultivation is necessary. A rigid-tine cultivator is the most suitable implement. The lucerne field should be given a thorough stirring with this in July or August, and if necessary again later in the season. The loosening of the surface allows moisture to percolate to a greater depth, and prevents it from flowing away over the surface. Owing to the depth to which even light showers then penetrate less loss occurs through evaporation.

If a rigid-tine cultivator is not available, a springtooth cultivator can be used very effectively, if fitted with narrow tines specially designed for the cultivation of lucerne fields

Lucerne Haymaking.

Lucerne is more difficult to cure than any other kind of hay crop, and greater loss occurs to it than any other when improperly treated. Careful handling is required from the time the crop is cut until the hay is baled for

Mowing Lucerne, Hawkesbury Agricultural College.

market. The eagerness with which buyers snap up well-cured lots of lucerne hay indicates the importance of curing and of marketing in the very best condition. They prefer hay that is green in colour, dry, free from weeds and rubbish, and which contains a large proportion of leaf. A dirty appearance, indicating careless handling in the field, or the slightest sign of heating in the bale causes buyers to reject the lot or to accept it only at much reduced prices. Since quality is of just the same importance when lucerne hay is fed on the farm the same care is necessary in its treatment.

Lucerne should be cut just after the first flowers have appeared, though many growers prefer to watch the crown for the young shoots of the next cut. Much more depends upon the selection of the right time to cut lucerne than with other hay crops. In the latter cases loss is chiefly due to deterioration in digestibility, but in lucerne the loss is not confined to this but

extends to actual loss of weight in the hay and to poorer growth in the succeeding crop. After lucerne flowers the nutriment in the stems and leaves is withdrawn and transferred to the upper portions of the plant, and the stems harden and become indigestible and of less value as food. The leaves wither also and begin to fall, which results in loss of weight, and as these are the richest portion of the plant every effort should be made to retain them in the hay. No advantage is obtained when the crop is allowed to remain uncut past the stage recommended. The only time when such a course is justifiable is when the weather is unsuitable for haymaking, and the crop is left standing until good weather is assured. A loss in the succeeding cuttings also follows when cutting is left past the time indicated. This loss is due to two things. When the crop is left uncut until past flowering it is found that the succeeding crop does not start away so quickly as it does when the cut has been made earlier. Secondly, loss occurs through the greater time which the crop occupies the land. Lucerne mainly grows during the summer, and, provided rain is plentiful, good crops can be obtained at frequent intervals. If the average time for a cut of lucerne be taken at six weeks, and five cuts are obtained in a season of thirty weeks, it means that if each cut is allowed to stand seven weeks only four cuts can be obtained, which means an actual loss of 15 cwt. to 1 ton of hay per acre per annum.

It usually happens that owing to the cool weather the first growth of the season is late in flowering, and the leaves begin to drop and the stems to harden before the blooms or the young shoots of the next growth appear. The crop should be carefully watched and the cutting made when the lower leaves begin to change their colour.

Cutting is done with the mower or scythe. A time should be selected when the crop is at the right stage, and when there is a prospect of fine weather lasting until curing is completed. Showery or cloudy weather renders curing difficult, and hay of the best quality cannot be made. The usual practice is to start the mower going in the morning as early as possible, but if a heavy dew is on the crop cutting should be deferred until it has evaporated. External moisture, owing either to rain or dew, is objectionable, and causes deterioration in the quality.

Handling the Crop in the Field.

If the day continues fine the rake should be started about midday, so that the cut crop will be raked into the windrows before nightfall; in light crops it is often necessary for the rake immediately to follow the mower. Hay should not be allowed to lie in the swath too long, especially in hot, scorching weather, when it should be put into the windrows almost immediately after cutting. The heat causes rapid drying of the tender leaves, and these become quite dry, while the stems are still sappy. When the hay gets into this condition in the swath, a large amount of the leaf will shake off when raking into the windrows, and in cocking. In good hay the quantity of leaf ranges from 45 to 50 per cent., and as it is considerably richer than the stems in nutriment a very serious loss in both quality and quantity may occur through careless handling.

After the hay has wilted a few hours in the windrows it should be put into cocks. The time varies according to the condition of the weather. In cool, fine weather it may be left about half a day, while in hot, scorching

weather it should be put into cocks almost immediately. In cloudy, dull weather it is left from one to two days. Drying is done to remove the excessive quantity of moisture, and to get the hay in such a condition in the field that when stacked it will not heat too much nor become mouldy. The moisture is removed by the heat and wind drawing it off directly, as it is removed from a wet cloth, or by the leaves transpiring as they do when the crop is growing. Heat dries the tender leaves rapidly, causing them to become too dry while the stems are still insufficiently dry. The hay dries best when the activity of transpiration in the leaves can be maintained. This gradually exhausts the moisture of the stems, and the curing takes place more evenly. This natural transpiration of moisture is obtained by putting the hay into cocks soon after raking into windrows. The leaves in the cocks are protected from the direct rays of the sun, and are not scorched. By following this plan the loss of both quality and quantity is materially reduced.

Students Harvesting Lucerne, Wagga Experiment Farm.

The cocks should be made narrow and high, rather than broad and flat. In wet, muggy weather, mould is liable to form in the cocks, especially where leafy, sappy stuff is handled. To obviate this danger the cocks should occasionally be gently moved or turned over to let in the air. Just before stacking the cocks are sometimes moved to expose the lower hay which is inclined to be slightly damp. Exposure to the sun for an hour or two soon drives off the moisture and puts the hay in a proper condition for stacking.

The time the hay is allowed to remain in the cocks depends upon the weather conditions. In fine hot weather it can be stacked two days after cutting, while in cool weather three to four days are necessary. Care has to be taken that it is not stacked whilst so damp that combustion or mould will occur in the stack, but, on the other hand, it is equally important that it does not become so dry that its palatability, digestibility, weight and appearance are injured. It is work in which some experience is required to secure the best results. A farmer with a large quantity of valuable hay lying in the field is tempted to bring it in too early to avoid the risk of damage from rain, while in good drying weather he is inclined to leave it

longer than necessary to avoid the risk of loss in the stack. It must be remembered that good colour is of great importance, and by leaving it too long the hay on the outside of the cocks will bleach, and lose its green colour, and seriously affect the appearance of the whole of the hay. Generally speaking, good drying weather can be obtained in most of the lucerne growing districts of the State, and the chief danger to provide against is over-drying.

Stacking.

It is almost impossible to indicate exactly when the hay is at the right stage for stacking. Little danger exists of insufficient drying of the leaves ; the chief danger exists in the stems. These should be examined carefully to ascertain whether they have lost their sappiness. If they are sappy and moist the hay should not be stacked. Generally it is right to bring in when it has a crisp feel rather than a dead, damp feeling. Lucerne hay should preferably be stored in sheds. It does not shed rain well in the open, though fair protection can be given by covering with a few inches of freshly-cut lucerne. Storing in sheds, besides being more convenient, has the advantage that when baling or feeding no damage can be done to the hay by rain or heat. Before building, a foundation of poles should be laid down to give ventilation to the bottom of the stack ; if stacked on the ground some of the hay is sure to spoil. In building a stack in the open the centre should be kept high so that the rain will not run in from the sides.

Under some circumstances the hay is liable to become so heated in the stack that firing occurs. In other cases heat is generated, but not sufficient *to cause firing, and the hay is only charred. As a rule spontaneous combustion* is found to occur in hay which has been made from heavy sappy crops, especially if it is made when the weather is not suitable for drying, or where the hay has been stacked before it has dried sufficiently.

Baling and Marketing.

Although baling is sometimes done direct from the field, or very soon after stacking the practice is not the best. A certain amount of curing takes place in the stack, the hay mellowing there before being baled. In baling from the field care must be taken that the hay is quite dry before it is put into tightly compressed bales, otherwise rapid heating may occur; and the slightest suspicion of heat will cause buyers to reject it. Of late the old large size bale has fallen into disfavour, and buyers now prefer a smaller-sized bale.

It is to the farmer's own interest to put his product up in such a way that it will command the best price : and it is absolutely certain that if he does not send his produce to market in a proper condition a fair price will not be realised. The keenness with which buyers note the different brands of produce on the market is indicative of their desire to be sure of the quality of the stuff they buy. Good known brands are snapped up readily because they have been proved by experience.

Brown Lucerne Hay.

This is made either accidentally or by design. Sometimes, when it is intended that dry green hay should be made, the crop is stacked while containing slightly too much moisture, and the changes in the stack result in a brown hay being formed. This is claimed by some to have certain advantages

over dry green hay. It is more succulent, freer from dust, and stock, in most cases, showed a decided preference for it. Generally speaking the price obtained is slightly lower than that for prime green hay, but when the sample is good the difference is not very marked. Probably brown hay would be more largely made, especially for dairy cows, were it not for the greater risk of loss by firing. The methods of cutting and curing are the same as in making green hay, except that the hay is not allowed to become so dry in the field. The risk of spontaneous combustion is therefore greater than in the case of green hay.

Grazing.

In dry districts the value of lucerne as a grazing crop commends itself to stock owners. Being very drought resistant, it often provides acceptable green feed when other succulent fodder is scarce or non-existent, and after a long dry spell it is almost an axiom that lucerne is the first plant to grow when rain comes.

The pasturing of stock upon lucerne, however, is attended by two risks—one to the plants and one to the stock.

Lucerne should not be heavily stocked the first season of its growth, as the plants are not then sufficiently strong to withstand the inevitable trampling. Again, it will not stand continual grazing at any time; and the method should be to put sufficient stock on to eat it down quickly, and then to move them off before the young plants have commenced to shoot. The paddock should be subdivided into small lots for grazing, so that the stock can be moved from one to the other in quick succession. Temporary fences should be erected and shifted as required. This prevents injury to the plants and reduces the loss of feed.

Even with reasonable care, the use of lucerne as a pasture will inevitably lessen the life of the plants. Lucerne not irrigated and fed off by stock in the drier districts will probably require to be sown after six or eight years. Whenever possible, a cut for hay or green feed should be taken.

"Bloat," or hoven, is caused by feeding stock upon green, succulent fodder at a time when the stomach is practically empty; or by giving an abundance of gas-producing feed before the digestive organs of the animal have been accustomed to dealing with such material. Cattle and sheep appear to be the only domestic animals subject to the danger. If the lucerne is wet at the time of eating the liability to bloat is increased, and the danger is especially great when the crop is in the early stages of growth.

In the drier districts there is not as great danger of bloat as on rich alluvial flats, for the simple reason that there is not the same abundance of succulent fodder.

Stock should not be put on lucerne when it is wet. The danger is accentuated in humid and windy weather. If possible the animals should go on with a fairly full stomach. Bloating usually occurs when hungry animals are put on the feed and eat large quantities in a short period of time.

Dairy stock cannot be placed in the paddocks with full stomachs. They should be put on and herded for twenty minutes or so each morning, and then put on for another twenty minutes in the afternoon. This practice is also recommended when sheep are being introduced to lucerne after other feed; once they have become accustomed to the feed they can be left alone.

Soiling is far more economical than pasturing for all kinds of large stock. Animals grazing on lucerne generally destroy far more than they eat, by trampling down the fodder. Various estimates are given of the increased number of animals which can be carried on a given area by this method, several authorities stating that from three to six times as many head of stock may be maintained by soiling as compared with grazing. The advantages claimed for soiling over grazing may be summed up thus :—

1. It saves land.
2. It saves fencing.
3. It economises food.
4. It keeps cattle in better condition and greater comfort.
5. It produces more milk.
6. It increases the quantity and quality of manure.
7. There is greater docility and discipline of animals.
8. There is less breaking of fences.
9. It ensures regularity of feeding and output.

The Lucerne Seed Crop.

The production of seed is mostly confined to those districts where lucerne has been grown for a number of years, and the practice is to allow one crop to go to seed when the conditions appear to be suitable. The venture is a somewhat risky one, but experienced growers appear to be able to judge the conditions with considerable accuracy. A well-established and somewhat thin "stand" is preferred for the purpose, though sometimes three-year-old plants are utilised. As a rule it is the second cut, or the one that would produce hay early in December, that is allowed to go to seed. The crop should be cut when the pod has turned a deep yellow, but before it has turned brown. The grain is then also yellow, and, though quite soft, will mature into prime seed after it is cut. If it is left standing too long in the paddock the colour will be spoilt, and, rightly or wrongly, buyers have a prejudice against dark-coloured seed. Should the crop not be ripening evenly the aim should be to harvest when the greatest quantity of prime seed may be expected, otherwise the matured pods will burst and the grain be lost. The crop is cut with the mower early in the morning and in dry weather. Sometimes the swathboard is attached to the mower and the crop left in the swath for two or three days, then drawn into heaps with pitchforks (not rakes), and left another day before being carted in and stacked. If the swathboard is not used it is put into heaps on the same day or the next morning, and carted in about the third day. In either case the handling must be with care so that the pods will not be knocked off.

The crop is threshed from the stack, an ordinary wheat thresher with very fine screens or a special lucerne thresher being used, together with a blast winnower through which the seed is put to clean it. The seed is usually stored in air-tight iron tanks, or in double bags in a dry place, where it matures before it is marketed. During this period it must be kept perfectly dry or it will turn brown and depreciate in value.

Lucerne seed is a profitable crop, 4 bushels to 6 and 8 bushels per acre being obtained, and with the price to growers reaching and in most cases exceeding *1s. 6d. per lb., the monetary return is good, but the risk is considerable. If the*

weather proves unfavourable the farmer finds he has lost valuable time in the extra period the crop has occupied the land, and that he has to be satisfied with a very inferior sample of hay that cannot be marketed on account of its bad colour, stemmy nature, and loss of leaf.

The Life of a Stand.

The time during which lucerne, once properly established, will continue to yield payable crops will be found to vary with the nature of the soil and subsoil, and the use to which the plants are put. On the best soils, such as the deep, well-drained alluvial soils of the Hunter Valley, the period for which it will pay to crop lucerne before breaking up the ground is much longer than on poorer types. Grazing stock on lucerne is much more injurious to the life of the plants, owing to the consequent trampling, than removing the cuttings for hay. While therefore, it may be said that the average profitable life of a lucerne paddock is seven years, this estimate will be found to be the mean between rather wide extremes.

Lucerne gradually dies out, the termination of the life apparently being due to the plants losing their vitality, as all plants do, but the termination of its profit-yielding period is governed by other factors as well. The continuous growth of the one class of crop exhausts the fertility of the soil, although lucerne, unlike clover, does not appear to cause land to become "sick" in the ordinary sense of the term. After the land has been utilised for other crops for a time it can again be successfully laid down to lucerne.

Top-dressing with Superphosphate.

There is a mistaken idea, prevalent among certain growers, that a lucerne field requires no further attention than perhaps the usual cultivation given early in the spring; and that it naturally increases in fertility. These farmers argue that lucerne, being a legume, can gather nitrogen from the air and enrich the soil; moreover, say they, its wonderful root system can traverse a wide area in the search of other necessary plant-foods. All these things are undoubtedly true, but to be profitable, and to be continuously so, lucerne requires attention as much as any other crop, and the farmer who would lengthen the life of his stand, and also derive from it the maximum return while it is with him, will take care of it and neglect nothing that will invigorate and maintain it. Lucerne removes much larger quantities of other plant-food from the soil than most farm crops, and therefore depletes the soil of these elements more quickly.

The value of top-dressing lucerne with superphosphate as a means of increasing the yield has been proved in quite a number of trials conducted by the Department in several parts of the State.

On the Coast.—A number of tests have been made at different centres in the central coastal district, viz., Mondrook, Pampoolah, and Dungog, and amounts of 1 and 2 cwt. of superphosphate per acre have been used on the plots, and comparisons made with unmanured plots. Very considerably increased yields have resulted from the application of the superphosphate, the difference attributable to the top-dressing being as much as 8 tons from a total of four cuts in one instance. These increases in the yields speak for themselves, but the general condition of the stand at each centre has been improved and the crop is of better quality.

On the Tablelands.—In trials conducted at Glen Innes Experiment Farm as far back as 1916 and 1917, increased yields of 3 tons 17 cwt. and 6 tons 10 cwt. resulted from applications of 1 cwt. and 2 cwt. per acre, respectively, of superphosphate. Top-dressing now forms part of the regular farm practice.

In Western Districts.—Some interesting figures that prove the value of top-dressing come from a farmer in the Orange district. Portion of a good stand of lucerne, which had nevertheless not been yielding as well as it might, was top-dressed with 1 cwt. per acre, and another portion with 2 cwt., while a third portion was left untreated for comparison. The whole paddock was worked with the springtooth cultivator both ways in the beginning of August, again "springtoothed" late in the month, and the superphosphate then applied with the wheat drill. The difference in the growth of the plots was very marked; the unmanured plot showed sickly growth mixed with grass, and the leaves died off as a consequence in the dry weather. The manured plots, on the other hand, grew luxuriantly, and showed a dark, healthy, green colour. In November the plots were cut, and the crops weighed at once, with the following results:—

	tons.	cwt.	lb.
No manure	0	5	64
1 cwt. superphosphate per acre	2	12	64
2 cwt. superphosphate per acre	3	7	78

These results were so satisfactory that the whole area was dressed with superphosphate and, though very dry weather followed and seriously checked growth, the manner in which the lucerne revived after rain suggested that the fertiliser really saved the stand from extinction.

Under Irrigation.—As the result of experiment, the top-dressing of lucerne with superphosphate in the spring has become a recognised feature of the farm work at Yanco Experiment Farm; and in various experiments conducted by the Department, in conjunction with settlers on the Murrumbidgee areas, applications of 2 cwt. of superphosphate have been the means of increasing the yields by as much as 1 ton 14 cwt.

Summary.—The outstanding advantages that are to be derived from the top-dressing of lucerne with superphosphate may be summarised thus:—

(1) The green fodder yield is greatly increased.
(2) A better quality product results—in fact, a healthy, dark-green colour is noticeable throughout the whole growing period.
(3) The general condition of the stand is built up consequent upon the vigorous growth developed.
(4) The useful life of the stand may be extended, and depleted stands largely restored.

The experiments conducted by the Department indicate the early spring as the best time to apply dressings of superphosphate. It is advisable first to stir the surface soil with a springtooth cultivator, and then to apply the superphosphate through the wheat drill, with the tubes loosely adjusted so as to give a broadcasting effect, or use a top-dressing machine to spread the fertiliser. Where there is no wheat drill or top-dressing machine, as on a good many coastal farms, it is better to broadcast the superphosphate by hand than to neglect the operation.

The indications are that the dressing should be at the rate of about 2 cwt. per acre; where the method is broadcasting, a slightly heavier application can be made with advantage.

Lucerne under Irrigation.

Throughout the western and south-western districts of this State there are many thousands of acres of land admirably adapted to the growth of lucerne under irrigation. The main requirements of the crop are plenty of sunshine, high summer temperature, sufficient moisture, and a deep, well-drained soil, rich in plant-food. Any porous soil with proper natural drainage will be found suitable for the growth of lucerne under irrigation. Heavy clay land should be avoided on account of its close texture, which prevents the free percolation of air and water, and also on account of the mechanical obstacles which it offers to cultivation. But clayey loam is quite suitable, and heavier soils will yield good results if they are of such a nature that the lucerne roots can penetrate freely through the subsoil.

Limestone country is particularly suitable for lucerne, and has the additional advantage of being naturally well drained. Lucerne under irrigation does particularly well on such soil. Wherever large mallee timber grows there is usually plenty of limestone in the soil, consequently in such country lucerne usually grows to perfection.

When to Sow.

The seed should be sown in autumn. The soil is then warm, it is possible to apply the water in such a way as to ensure a saturated subsoil and to work the surface so as to produce an almost ideal seed-bed, and the lucerne can be got above ground sufficiently before winter to enable it to continue slowly to establish itself during the cool months, so that in the spring it is ready to respond to the increasing temperatures and to such applications of water as the weather makes necessary.

Spring sowing is quite possible, but the plant is more delicate and requires more attention, greater care, and extra labour to ensure a profitable stand. Young spring-sown plants necessarily feel the effects of the advance of summer more, not being so well established as those sown in autumn, and will yield at least one cut less in the first season than a stand sown five or six months earlier.

Preparing the Ground.

It will perhaps be appropriate to remark at the outset that as the unhindered flow of irrigation water across the field has at all times to be kept in view, it is essential that all operations shall be conducted in the direction of the fall. The ploughing must be in small lands and not round and round, or it will be found that dips will remain in the centre in which water will lie and will kill out the lucerne. Similarly, the ploughing must not be across the fall, or the inequalities of the ground will interfere with the flow of the water. Cultivation (except of the very lightest character) must be in the same direction for the same season. The seed drill must work the same way or the rows of the lucerne, crossing the fall of the water. will impede its advance and produce uneven watering with possibly the killing out of patches. The surface cultivation to which the crops are annually treated after they are two or three seasons old must be guided by the same principle. In a word—all work likely to affect the levels, even a little, must be the one way.

The first ploughing should usually be given in December or January. It is generally found good practice to precede the sowing of lucerne with a cereal crop; the working tends to produce a good tilth and also enables the character of the soil to be known accurately. As soon as the crop is off, the stubble land should be ploughed 6 or 7 inches deep. A short fallow of two or three months should then be allowed before a louvred grader or smoother is put over the land, across the plough, to produce an even surface. A type of scoop called the buckscraper is also very useful for this purpose.

Louvred Smoother or Grader Used to produce an even surface.

Making the Check Banks.

The method of irrigation adopted for lucerne is flooding, but flooding over limited areas, and between check banks that run down the field in the direction of the fall.

The formation of these check banks is the next operation. They are placed half a chain apart, and are formed by throwing two furrows together with a single-furrow plough. The soil is then filled into the furrow with a road-grader to which is attached a long blade, so that the soil is levelled and the banks strengthened. The preservation of these banks throughout the life of the lucerne stand is essential, for they are a most important feature in thorough and efficient application of the water. Hence, on account of these banks, as well as the preservation of a level surface between them, all subsequent work must be in the same direction—that is, from head ditch to drain. The ends of the checks have to be finished off by hand, as the road-grader or levelling machine referred to will not work right to the end of the paddock.

It is most essential that the blocks should not be too long; in other words, the distance between the head ditch and the drain at the lower end should not be more than 6 or 7 chains. At that length an even flow of water from the upper end to the lower is assured, but longer blocks are irrigated with difficulty.

The drain along the lower end of the paddock is quite essential, as every irrigationist well knows. Stagnant water is a thing not to be tolerated on a well-managed irrigation farm; hence, drainage must be provided as a concomitant of the head ditch, or damage will certainly occur.

Working the Seed-bed.

In April the land thus prepared for sowing should be given an application of water. It is found that if the soil (already warm and well worked) is also moist, the seed germinates quickly and also evenly. Sowing in a dry seed-bed has been one of the common causes of failure of irrigated lucerne. In such cases the seed is sown with the intention that the ground shall be irrigated after sowing, but the method is rarely satisfactory. In many instances the effect of the irrigation water is to cake the surface over the tender little seedlings, which are therefore unable to reach the sun and air. It does not need to be pointed out that to attempt to disturb the surface at that stage is almost as fatal to the little plants as to leave it alone. The lucerne seedling is a very tender plant. All cultivation of lucerne must be after the plant is well rooted.

In April, then, the land is furrowed out between the check banks with special furrowing shovels attached to an ordinary cultivator. These shovel points, which really belong to the Planet Jr. type of fittings, make the furrows 2 feet apart. The water is turned into these furrows from the head ditch, and the land thoroughly saturated; the water is confined to the furrows as much as possible, and it advances slowly along the furrows, soaking downwards and laterally, and giving a far better result than would be obtained by flooding between the check banks without furrows. It takes the water twenty-four to thirty-six hours to reach the lower end, but the furrows are not allowed to overflow.

Should the land have been fouled with weeds, it would be well, perhaps, to forego (in part) the advantages of the fallow period, and to form the check banks and furrows earlier in the year, turn in the water to germinate the weed seeds, and kill them by cultivation. A further irrigation in view of the sowing of the lucerne will probably then be necessary, according to the state of the ground when the beginning of April arrives.

The Sowing.

As soon as the surface is dry enough to carry the teams, the tine cultivator should be employed to produce a level and fine surface. The seed-bed is now in an ideal condition, and the seed should be sown at once, the drill generally no more than half a day behind the cultivator. If by any mischance the ground unfortunately dries out before the seed can be sown, it is better to cultivate and irrigate again before sowing rather than attempt to do any good on the dried out surface. If, for any other reason, the seed fails to germinate after treatment on these lines, it is better to leave the whole thing until next year, and to use the paddock in some other way in the meantime.

For the sowing, the grass-seed attachment of the ordinary wheat drill may be used, the seed being fed at the rate of 10 lb. of seed per acre through all the tubes into the main holes of the drill. Some farmers use the drill but sow broadcast, leaving the tubes out of the holes; the results are seldom so satisfactory as when the seed is put down into the soil with the aid of the hoes (withal, of course, not too deeply). Where the soil is a fine loam, the hoes could run free, and not in the notch at all, and the weight of the hoe would be sufficient to sow the seed deep enough. When sowing the headlands where the horses have trampled down the surface, it may be necessary

to put the drill in the second notch in order that the seed may be sown at the right depth. The principal thing is to ensure that the seed is put down on the moisture and to work the drill to that end.

The superphosphate should be sown through the manure box of the drill at the *same* time as the seed.

Irrigation by furrows previous to cultivating and sowing.

Handling the Young Stand.

The seedling lucerne plants will thus be up by the early part of May, and *winter showers will keep them growing slowly until the spring. About* September it is advisable to run the mower over the ground and to allow the cutting, if light, to remain on the ground; the same may have to be done again in October, though it may be possible with a good stand to harvest a light hay crop. The plants must be encouraged to stool at this stage, however, and cutting is valuable to that end. The growth must be watched with care, for (as with most other plants) as soon as the conditions become a bit adverse there is an impulse to preserve the species by setting seed—an occurrence that cannot but exhaust the plant and permanently affect its vigour. In November a good cut of hay will probably be obtained.

Irrigating the Growing Crop.

The first application of water is given as soon as the first crop of hay is off the land in order to stimulate an early growth, and further irrigations follow as the season requires. Generally speaking, one irrigation for each cut is sufficient in the early part of the season, but as the weather gets hotter more are necessary, averaging two per cutting, and the exact time when these are made must depend entirely upon the season: the usual practice it to irrigate a week before cutting, and to give a second watering as soon as the *hay has been taken off.* Should the weather be excessively dry and hot an extra watering about fourteen days after cutting may be found necessary. The object aimed at should be to keep sufficient moisture in the soil to produce maximum results. It is not advisable to wait until the lucerne shows signs of distress; this must be anticipated as much as possible.

It is one of the disadvantages of spring sowing that before the plant has attained any height it may be necessary to apply water, which in turn makes a light harrowing a necessity in order to loosen the surface.

As already indicated, a big body of water should never be turned onto lucerne at one time. The head ditch is filled and then a gap is opened in the bank about half-way between the check banks, allowing enough water to escape to spread from bank to bank, just covering the surface and moving forward very slowly. A rush of water is never satisfactory, for it wets the surface without saturating the subsoil. It should take from six to eight hours for the water to reach the lower end of the block 6 chains away, by which time the water can be shut off at the upper end. If the land has been well graded, and the water properly applied, there should be very little surplus water to fall into the drain.

Flooding a Lucerne Block.
Slow soakage is the method sanctioned by experience.

The method described is that adopted on a heavy soil; on lighter soils, which absorb water more rapidly, the flow can be a little faster. If too much water is applied the effect is a consolidation of the surface that deprives the roots of the lucerne of air, and hinders bacterial activity in the soil.

It is imperative that facilities be provided for thorough surface drainage. Water lying on lucerne for three hours on a hot day will scald the plants and do irreparable damage to the stand. Special attention is necessary in the evening in ceasing operations to prevent flooding. This is achieved by starting more checks, which will take the whole night to run through.

A close watch must be kept on the growth, and so soon as there is any indication that water is required it should be applied. If the water is left too late the growth seems to harden off, and can never be brought back to its original freshness; indeed, watering after the top growth has hardened off only promotes the development of the next growth from the ground, and does little for the standing crop.

The secret of success with lucerne is to watch it at all stages, to keep it growing as if it was a soft green vegetable for the table, and to cut it as soon as it is ready.

The "hardening off" referred to is difficult to describe in any other term, but the observant farmer will quickly detect it. The best treatment is to turn in the water immediately that symptom appears; if done quickly enough the effect may be to save the crop and bring it back to its original freshness. If it is impossible to water at once it will be better to proceed to harvest the crop for hay in the ordinary way, and to take greater care thereafter not to allow the crop to go so long without water. When the crop has lost its fresh, green colour and has acquired a bluish appearance, it is too late to restore it to the sappy condition that makes the best hay.

When to Cut.

Lucerne forms its new growth from buds on the crown, and just before a crop is fit to cut for hay the buds shoot. This usually corresponds with about 10 per cent. of blossom showing, but with the first cut of the season the blossoms are not a reliable guide, and the bud growth should be noted. A spike of lucerne, if nipped off, will not grow, but hardens off, and its place is taken by a new shoot from a bud. It is for this reason that slow grazing is so harmful, while quick grazing, which is similar to cutting with a mower, does not greatly affect the stand. Lucerne must be cut off or fed off regularly at the proper stage to obtain the highest yields and to promote long life.

Enemies of Lucerne.

Dodder.

This is the greatest enemy of lucerne. It is a parasitic plant, with long leafless stems, orange yellow in colour. The dodder seed germinates in the ground, and the young plants attach themselves to the lucerne seedlings. As soon as the thread-like vine is firmly attached to the lucerne plant, the stem connecting it with the ground withers away, and the dodder draws its sustenance from the lucerne by means of tiny suckers, which enter the tissues of the host plant. The dodder flowers are a beautiful golden colour. As the parasite develops, the tangled masses of crop in which it occurs have the appearance of ringworms, working from the centre outwards.

Lucerne and Dodder.

On no account should dodder be sown with the lucerne seed. Fortunately the removal of seeds of dodder is a simple process, as they are much smaller in size than lucerne seeds, and can be removed by screening through a

mesh sufficiently close to retain healthy lucerne seed, whilst allowing the dodder to pass through. If dodder appears in a lucerne paddock it should never be allowed to seed, but the affected growth should be removed as soon as possible. The plants should be cut with a scythe or chipped to the crowns. The patches should be treated before the general crop is cut, as otherwise the parasite may be distributed throughout the field by the machinery. Remove the infested material from the field, taking care not to drop any of the dodder during the process. Destroy the material by burning.

Stem Nematode (*Tylenchus dipsaci*).

The disease is characterised by the occurrence of thinned areas throughout the field, leaving a poor stand of dwarfed plants, with a reduced number of stems, which are sometimes yellow and distorted; slightly affected plants may wilt during warm weather. The stem bases and crowns of badly affected plants generally rot away, and in such plants the rot usually extends into the root system. The swollen nature of the stems at the base, their brown colour and brittleness, are other features of the disease. The buds and sprouts which arise in the crown of affected plants are usually swollen, spongy, and of pale colour; these new shoots generally remain in an arrested condition of growth for about three months. A favourable time for detecting this and other features of the disease is about three or four weeks after cutting, when the new growth has made a good start. The presence of the disease can most readily be observed during spring.

Lucerne affected with Stem Nematode.

The disease is caused by an eelworm or nematode known as *Tylenchus dipsaci*, less than one-twentieth of an inch in length. It reproduces itself by means of eggs from which the tiny worms emerge and migrate to other plants, where they penetrate the tender succulent tissues. The nematodes grow to maturity within the plant, and may be so abundant as to completely kill the plant, whereupon they migrate into the soil and attack other plants within their reach. This eelworm does not attack the roots of lucerne, and is distinct from that which causes root-knot.

The nematodes may be distributed by means of flood waters, irrigation water, hay, farm implements, or by animals and man, any one of which may carry soil or parts containing the parasite or its eggs.

Control Measures.—The control of this disease is difficult, but it is suggested that affected fields be ploughed up and some other crop substituted for at least three years in order to starve the organism out of the soil. It is important to eradicate all plants on affected areas. Implements used in the work of eradication should be thoroughly cleaned and disinfected before being used on clean areas.

FUNGOUS DISEASES.

Crown Wart.

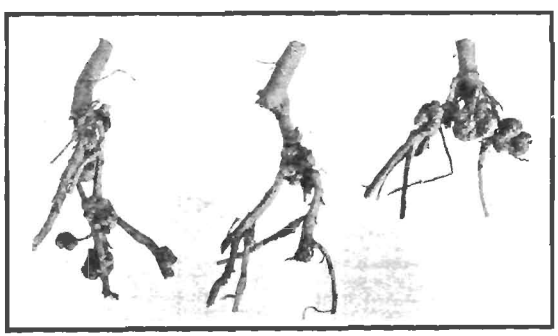
Plants affected with Crown Wart, caused by the fungus *Urophlyctis alfalfae*, are characterised by the development of galls on the roots and on the stems close to the ground. The plants wilt and frequently die. The causal organism is known to remain in the soil when affected plants decay and disintegrate. Development of the disease is favoured by excessive moisture in the soil during the infection period in early spring. Although Crown Wart has been observed in this State, it is not widespread.

Control Measures.—

1. Remove affected plants and destroy by burning.

2. Do not plant lucerne on affected areas for three years.

3. Avoid as far as possible transfer of soil from diseased areas by stock, implements, &c.



Lucerne Stems showing Crown Wart Galls at the Ground Level.

Rust, Leaf Spot, and Downy Mildew.

Rust is caused by the fungus *Uromyces striatus*, and is chiefly found on the under-surface of the leaves where the characteristic small, brownish, elevated rust patches or pustules develop. Later these pustules burst and expose a reddish-brown mass of spores, which are distributed by wind to other plants, where fresh infections occur. This disease is of minor importance.

Leaf Spot is due to the fungus *Pseudopeziza medicaginis*, and is quite different from rust in its characteristics. The leaves first show small brown to black spots, which extend through the leaf from surface to surface. Badly affected leaves turn yellow and fall to the ground. The lower leaves and leaves of older plants are particularly liable to Leaf Spot. The disease also occurs on the stems. Plants are never killed by this disease, and any loss in hay from this trouble is attributable to the shedding of affected leaves.

Downy Mildew, caused by the fungus *Peronospora trifoliorum*, attacks both lucerne and clover. In affected plants the leaves and stems are covered by a thick, greyish or violet-grey, downy layer. It often occurs more profusely on the under than the upper surface of the leaves. Diseased leaves are usually yellowish in colour, and their edges curl downwards and inwards towards the midrib. Such leaves fall quickly. Downy Mildew often is confined to plants in moist situations, whence the disease may spread if the weather remains warm and moist. A spell of bright, dry weather, however, usually checks the development. When localised in patches the disease may be checked by destroying affected plants and fallen leaves by covering with straw and burning.

Control of Rust, Leaf Spot, and Mildew.—

The loss from these diseases is generally only slight, and the usual method for combating them is frequent cutting of the crop to allow of the removal of the affected portions before the causal fungi produce full crops of spores. This should be done before diseased leaves fall, so that the new shoots which develop may escape infection.

Lucerne Leaves showing Rust and Leaf Spot.

INSECT PESTS OF LUCERNE.

Lucerne is attacked by a number of different insects, but the Lucerne Web moth, the Corn Ear worm, and the Lucerne Seed wasp are easily the most important pests. As with most crops grown on a large scale, the treatment of insects attacking lucerne is very difficult It is believed, however, that further experimental work will show dusting the crop with arsenical dusts to be a satisfactory method of control.

Maize and Tomato Moth (*Heliothis obsoleta*).

This moth, which attacks many different crops, is also a pest of lucerne, but is fully described under insect pests of tomatoes (page 701), to which the reader is referred for further information.

In lucerne, however, its eggs are laid singly on the foliage. The caterpillar is responsible for all the damage, and may injure the plant in two ways—(1) by feeding upon the foliage and reducing its value for hay, or

(2) by burrowing in the ovary even before the blossoms fall, thus preventing the seeds from setting. It is this latter aspect of the damage that is perhaps the most serious, as, in those districts where soil and climate are suitable for seed production, heavy or total losses may result.

It is hoped that further experimental work will prove dusting of the crop with arsenical dusts, such as calcium or lead arsenate, an effective and economical method of control.

The Lucerne Web Moth (*Tortrix divulsana*).

The little leaf-rolling caterpillars of this moth are a well-known pest of lucerne fields, and though they are more or less in evidence nearly every season, it is only now and then that they increase in such numbers as to become a very serious pest. As a general rule the pest appears early in September, and does not disappear until the end of February.

The larva is a bright green caterpillar, slightly over half an inch in length, of slender form, and with a hair or bristle on the sides of each segment. Generally several live upon each head of lucerne in a mass of silken threads and curled leaves, finally pupating in loose cocoons among the foliage. The small moth, which measures slightly over half an inch across the outspread wings, is dull yellow in colour, and sometimes mottled with brown on the fore wings.

Apart from the damage caused by the caterpillars feeding upon the foliage, the matting of the leaves together by the caterpillars retards or stops the growth of the plants. It is believed that the use of arsenical dusts will prove a satisfactory method of control.

Cultural methods have proved to be of some value, and growers are especially advised to cut the crops if the caterpillars are noticed to be very abundant. If this is done while the caterpillars are small the development of large numbers of them will be prevented and subsequent broods reduced.

The Lucerne Seed Wasp (*Bruchophagus funebris*).

The Lucerne Seed Wasp (*Bruchophagus funebris*) is a very small black chalcid wasp. The winter is passed in the seeds, either as larvae or pupae, but about blossoming time the adults emerge and begin egg-laying. The female punctures the forming seeds and deposits an egg beneath the skin, under shelter of which the little maggot feeds upon the contents and pupates within the seed coat. When matured it emerges from the pupal covering and gnaws its way out through the side of the seed.

A large percentage of seed is often so damaged in this way as to be useless.

COWPEAS.

Cowpeas require climatic conditions somewhat similar to those for maize, with the exception that greater and more uniform warmth is required. They will not at any period of their growth withstand frost or extremes of cold weather. Given warm weather, with the exception of a few early maturing varieties, they continue to grow and produce seed until checked by dry weather or frost.

Climatic conditions favourable to growth are generally met with on the North and South Coast. The crop will not thrive on the Tablelands or

cooler portions of the State. Cowpeas are not drought-resistant in the western sense of the term, but withstand periods of dry weather well in the coastal districts.

Like most crops, cowpeas do best on good soils, but provided the drainage is good they will thrive on practically all classes of soil. As a general rule, growth on the poorer soils is not so prolific, though better than many other crops, but there is a greater tendency for the plant to produce a heavier crop of seed.

Preparation of Land and Planting.

When the crop is intended to be grown alone, the land may be prepared in a similar manner to that adopted for maize. Provided the seed-bed is fine, moist, and warm no difficulty will be experienced in obtaining a vigorous and healthy stand. Planting should be delayed until all danger of frost has passed, and the soil has warmed up sufficiently so as to insure a rapid germination. Too early planting will result in many of the seeds

Cowpeas in Mr. Macinanti's Citrus Orchard near Gosford.

rotting and moulding, a poor germination, and slow, unsatisfactory growth. The seed may be broadcasted or sown in rows 2½ to 3 feet apart, and the seed spaced from 6 to 9 inches apart in the drills. Depending upon the variety, from ½ to 1 bushel of seed is required to plant an acre when broadcasted. When drilled in rows 3 feet apart the rate of seeding will vary from 4 to 15 lb. per acre, depending on the size of the seed of the variety sown. Drilling is recommended when the seed-bed has had insufficient preparation, is dry, or is known to be heavily infested with weed seeds.

Varieties.

A large number of varieties are in existence, but many have proved to be of little value for New South Wales conditions. The varieties mostly grown are Black, New Era, Poona, and Victor. In districts where root rot and wilt are prevalent, it is recommended that only varieties such as Victor and New Era be grown, as these have proved to be resistant to eelworm.

Black.—This is an old standard variety, having a wide distribution, and is better known than any of the others. It is late maturing, and produces a large bulk of green stuff. The vines have a procumbent to semi-procumbent habit of growth, the pods are large, measuring 8 to 9 inches in length, and contain large black seeds. It is in favour with seed growers on account of the large pods, which are easy to pick, and the fact that they mature fairly evenly greatly facilitates picking. From 14 to 16 lb. of seed is required to plant an acre in drills 3 feet apart.

Poona is a very late maturing variety. It produces a large bulk of green stuff, equalling that of Black, and oft-times exceeding it. At times this variety ripens unevenly, and this in combination with the small seed makes harvesting costly. For seed purposes the best method to adopt is to harvest the vines when they are carrying the maximum amount of mature pods, then cure and thresh the whole plant. The seed shatters very easily. From 4½ to 5 lb. of seed, in rows 3 feet apart, is required to plant an acre.

New Era.—This is one of the best of the newer varieties, and has given good results at most places where tried. Because it is much earlier than Black, is a prolific seed bearer, and is resistant to wilt, it is worthy of extended cultivation. It is medium early, has a semi-procumbent habit of growth, and produces a fair bulk of green stuff. The pods, which are borne well off the ground, are medium large and abundant, and it is rarely difficult to obtain a large quantity of first-class seed. It requires about 12 lb. of seed, in 3 feet rows, to plant an acre.

Victor.—Is prized mainly for its resistance to wilt. It is a medium late maturer, semi-procumbent in habit of growth, and gives a large bulk of green stuff. The principal drawback to Victor is that at times it is a very shy seed bearer and ripens unevenly. The pods are of medium size, borne well off the ground, and resemble slightly those of New Era. From 9 to 10 lb. of seed is sufficient to plant an acre when drilled in rows 3 feet apart.

Cowpeas for Soil Improvement.

Once the first pods commence to show signs of ripening it is advisable to plough the vines under immediately, otherwise the stems become coarse and tough and the crop is much more difficult to deal with. Some difficulty has been experienced in ploughing the crop under, owing to the heavy growth of foliage and twining stems. To facilitate ploughing, and so that the vines may be thoroughly mixed with the soil, it is advisable to chop the vines. This may be done by first flattening the crop with a roller, and following up with a sharp disc harrow, which will thoroughly chop the vines. They can then easily be turned under with a disc plough. Chopping not only greatly assists in turning the crop under effectively, but puts the ground in better condition, decay being much more rapid and the likelihood of a sour mass of decaying vegetable matter obviated.

Apart from the system of growing cowpeas alone as a green manure crop, there is another method that is finding favour and has much to recommend it. Plant cowpeas between the rows of early-sown maize after the last cultivation, which should be carried out about tasselling time. Maize planted early in September will tassel during November, by which time the soil is warm, and provided sufficient moisture is present, no difficulty will be met

in obtaining a good stand of cowpeas. A corn-dropper fitted with a suitable plate can be used to advantage for planting. The cowpeas will make the bulk of their growth after the maize has commenced to ripen off, and therefore will not usually affect the yield of the latter crop. For this purpose it is advisable to choose a quick-growing variety, such as New Era. After removal of the maize the cowpeas and residues may be grazed or ploughed under immediately if it is intended to follow on with an autumn-planted crop.

Cowpeas for Fodder.

A good deal of prominence has been given to the cowpea as a crop eminently suitable for green manuring, and it might be supposed that they are only suited for this purpose, but this is not so, since they can be used for grazing, grown in combination with other crops for green fodder or silage, or made into hay.

The ploughing under of a crop, while undoubtedly beneficial to the soil, is often a wasteful practice. Cowpeas have a high feeding value, so where possible it it more economical to first graze the crop and then plough under the residues. By following this practice ploughing under is simplified, decomposition takes place much more quickly, the full feeding value of the crop is obtained, and from 50 to 75 per cent. of the manurial value is returned to the soil. Pigs have a liking for and thrive on cowpeas, but it takes some time before cows become accustomed to them. If the crop is cut and carted from the land there is a loss of plant food, although the nitrogen content will remain about the same.

One of the best ways to use the crop for fodder purposes is to grow it in combination with maize, sorghum, or millets. Use long, twining varieties, such as Black for this purpose. These will be suported and twine around the maize or sorghum stalks, thereby simplifying harvesting. A mixture such as this provides a good balanced ration, and is suitable for feeding in its green state, or making into silage. Cowpeas alone do not make good silage, as they form into a sour jelly-like mass, and there occurs a large loss of protein, due to the chemical changes that take place in the silo. The usual rate of seeding for rows 3 to 3½ feet apart is 10 to 12 lb. of maize, 4 to 6 lb. of sorghum, or 3 lb. of millet, sown in combination with 8 to 12 lb. of cowpeas per acre.

Cowpeas when grown alone are difficult to harvest unless suitable machinery is available. They also require special care in curing to make a good sample of hay. When properly cured, the hay, although rather coarse, has a high feeding value, and is relished by stock. When the pods have commenced to ripen, but before the leaves begin to drop, is the correct time to cut for hay, for at this stage the plant contains the maximum amount of nutriment. Earlier cutting will mean a loss in weight and nutriment, while, if harvesting is delayed until the pods have ripened, many of the leaves will have dropped off and the stems will be coarse and woody. Cowpeas make good hay, and although the hay is somewhat difficult to cure, it actually stands more rain during curing than many other hay crops. In the southern states of America cowpea hay is grown to a large extent as a substitute for lucerne hay, in a climate of abundant rainfall similar to our North Coast. Where lucerne can be grown successfully it is superior to cowpeas for hay, and much more easily handled and cured.

SOYBEANS.

Soybeans were introduced and tried out, chiefly on the coast, several years ago, but were discarded as having no special merit. Further introductions (from America and elsewhere) were made more recently, however, and the crop was tested in some of the tableland districts with much more encouraging results. It was found also that whereas most varieties of soybeans did not make very good growth on the coast, there were a few late-maturing varieties of recent introduction which gave excellent promise.

The growing of soybeans in New South Wales has so far been restricted to a few experiment farms and a handful of farmers in scattered districts, but the utility of the crop is evident from these tests. The good growth made under a wide range of conditions, the high protein value, the palatability of the forage, and the beneficial effect on soil fertility should result in the rapid extension of the area sown to it once local farmers have given it a proper trial.

Soybeans at Emu Swamp, near Orange.
The crop was grown on a poor white pipeclay soil in a very dry season.

Climate and Soil.

Soybeans cannot be sown in any district until all danger of frost is over, and they should reach their desired development, whether they are being sown for green fodder or for seed, before the occurrence of autumn frosts. Varieties differ greatly in maturing period and growth, and care must be exercised in their selection according to district and time of planting to secure the best results. Soybeans may be classed as a very drought-resistant crop in tableland or coastal districts, but do not withstand the more extreme summer conditions of the western slopes or plains unless on alluvial or deep soils which hold moisture well.

Although the best growth of soybeans will be obtained on the most fertile soils, they thrive under conditions which are unfavourable to many other crops, and on some poor soils, especially if assisted with an application of superphosphate.

Planting.

The best time to sow soybeans is about the time maize should be planted, or better, slightly later. The growth is slow at first, and if sown too early, weeds may grow faster than the crop and the soybeans will be injured in the attempt to smother or otherwise deal with the weeds.

Soybean seed heats very quickly in storage (especially in a warm, moist climate), and also loses its germinating power very quickly if kept for any length of time, especially over one season. When there is any doubt about the vitality of the seed, a test of the germination should be made or the seed should be sown thickly.

Above all, care should be taken to plant the seed only at a shallow depth—not more than 2 or 3 inches. Many disappointments have been caused by deeper sowing.

The rows should be about 2½ or 3 feet apart and the seed 4 to 6 inches apart in the rows, 5 to 12 lb. seed being required per acre, according to the size of seed of the variety. Sowing can be done with a maize-drill with a special plate, or with a wheat-drill by blocking up all but a few of the tubes.

The young plants have no ability to push through a crusted surface soil, and care should be taken to keep the surface loose by light harrowing before the plants come through.

Varieties.

Varieties of soybeans differ greatly in the length of time taken to mature, the nature of the growth, and the size, shape, and colour of the seed. As a rule the later maturing varieties grow more vigorously than the early varieties and usually give the best yields of fodder, though some of the earlier ones are good seed producers. For hogging down dual-purpose varieties are required, that is, varieties that will produce good yields of both fodder and seed.

In the coastal districts Otootan and Biloxi are the only two varieties worth consideration. These are, however, mostly too late in maturing, especially for seed production, on the tablelands, where Virginia and Pekin generally seem to be the best of a number of varieties tried so far.

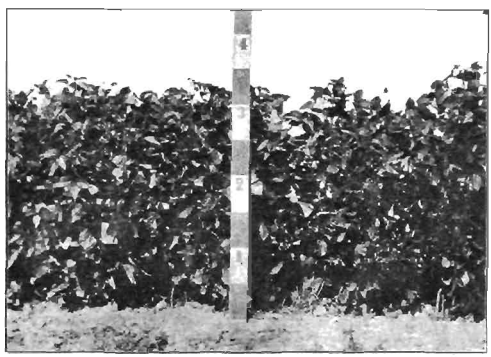
Soybeans for Hay.

The following table, compiled from "Feeds and Feeding" (Henry and Morrison), shows the percentage of digestible nutrients in soybean hay and other hays:—

	Digestible Crude Protein.	Digestible Carbohydrates.	Digestible Fat.	Total Digestible Nutrients.
	per cent.	per cent.	per cent.	per cent.
Soybean hay	11·7	39·2	1·2	53·6
Lucerne hay	10 6	39 0	0·9	51·6
Red clover hay	7·6	39 3	1·8	50 9
Oaten hay	4 5	38·1	1·7	46·4

Yields of 1 to 3 tons of soybean hay per acre, according to the rainfall, soil, and temperature, are stated to be not uncommon in America, and some local experimental crops have been estimated to yield well up to 3 tons of

hay. When it is realised how much superior soybean hay is to oaten hay and how favourably it can compare with lucerne hay from a feeding standpoint, soybeans will doubtless be grown in certain circumstances in suitable districts to replace part of the area under these crops. There is nothing so much required by dairy cattle generally throughout many of our districts as foodstuffs containing a higher percentage of protein.



Biloxi Soybeans at Grafton Experiment Farm.

The highest feeding value and the greatest palatability occur in soybeans just as the pods are forming, but when the pods are full grown nearly double the yield of fodder is obtained. The best time to cut for hay is when the seeds are about half developed. Some varieties have more persistent leaves than others, but in most varieties the leaves are usually shed completely when about half the pods are ripe or a little later.

For seed, the crop should be cut when about three-fourths of the pods are ripe. If left later than this a quantity of the seed may be lost by shattering.

The ordinary mower can be used for harvesting the hay and also for seed, though it is also possible in many cases to use the grain binder for the latter purpose. Threshing can be done with the ordinary grain thresher by making a few adjustments to avoid cracking the seed.

Soybeans as a Supplementary Crop in Maize.

As with cowpeas, a place should also be found for soybeans as a supplementary crop in maize, particularly where the maize crop is utilised at any stage for feeding to stock, or where the field is utilised for grazing after harvest.

Soybeans do not come again after grazing, so they should always be sown early in a maize crop in order to make the best possible growth.

On the North Coast, cowpeas are often sown at the last cultivation of an early sown maize crop for green manuring or for ploughing in when stock have grazed to some extent on the land after harvest, and it is not yet known how far soybeans are likely to replace cowpeas for this purpose. It is certain, however, that only late, good fodder-producing varieties of soybeans like Otootan or Biloxi will be of any use here.

In America, soybeans are largely used in combination with maize for silage, it being claimed that the silage produced by the combination crop has a much higher feeding value than maize silage alone. So far this combination has not been tried in New South Wales, but if the crop grows well in such an association it may come into use in this way. In such case the combination silage, with its higher protein content, should mean a saving on bought concentrates. Some farmers in America plant maize and soybeans in separate fields with better results, and mix the two when filling the silo.

VELVET BEANS.

The velvet bean is practically unknown in New South Wales as a farm crop, yet in the southern States of America it is very largely grown, and in South Africa it is stated to be, "without exception, the most important crop introduced into Rhodesia."

On the North Coast, where the climatic conditions most suit this crop, one cannot but be struck with the extremely copious growth it makes, easily outyielding any of the cowpeas and soybeans, and being especially capable of making good growth on land too poor to grow cowpeas successfully.

This vigorous growth of the velvet bean makes it extremely valuable as a green manure or cover crop; but it is now also beginning to be recognised and valued very highly as a palatable and nutritious fodder, especially for cattle and pigs.

Valuable Winter Pasture.

It is as a winter pasturage that the velvet bean excels. Even with the cold winters experienced in America it is stated that velvet beans will remain in the field all through the winter, weather conditions having such little harmful effect on the vines, leaves and pods. With the shortage of feed during the winter, particularly in the specialised dairying districts on the far North Coast, where paspalum is chiefly relied on, and where little winter fodder is grown, velvet beans seem destined to fill a place as a cheap winter feed for cattle, especially with the appeal they make on account of their ease of handling as a winter grazing crop. Leguminous fodders should be welcomed here on account of the shortage of protein in the usual farm-grown feeds, and the recognised necessity for its purchase in the form of bran, oil meal, &c., and the velvet bean is well worthy of a trial.

The usual practice in the southern States of America is to sow velvet beans in the maize crop. Owing to the immense growth made by the velvet beans, sowing at the same time as maize in the same rows is undesirable owing to the velvet beans pulling down and smothering the maize stalks and rendering the harvesting of the maize difficult or impossible. After fifteen years' experience, the Massachusetts Experiment Station found that the ideal method was to sow two rows of maize 3 feet apart to one of velvet

beans sown six weeks later than the maize. By this means the best of the maize can be pulled with little trouble when mature, leaving the nubbins and the velvet bean fodder for winter grazing.

The amount of grazing afforded depends on the growth of the velvet beans, and on the amount of maize not harvested, but the Massachusetts Experiment Station states that it is the custom to allow one-third or one-half acre per month per cow. A good picking for pigs is also afforded from the trampled vines and beans if they are allowed to follow the cattle.

Velvet Beans for Seed.

Only on the North Coast is it possible to get velvet beans to mature a good crop of beans, and the value of these as a concentrated feed entitles them to some consideration.

Seed may be harvested from the field sown with maize, as mentioned above, before stock are turned in, or a separate small field may be sown specially for seed. A satisfactory method is to sow the beans in the same drill as the maize, planting two grains of maize alternating with two beans

Velvet Beans at Gratton Experiment Farm

with a distance of 12 to 18 inches between each drill. The drills are planted 6 feet apart in the case of the twining varieties. For the bush type it is better to sow in drills 3 feet apart without maize at the rate of two beans every 12 inches or so.

When sown in 6 feet rows the larger seeded varieties take from 25 to 30 lb. of seed per acre. The average yield of seed is from 800 to 1,000 lb. per acre. The weight of unthreshed seed in the pod will be about double this. When fully ripe the seed is enclosed in a very hard pod, and this makes threshing a difficult matter. One of the simplest methods of threshing is to put the pods out in the hot sunshine and they will burst themselves.

For feeding purposes the seed need not be threshed from the pods, the usual method of feeding being to use pods and all, either soaked for twenty-four hours or crushed into velvet bean feed or meal.

Velvet Bean Meal.

It seems possible that for the average farm the soaked pods will be the best form in which to make use of the high feeding value of the seed at the least expense. Considering the fact that large quantities of bran are bought to supply protein at present by North Coast dairymen (particularly in the far North Coast—the big scrub country), the composition of velvet bean meal and the results obtained from its use in America and other countries should be of interest.

The following comparison with wheat bran is given:—

	Ash.	Crude Protein.	Fibre.	Nitrogen-free Extract.	Fat.
Velvet bean meal ..	4·5	29·3	16·5	54·5	4·4
Wheat bran	7·0	17·8	10·7	59·6	4·9

It will be seen that the chemical composition of velvet bean meal resembles that of wheat bran. It is slightly higher in protein, but contains a little more fibre.

As the result of feeding experiments at the Massachusetts Agricultural College, where digestion studies were also made, velvet bean feed was found to contain about 130 lb., or 11.5 per cent. more digestible nutrients per ton than wheat bran, and in two feeding experiments cows receiving a velvet bean ration produced an average of 5 per cent. more milk than on a wheat bran ration.

The yields obtained per acre and the cost of harvesting will determine whether it is more profitable to feed a home-grown concentrate like velvet bean meal (or soaked beans) than to purchase wheat bran.

Value for Soil Improvement.

The value of the velvet bean for soil improvement also must not be overlooked. The increase in the nitrogen and humus content of the soil is reflected in better yields in the various crops. In America an increase of 12 bushels of maize per acre is recorded after velvet beans, while up to 20 bushels increase per acre has been made in Rhodesia after green manuring with velvet beans. Appreciable increases in the yield of the subsequent crops should also follow where velvet beans are utilised for winter grazing. Velvet beans are also suitable for sowing with maize for silage.

Many varieties are at present under trial at the experiment farms. Of the twining type White Seeded Stringless is a variety which is a heavy yielder, and being a late maturer grows well into the winter. Wakulla and Yokohama are much earlier and are also good yielders.

Of the bush type the variety Bush has proved itself a prolific seed yielder, over 1,000 lb. of seed per acre being obtained during a dry season.

Other varieties that are under trial are Osceola, Alabama, Chinese, and Georgia.

THE PEANUT.

The peanut has been grown in Australia for many years, but until *recently the area devoted to its cultivation has been limited to small garden* patches and experimental areas.

Australia's consumption of peanuts in the shelled form amounts to 1,500 tons per annum, and these requirements might be largely increased by suitable propaganda work. Under these circumstances it must be admitted that there offers ample scope for the permanent cultivation of the crop on a large scale.

Peanuts may be utilised for human consumption in a variety of ways. The most popular forms are: Roasted and salted peanuts, as component parts in confectionery, peanut butter, margarine, and oil. A high grade, palatable meal, relished by stock, and containing from 35 to 45 per cent. protein (according to crushing process) is a by-product of the peanut after the extraction of the oil. In America the peanut is grown extensively for "hogging down" or feeding to pigs. The hay, although rather coarse, forms a valuable fodder and is relished by all classes of stock. The yield of hay varies considerably according to variety, soil, and seasonal conditions, but from 10 to 20 cwt. may be taken as a fair average.

The Plant.

The peanut crop is useful in maintaining the fertility of the soil; more particularly does this apply if it is grazed off. The peanut differs from *most other cultivated crops in that it possesses the peculiar and practically* unique habit of forming its seed (nuts) beneath the surface of the soil. Botanically the peanut is not a true nut, but should be regarded as a pod containing edible peas or seeds.

Peanuts will not stand frost, being susceptible at all stages of growth. Abundant sunshine, moderately high and consistent temperatures, and a well distributed but not excessive rainfall, provide conditions favourable to *their growth. Generally speaking, it will be found that the peanut* will thrive in districts suited to the late varieties of maize.

Suitable Districts and Soils.

The crop grows well in the coastal districts, particularly the North and Central Coast.

Peanuts will thrive on a large variety of soils, ranging from light sandy loams to dark medium heavy clays. A fertile, well-drained, light sandy loam, with a good humus content is preferred, particularly if it is desired to *grow nuts for the roasting trade. Heavier soils retard freedom of* "pegging," and tend to produce a large bulk of foliage at the expense of nut development. Nuts from coloured soils are invariably stained, thus detracting from their market value, although the feeding value is in no way impaired.

Planting and Cultivation.

Early ploughing is essential so that moisture may be conserved and a loose, fine, friable seed-bed, free from decaying crop residues, weeds, and large clods obtained. Weed growth is a sure yield reducer and in the *growing crop is expensive to eradicate; thorough soil preparation will* do much to minimise this costly work. Where possible, select a site that is known to be comparatively free from weeds.

For planting, unshelled nuts, nuts broken in half, or shelled nuts (kernels) may be used. To ensure a uniform planting of only well-developed kernels and a quick germination it is advisable to use shelled nuts. The vitality of the kernels often rapidly weakens if they are damaged, and it is therefore advisable to delay shelling until a week or so before planting.

As the peanut is susceptible to frost at all stages of growth, aim at planting and harvesting during the frost-free period. The time of planting is in the neighbourhood of that recommended for maize, but planting should be delayed until the soil has warmed up sufficiently to induce a vigorous germination. Nothing will be gained by planting early in a cold soil. In most districts October and November plantings will give best results, although on the North Coast plantings may be made, with early-maturing varieties, until January. Usually late plantings do not yield so well as early plantings.

The ordinary maize-dropper is unsuited for planting peanuts, due to damage done to the kernels. Peanut planters and special attachments for the maize-dropper are on the market, and these operate very satisfactorily. Machine planting for a number of reasons is preferable to hand planting. For hand planting the simplest method to adopt is to draw shallow furrows with the plough at the desired distance apart, drop the seed along the furrow, and cover with a single horse cultivator with the back tine removed and a notched board fastened across the back so as to leave a slight ridge.

The quantity of seed required to plant an acre will depend on the variety and partly upon the class of soil. For early-maturing varieties grown on light sandy soils heavy seeding is required, while runner types grown on the heavier types of soil require ample space to develop.

PLANTING Distances and Amount of Seed Required per Acre.

Variety.	Distance between Rows.	Distance between Plants.	Amount of Seed per Acre.	
			Unshelled.	Shelled.
	Inches.	Inches.	lb.	lb.
White Spanish	30 to 36	6 to 8	40 to 45	30 to 35
White China	36 to 42	12 to 18	40 to 50	20 to 25
Valencia	36	9 to 12	30 to 40	20 to 25

The necessity for cultivating the growing crop cannot be too strongly stressed. It should commence immediately the young seedlings make their appearance, and be continued until the vines have completely covered the intervening spaces between the rows. A loose, friable surface is essential so that the flower pegs may gain entrance to the soil with the least possible effort. Provided the land is free from rubbish and large clods, the first few cultivations may be carried out to advantage with a light set of lever harrows, always running across and not the same way as the rows are running. For later cultivation use a single-horse implement, and aim at gradually working the loose soil towards the plants. Weed growth is one of the greatest factors in reducing yield, therefore commence cultivation early and continue at frequent intervals.

Varieties.

Peanut varieties may be divided into two groups, namely, runners and bush types. The runner type rarely exceeds 9 inches in height, and under favourable conditions may spread to a distance of 5 feet. In most cases they are late maturing and good yielders of both nuts and forage. The bush types grow from 12 to 30 inches high, with a spread of about the same distance. They are easier to harvest and thrash, and, as a general rule, yield better on the heavier types of soil or under unfavourable conditions than the runner types.

There are two distinct market requirements for peanuts, namely, for the roasting and the confectionery trade. Peanuts required for the roasting trade must conform to the White China type, and be of uniform size with clean white shells. To produce this class of nut they must be grown on light sandy soils. For the confectionery trade peanuts with a high shelling percentage and containing kernels of uniform size, and a high oil content are required. Peanuts of the White Spanish type conform to these requirements. There are a large number of varieties, many of which closely resemble each other, while others are of little commercial value.

White Spanish.—There are a number of strains of this variety showing a fair amount of variation, and they have been classed as large, medium, and small. White Spanish is a high-yielding, early-maturing variety which readily adapts itself to a large range of conditions. It has a bushy habit of growth, and the nuts are borne closely clustered around the tap-root. The nuts are small and generally contain two light pinkish to brownish-coloured kernels, which are tightly packed in the shells. It is eminently suited for the confectionery and peanut oil trade.

White China is generally of the running habit of growth and is best suited to sandy soils. It is a late maturer, the nuts are large and contain two long, large, pale-coloured kernels. When grown on light-coloured soils, the nuts are clean, bright, and attractive, and are eagerly sought after for roasting purposes.

Valencia.—This is a vigorous mid-season variety, having a bushy habit of growth, and the nuts are borne closely clustered around the tap-root. The pods are of medium diameter and long, and contain three or four small kernels, bright red in colour, which are closely crowded together. Valencia peanuts are reputed to be of excellent flavour and are greatly in demand by confectioners. They are also used for roasting purposes.

Harvesting Peanuts.

No hard and fast rule can be laid down as to the exact time to harvest the crop. The growers must aim to harvest when the vines are carrying the maximum number of mature pods. That the crop is reaching maturity is, in some cases, indicated by a yellowing of the foliage and the lower leaves dropping off. Pull up a few plants, allow to wilt in the sun, and if, upon examination, the kernels are found to be firm and unshrivelled, this may be taken as a good indication that the crop is fit to harvest. Care must be taken not to harvest too early, for this will result in light, undersize, shrivelled kernels, while on the other hand, if harvesting is delayed, there is danger that the nuts will sprout and break away from the vines.

Harvest on bright warm days, after the dew has dried from the plants, and when the soil is moderately dry, so that any adhering dirt may be easily shaken from the roots. The vines can be harvested by hand-pulling, ploughing out with a mouldboard plough or with a potato digger. Hand-pulling is only advised on loose, sandy soils. If turned out with the plough, shake the dirt off the roots and place three or four rows together to form a windrow. Allow to remain in the windrow for about a day, to wilt, and stack around poles to complete the curing process. From twenty to twenty-five poles, about 7 feet long and 2 to 3 inches in diameter are required to stack an acre. If it is not desired to stack, the crop may be partly cured in the field for a few days by turning the roots uppermost to the sun or placing in small cocks. When the vines have dried out sufficiently they may be carted to an airy barn to complete the process. This method is only likely to succeed provided birds are not troublesome and weather conditions are favourable while the crop is in the field.

Do not commence thrashing before curing is complete. The nuts are fit to pick when the pods are dry and the kernels firm.

FIELD PEAS.

These crops deserve more extensive cultivation than they have received in the past. As a fodder for sheep, pigs, and other stock they have been found excellent. For several reasons, however, they are more frequently grown with wheat, oats, or barley, forming a very palatable and well-balanced fodder.

The most suitable soils are loams and clay loams of an open nature. Sandy soils give but poor results, partly on account of their general lack of plant-food, and partly because of their tendency to dry out rapidly and become warm during a spell of hot, dry weather. On such soils it is advisable to use farmyard manure whenever obtainable, and many stockyards where manure has accumulated for years could be sweetened and very profitably used by growing peas in combination with oats or barley for green feed.

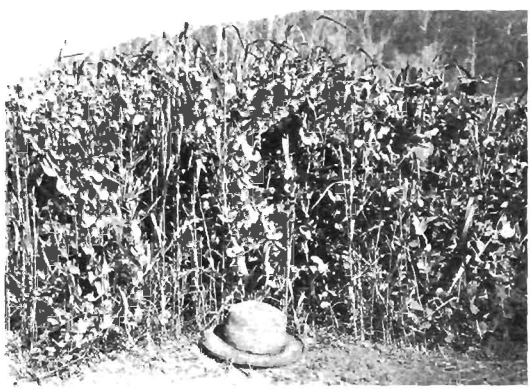
In most of the river districts of the North Coast large areas of field peas are grown each year for feeding milch cows. Besides producing a rich milk-producing food, the refuse is ploughed under in the spring, and the soil considerably enriched for the summer crop of maize.

A method of sowing field peas that has come into some prominence on the North Coast, where maize-growing, in conjunction with dairying, is practised, is to sow the peas between the rows of late maize just prior to the last cultivation. Very little growth is made until the maize ripens, when the falling leaves allow free ingress of light and air, and cause a quick growth of succulent forage. When the maize is pulled the dairy cattle are turned in, and an immediate increase in milk yield is the result. In addition, this system prevents the growth of weeds, and, most important of all, helps to maintain the fertility of the soil by reason of the power peculiar to this group of plants of enriching the soil with nitrogen.

Field peas may be sown from February to May. If a succession of sowings be made every fortnight or so the crop can be utilised much more economically, as there is less waste.

For fodder purposes peas may either be grown in rows or broadcasted. In the former case the rows are drilled 2 feet to 3 feet apart, and the seed sown at the rate of 15 to 30 lb. per acre, the exact quantity depending on the size of the seed and the luxuriance of the variety. When broadcasted, the seed is sown from 1 to 1½ bushels per acre. In a good season this produces a thick stand of succulent and nourishing fodder. Until nearing the flowering stage the vines grow fairly upright, and are easy to harvest. At a later stage this operation is more difficult, but the full feed value of the crop is obtained.

When grown for pigs the vines are allowed to bear pods, and when in the dough stage are eaten off. The pigs will harvest the pods and eat at the same time a good quantity of the greenstuff. If the vines are dead ripe trouble is often experienced from the pigs eating the hard grain, and consequently suffering from digestive troubles.



Grey Field Peas and Huguenot Wheat, showing how the Peas are supported by the Wheat.

Field pea hay is of excellent quality, but very difficult to make. This is especially so when the vines are allowed to reach that stage when they contain their full nutritive value.

A question of importance in broadcasting is to bury the seed sufficiently deep, which in normal soils will be 2 to 3 inches. Harrowing it in on freshly-ploughed ground will often act satisfactorily, as the seed mostly falls between the crowns of the furrows. Seed should not, on any account, be sown on smooth land with the intention of only harrowing it in. If the land needs a second and a shallow ploughing, the seed can be broadcasted in front of the plough.

Drilling is recommended where possible instead of broadcasting, as 1 bushel of seed per acre will be sufficient, with ½ to 1 cwt. superphosphate. The seed can be buried at a more uniform depth, and less seed is necessary than with broadcasting. As the seed is expensive this is worthy of consideration. Farmers are advised to grow their own seed.

Peas will stand a great deal of dry weather, but, on the other hand, will suffer from too much rain. If the soil does not go out of condition during the growing period they will yield heavy crops on a medium rainfall, and leave the land in fine working condition.

Caution should be observed in feeding a succulent growth of field peas to cattle, particularly if hungry, owing to the liability of "bloat" or hoven.

Field-peas are specially valuable in districts where trefoil and clover are scarce in the natural pastures, and in their adaptability for mixing with cereals.

Field Peas Combined with Cereals.

In addition to the combination with maize already mentioned, field-peas can be grown with any of the winter cereals. The mixture of peas and oats is a well-recognised and valuable combination where these crops will grow, although the yield from wheat and peas has given decidedly better results on the North Coast.

As a green manure, peas can best be mixed with either barley or rye. Especially on poor sandy soil, the rye combination gives a mass of green-stuff which is of great value in improving the texture of the soil. The peas should be carefully drilled, or broadcasted on rough land, so that they will be covered to a fair depth. The cereal can be broadcasted and harrowed in afterwards, or the two crops may be sown together. The difference in the size of the grain, and the different depths at which they should be sown, make it somewhat inconvenient to mix the seed.

From one and a half bushels of the cereal, and one half to one bushel of peas per acre are usually sown. It may often be found advisable to alter the proportions, and this can be settled only by trial.

Varieties.

The varieties which have been most successfully grown are the Grey field pea and the Blue field pea.

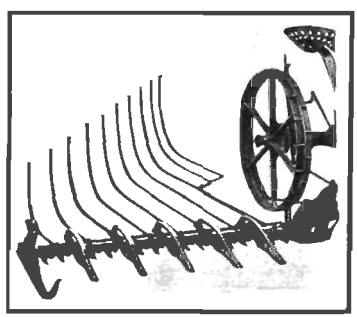
The Grey field pea invariably gives the heaviest yield of greenstuff. It is later than the others, and is a very hardy and vigorous grower. In comparative trials at Hawkesbury College the yields were as follows:—

Grey Field Pea	9 tons 15 cwt. per acre.
Blue Field Pea	4 tons 14 cwt. per acre.

The Blue pea is largely grown in Tasmania and other cooler parts for the production of seed. For fodder purposes it is hardly to be recommended, as the yield is not great, and the variety is not very hardy.

Harvesting for Seed.

A *special pea-harvesting attachment* for the mower, which will lift the vines from the ground in front of the mower blade, can be obtained from most implement firms. A windrowing attachment is also desirable to prevent trampling by the horses and the consequent loss of seed. The crop should be mown when about half the peas are ripe. A flail or a pitchfork should be used for beating out the seed, and a tarpaulin spread underneath. In dry weather the vines are soon fit for threshing, and it is best to do the work in the field; carting to a shed causes loss of a quantity of seed. The peas may be cleaned by passing them through a winnower, or, if the quantity is small, by pouring into a bag from a large dish, using the wind to winnow. When growing quantities of seed for sale the peas should be carted from the windrows to a thresher, the drum of which should be set rather open, as the peas readily crack.



A Type of Pea-harvesting Attachment for the Mower.

VETCHES AND TARES.

The vetches for the most part are slender climbing plants, producing numerous tendrils at the ends of the leaves. Their habit of growth is recumbent, and to facilitate harvesting they require to be grown with a cereal crop. To most farmers the terms vetches and tares are synonymous, and are used indiscriminately to include all varieties of this crop. Correctly speaking, there is a botanical difference between the tare (*Vicia sativa*) and the vetch (*Vicia villosa*). The difference, however, does not seem to be taken into account by the seed merchants, and is therefore of little practical importance.

Vetches may either be used as a fodder, or as a winter green manure. If for the former they are usually mixed with wheat, oats, barley or rye, and give a heavier yield and a better balanced ration. Such varieties of wheat

as Gresley are to be strongly recommended. Vetches seem to do better with wheat than with oats, of which Sunrise is the most popular variety. If used as a green manure, vetches may be sown alone or in a mixture.

The crop is probably grown more extensively along the Macleay River than on any other coastal river. In that district it is used as a dual-purpose crop, the greater bulk of the growth being used as a "soiling" fodder and the residue being turned under for green manure. It is this procedure that to a large extent keeps up the fertility of the land. Maize is the chief crop grown, and to crop continually without a change, as vetches, soon has a marked effect in decreasing its yields. Vetches are more highly valued by mixed farmers as a fodder crop than any other legume, excluding lucerne, and they are easily grown.

Black Vetches and Huguenot Wheat.

Along the Manning River the vetch is chiefly used mixed with oats, wheat, or barley as cow fodder. Used in this manner it is preferable to field peas, which are not always relished by cows. It has often been noticed that where vetches have been included with a cereal the latter invariably has a richer colour than when sown alone, thus showing the value of the vetch as a soil renovator early in its growth.

This crop can be grown in most parts of the State where there is a fair rainfall during the winter. In the moist coastal districts it grows very luxuriantly in the cool weather, and produces a valuable fodder during winter and early spring.

The soil best suited to vetches is a loam or clay loam. Sandy soils are not generally suitable, although vetches will do better than peas on such soils, and, given a good season, they do moderately well on the poor sandy soil at Hawkesbury Agricultural College.

Seeding may commence about February, and continue till May. When sown with a cereal, about 15-20 lb. of vetches and 40 to 60 lb. of wheat, oats, barley, or rye, will usually give a good stand. The seed can be mixed and sown broadcast or with a wheat drill. If sown alone in drills with a maize-dropper and sorghum plate, a smaller quantity of seed (8 lb.) will be required. Besides this, the crop can be cultivated for a limited period before it spreads across the rows. The seed is difficult to harvest and consequently high in price, averaging about 24s. per bushel of 60 lb. For this reason the use of smaller quantities of seed may be found to be more economical

The value of maize stalks as a winter fodder can often be enhanced by sowing the seed of vetches between the rows of late maize after it has received its last cultivation. This should be done some time during or after February. Seedings before this month can be made more satisfactorily with cowpeas.

Hairy Vetches (*Vicia villosa*).

The difficulty attending the harvesting of this crop prevents it from being of much value as hay, although the quality of the fodder thus preserved is said to be very good. When mixed with cereals the growth is more upright, and correspondingly easy to harvest. The pods, when dry, shell very easily.

This crop makes demands on the soil similar to other legumes. It enriches the soil considerably in nitrogen, hence its value as a green manure. Under such circumstances it is advisable to encourage as much growth as possible, and manures can often be more effectively used by applying them to the green manure crop rather than to the main crop.

Golden tare is the most popular variety grown, and the one most commonly quoted by the seedsmen. The *Hairy* vetch is a more vigorous grower and a much later variety. Two recently introduced varieties—Purple vetch and Woolly Podded vetch—are very promising, and are giving greater yields than either Golden tare or Hairy vetch.

CLOVERS.

Clovers are leguminous plants belonging to the genus *Trifolium* (three leaves). They are distinguished from other legumes by the flowers being clustered in a head and by the seed pods being scarcely longer than the calyx of the flower. Again, the seed pods do not open, and often fall off the plant when the enclosed seed is quite ripe.

Clovers are very common throughout the world, and although there are over 200 species, comparatively few are found growing in any abundance. For example, as far as this State is concerned, the following are the only species found growing spontaneously in pastures in any quantity:—White clover (*Trifolium repens*), Hop clover (*T. minus* and *T. procumbens*), Hare's Foot clover (*T. arvense*), Ball clover (*T. glomeratum*), and Woolly clover (*T. tomentosum*).

These legumes have long been recognised as some of the most useful plants to grow as (1) an adjunct to pastures, (2) a rotation or green manure crop, and (3) a hay crop.

As an adjunct to pastures clovers are of inestimable value in this State. In the coastal districts White clover has increased the productiveness of couch, paspalum, and other grass pastures to a very great extent. The manner in which it will grow on the poorest of soils is particularly noteworthy, while on the rich volcanic soils of the northern rivers it provides the necessary supplementary constituent to complete a ration. In the interior, particularly in the south-west and Riverina, Ball and Woolly clovers are very abundant, often dominating the situation. Their capacity to fatten lambs in the spring is well known.

The value of clovers and other legumes as rotation crops has not been thoroughly realised. For example, many of the best wheat-farmers in the south-west and Riverina adopt the method of alternate fallow and wheat for two or three years, and then throw the land out of cultivation for a couple of years, allowing it to run to pasture. The resultant pasture includes a very large proportion of legumes, such as *Medicago denticulata*, *M. minima*, and Ball clover (*Trifolium glomeratum*). The increased yields in the succeeding crop of wheat, after feeding-off and ploughing in the humus, laden with nitrogen, is very marked. The result could, however, be obtained much more quickly if the seed of such legumes as Ball clover and Burr trefoil were sown, and the area top-dressed with $\frac{1}{2}$ to $\frac{3}{4}$ cwt. superphosphate per acre.

Clover, particularly the Red and Berseem varieties, makes excellent hay, rich in protein and very palatable to stock. It has been ascertained that 1 ton of well-cured clover hay is worth, for feeding purposes, nearly half as much as a ton of bran. Clover hay, fed with cereal or grass hay, provides an ideally-balanced ration, particularly suitable for young stock and dairy cattle. Care, however, has to be exercised in curing the hay, as over exposure to the hot sun produces extreme brittleness in the leaves.

The Soil.

Clover requires fairly good soil. Those of a clayey nature, such as stiff clays and loams, give good crops; light loams also prove satisfactory. Rich alluvial flats are eminently suitable, and usually give splendid crops. Sandy soils are unsatisfactory, and good crops are rarely obtained from them. An abundance of potash and phosphoric acid encourages its growth, as does also

lime. This last is essential as a plant-food, but its chief value to the clover crop appears to be that it increases the amount of soluble potash in the soil. It is noticeable that where lime is applied to clay soils clover appears spontaneously in the pasture. It rarely so appears in sandy soils, except perhaps to a limited extent.

Seed and Manure.

The land must be worked down to a fine, level, firm condition. Deep ploughing should be given, and the harrow and, if necessary, the roller used until the right degree of fineness is reached. The seed should only be lightly covered.

Fairly liberal manuring is required on poor soils. Superphosphate gives excellent results and should be applied with the seed at the rate of 1-2 cwt. per acre.

Utilising the Crop.

Clover can be fed either as a green feed, hay, or pasturage. For green feed or hay it should be cut when about one-third of the bloom is showing. The hay is a little difficult to cure, but if the methods recommended for lucerne are followed, good hay will be obtained. Clover hay is equal to lucerne hay, and, like it, improves the feeding value of green maize or silage. Care should be taken in feeding green clover, as it is liable to cause bloating. Stock should be accustomed to it gradually, and given some other feed in addition.

Types of Clover.

There are three distinct kinds of clover, viz., annual, biennial, and perennial, and there are several varieties of each.

Annual Varieties.

All the clovers of the interior, including Ball clover (*Trifolium glomeratum*), Woolly clover (*T. tomentosum*), and Hare's Foot clover (*T. arvense*), are of an annual nature, and, in addition, most of the medicago family generally termed clovers, such as Burr clover (*Medicago denticulata*), Spotted Trefoil (*Medicago maculata*), Woolly Burr clover (*M. minima*), and Button clover (*M. orbicularis*). These valuable nutritious fodder plants occur spontaneously in pastures, and provide a considerable amount of feed in the spring months.

In addition to these varieties which are grown inland there are many annual clovers which could be grown on the coast, or in the cooler parts of the State. The most important are:—

Egyptian or Berseem Clover (*Trifolium alexandrinum*).

This is a clover best utilised for green feed or as hay, which is highly palatable and nutritious. It has proved its capacity to do well in the coastal districts and under irrigation in the interior. To obtain the best results it requires to be sown early—in March, at the rate of 10 to 12 lb. of seed per acre. In a good season it is possible to obtain as many as three good cuts. It is a valuable rotation to employ between two summer fodder or grain crops.

Crimson or Scarlet Clover (*Trifolium incarnatum*).

This clover is well adapted for green manuring purposes on the coast and tablelands, though many failures are reported owing to faulty germination of the seed, which must be fresh in order that a good stand may be obtained. It also suffers severely in a dry spell. Owing to its slow growth under very cold conditions early sowing is essential, as otherwise the winter weeds, especially herbage, will quickly smother it. The principal use of this clover is as a rotation crop; being somewhat hairy, it is not eaten readily by stock.

Crimson Clover (*Trifolium incarnatum*).

Sweet (Bokhara) Clover (*Melilotus alba*).

Subterranean Clover (*Trifolium subterraneum*).

Probably the most successfully grown annual clover under irrigation, or in districts with a fair winter rainfall, Subterranean has proved an excellent clover to have in winter pastures at Yanco, and is giving excellent results in coastal and tableland pastures, and also in parts of the Slopes and Riverina. Owing to the manner in which the runners set a proportion of their numerous seeds under the soil, it re-seeds itself even under heavy stocking, and maintains practically a permanent character.

Biennial Clovers.

There is only one biennial clover of any importance, and it is not really a clover, although the term Bokhara or Sweet clover is now permanently fixed. Its scientific name is *Melilotus alba*. On the Northern Tableland it is giving good results in situations where Perennial Red clover will not thrive. This is particularly the case in the Tenterfield district.

It can be sown in early autumn or early spring at the rate of 10 to 12 lb. of seed per acre. The seed should be sown on a well-rolled seed-bed, and lightly harrowed in. The growth should be pastured or cut before it becomes too woody. By allowing the crop to seed in the second year a permanent pasture is practically guaranteed.

Perennial Clovers.

The perennial varieties seem to do best in the cooler districts of the State—on the coast and tablelands—in fact temperate conditions are essential to their growth.

White or Dutch Clover (*Trifolium repens*).

This well-known clover occurs spontaneously in coastal and tableland pastures, and it should be combined with most grass mixtures at the rate of 2 lb. seed per acre. It appears to be the only clover which will grow successfully with paspalum, and it should always be added to the latter, as by this means a balanced ration is obtained.

An undoubtedly improved strain of White clover is Ladino clover. This variety has a much wider leaf and produces fully three times the growth of the ordinary strain.

Alsike Clover (*Trifolum hybridum*).

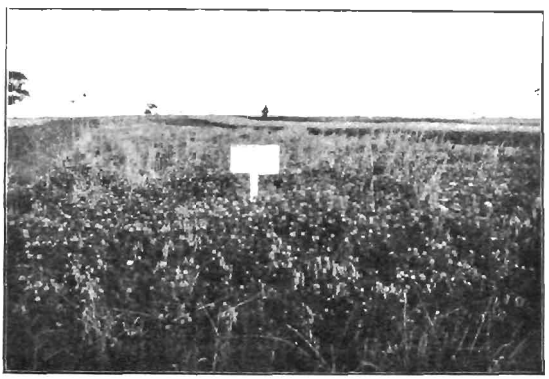
Particularly suited to the Monaro and New England districts, this is a good clover to have in pastures on good soils in cold districts generally. It will also thrive in soils which remain fairly damp during the colder months of the year.

Strawberry Clover (*Trifolium fragiferum*).

This plant does particularly well under conditions which are too wet for any of the other clovers. On country that carries a lot of surface moisture during the spring, Strawberry clover will thrive and produce a large quantity of feed. To establish the clover use 1-2 lb of seed per acre, scattering a few seeds in damp spots where it is likely to spread rapidly.

PERENNIAL RED CLOVER (*Trifolium pratense* var. *perenne*).

This is one of the most useful clovers for planting in the coastal or tableland districts. It provides good pasturage for all classes of stock. Many stock-owners were under the impression that this clover did not set seed, but latterly, however, it hardly ever fails to set seed, and for this reason is steadily improving its popularity. For coastal and elevated tableland pastures it should be included in mixtures with pasture grasses sown on cultivated land. If the clover is sown alone, use 10 lb. seed per acre.



Perennial Red Clover after Oats at Glen Innes.

MEDICS, TREFOILS, AND CROWFOOTS.

To the grazier and pastoralist in this State the most important representative of the *Medicago* family of plants is the well-known *Medicago sativa*, or lucerne. *Medicago lupulina* (English trefoil), is the only other member of the family cultivated to any extent. Many others, however, are important owing to their value in pasture land and to their possibilities under cultivation, and several of the more important are discussed below.

The medics are legumes with leaves like clover, but characterised by having pods curved or spirally twisted. Certain species have their pods provided with spines and are called burr medics or trefoils, while the pods of other species, *e.g.*, *M. orbicularis*, are not provided with spines.

Burr Medics or Trefoils.

The burr medics or trefoils are very heavy seeders, and owing to the manner in which the burrs are carried about by sheep are now distributed throughout the length and breadth of the State. Again, as the burrs contain up to eight seeds in a pod, the plants form a dense mass of vegetation under conditions satisfactory for the germination of the seed. The

tough pod acts as a protection to the enclosed seed and supplies the necessary moisture during the germination period. Although sheep have now become accustomed to the burr trefoils in the wheat-growing districts, exceptional cases of "bloat" have been known to occur. Bloat is most likely when the plants are wet, and when the stock are hungry. Pastoralists who are desirous of introducing the burr trefoils in their pastures sometimes encounter difficulty in getting the seed to germinate satisfactorily. Such faulty germination is due to the hard nature of many of the seed-coats. Most of these seeds will, however, eventually germinate, though the time taken to do so will vary.

BURR TREFOIL OR BURR MEDIC (*Medicago denticulata*).

This plant is most commonly called trefoil or Burr clover, but sometimes Burr Medic and Toothed Burr clover. It is one of the commonest and most abundant plants growing in New South Wales, and often succeeds in dominating the whole of the vegetation in the wheat-growing districts during the cool months of the year. On river flats and on the black-soil plains this trefoil has almost entirely displaced the original native pastures. Such country is often termed "trefoil country." The growth of such trefoil in the warm months of the year is so abundant that the ordinary number of sheep carried on the farm cannot keep it eaten down. If all this surplus feed were properly utilised as hay, it would assist in serving the grazier's needs as a standby for dry times. The trefoil, however, has a short life. Under ordinary conditions it commences growth in the autumn, and seeds about September or October. After this, burrs are left in great abundance on the ground, sometimes as many as 1,500 per square yard, and these burrs provide the main source of feed during the summer months on ground often absolutely destitute of vegetation.

SPOTTED TREFOIL (*Medicago maculata*).

This is an annual trefoil or medic, not nearly as abundant as *M. denticulata*, being mainly confined to the pastures of coastal and colder districts of the State. It can be used as a hay crop to a certain extent, but plants should be cut as soon as the blooms are abundant, as the plants fall down if left too long.

The Spineless Medics.

The advantage which the spineless trefoils possess over the burr trefoils is obvious, and as they possess all the good qualities of the latter, they deserve every possible encouragement. The more important species are briefly mentioned:

ENGLISH TREFOIL (*Medicago lupulina*).

This variety is also commonly called Black Medic. It is found growing spontaneously in pastures and fallowed lands throughout the cooler portions of the State. In New England it is perhaps more common than elsewhere, and provides a fair amount of winter feed. It is well adapted to heavy, rich soils in cold districts, and provides good bottom herbage where other clovers are not too good.

BUTTON CLOVER (*Medicago orbicularis*).

This species is most abundant in the north and north-western portions of the State, but does not appear to thrive in the very cold localities. It is badly affected by dry conditions.

The Crowfoots (*Erodium* spp.).

There are three species of crowfoot commonly found in this State, namely, *Erodium cygnorum*, *E. moschatum*, and *E. cicutarium*.

The crowfoots are very abundant on the lighter soils throughout the wheat-growing districts.

Native crowfoot (*E. cygnorum*) is confined mostly to the warmer parts of the State, such as the north-west and far west. West of Parkes right through to Condobolin it can be found in great abundance. On the black soils of the north-west it will grow to a height of 4 feet in a good season. It is a very rapid grower, its period extending from late autumn to early spring. The mature growth is seriously affected by heavy rains; owing to the succulent nature of its growth it falls prostrate, its leaves fall off, and only a mass of dry stalks remains. All classes of stock do exceedingly well on the green growth. So luxuriant is its growth in a good season that thousands of tons go to waste. It makes good silage if mixed with coarser plants, such as grasses or cereals.

Musky crowfoot (*Erodium moschatum*) is very abundant in the cooler parts of the State. It is generally associated with *E. cicutarium*, but owing to its more vigorous habit of growth, is generally more abundant than that plant. In the very cold districts, where the mean winter temperatures range between 35 degrees Fah. and 62 degrees Fah., it partakes of a rosette habit of growth.

Erodium cicutarium is thought very highly of in this State. Although it does not produce the body of feed that Native crowfoot does, its growing period is longer and it is capable of being closely grazed. When it takes possession the plants are invariably prostrate. This crowfoot is also credited with being a first-class bee plant.

SECTION VIII.

Miscellaneous Crops.

TOBACCO.

A LIGHT, friable, sandy loam is the most suitable for the production of a good quality tobacco that will give the desired aroma, texture, and colour. The plant is, however, easily affected by climate and by the chemical and mechanical conditions of the soil. Bright-coloured tobacco is usually produced on light-coloured soils, and dark leaf on dark soils.

The presence of clay has a great influence on the product, and it will be found that a proportion of eight to ten parts of sand to one of clay is most likely to produce bright or yellow tobacco. Large proportions of clay will produce a tobacco which cures out a dark colour.

It is desirable that the subsoil should underlie the soil at a depth of about 12 to 18 inches, and that it should contain a larger proportion of clay than the soil above. It is found that where the subsoil is too near the surface the tobacco is inclined to cure out a darker colour. On the other hand, it must not lie too deep, for the sandy nature of the surface soil may allow moisture to get beyond reach of the plants, which may thus suffer from insufficiency of moisture should a dry spell occur during the growing season. Thus the subsoil should lie neither too near the surface nor too deep, and within 18 inches of the surface is most satisfactory.

In new localities the suitability of the local and climatic influences should be determined by experiments before tobacco-growing on a large scale is attempted. The land should be well drained, and the soil as free as possible from weeds.

Preparation of the Ground.

The land should receive a thorough ploughing early in the winter, and as soon as weeds appear thereafter, or a crust is formed on the surface, the springtooth cultivator should be used. The operation will not only kill the weeds, but will conserve moisture and sweeten the subsoil. Shortly before the season for transplanting, a second ploughing should be given to a depth of 9 inches, and the soil harrowed to produce a fine tilth, so that the rootlets of the tobacco plants may be hampered as little as possible in their search for nourishment.

As tobacco should arrive at maturity in two to two and a half months after transplanting, the grower requires to give careful attention to the preparation of his ground. With anything like unfavourable soil conditions the rapid and healthy development of the plants is bound to be interfered with, and it should be the concern of the farmer to do all that is within his power to prevent such a state of affairs.

Preparation of the Seed-beds.

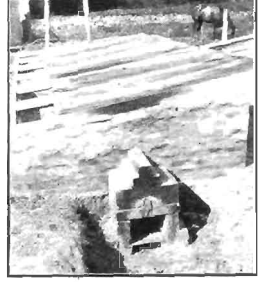
One hundred square feet of bed is sufficient for an acre, but the bed will require to be pulled over a period of a few weeks, and the grower should not miss an opportunity of getting out as many plants as possible at one time when the weather conditions are favourable. Then, too, the danger from loss of plants by destruction by insects and other causes must not be overlooked. The grower will find that, on the average, the provision of 50 per cent. extra seed-bed accommodation will amply repay him.

The site chosen for the seed-beds should be in a position sheltered from prevailing winds, and the soil should be a well-drained, rich, sandy loam. First mark off beds 4 feet wide, then pile a quantity of timber and brushwood on the surface, and start a fire on the leeward side, the intention being to raise sufficient heat to kill insect eggs and seeds of any weeds that may be present. Rubbish of any size should be raked off, but the fine ashes should be left, as these will act as a fertiliser when worked into the bed. Then the surface should be broken to a depth of 5 or 6 inches, and worked up to as fine a tilth as possible.

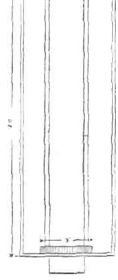
If it is desired to obtain plants quickly, lightly cover the whole bed (so that it may be plainly seen) with high-grade superphosphate before sowing; about 3 or 4 lb. will be required for each 100 square feet of seed-bed. Take a rake and *lightly* draw it over the bed once. Plants cannot be obtained quickly, however, if the ground is not warm and the weather spring-like.

Suitable Types of Frame.

The bed should be enclosed with a framework of wood, which can be roofed over with cloth. If squared timber is not available, straight logs about 6 to 9 inches in diameter will answer the purpose.



A Hot-air Heated Frame.



Plan of Hot-air Heated Frame.

This type of frame has been used with success at Bathurst Experiment Farm for several years.

Successful control of the Blue Mould disease in the seed-bed has been obtained by the use of artificially-heated frames, which also allow the amount of water supplied to be regulated. Such a frame (see accompanying illustration) should be made of brick, concrete, or pisé, and a useful size is 20 feet long, 6 feet wide with the walls 3 feet high at the back and 2 feet at the front. It is covered with sliding sashes of glass or oiled calico. A fire-grate is provided at one end, and two 4-inch pipes are carried from the grate through the frame. Sand is placed in the bottom for drainage, and 6 to 8 inches of good soil on the sand for the seed-bed.

Sowing the Seed.

The last week in August is early enough to start sowing the seed, and this should be continued at regular intervals of a week or ten days up to the first week in November, so that the grower may be assured of a sufficiency of plants whenever the weather is favourable for their removal to the field, after danger from frosts is past.

One level teaspoon of seed is sufficient for a bed 4 feet wide and 25 feet long, and should yield enough plants for one acre. To ensure even distribution, the seed should not be sown without addition to its bulk. A simple method is to use two buckets, one of which should be about one-third filled with fine ashes. Place a thin layer of ashes in the empty bucket, and sprinkle as evenly as possible a pinch of seed over it; add another layer of ashes, and mix well. Repeat the process until the quantity of seed it is desired to sow is used up, together with the ashes, and then mix again with the hands.

The early morning will probably be found the best time to sow the seed, *before the wind becomes troublesome. It is inadvisable to sow with a strong* wind prevailing, if it can possibly be avoided, as the seed is so light that it will be blown away. The mixture of ashes and seed should be distributed over the bed as evenly as possible; the colour will be found a guide as to evenness. The seed should not be raked in, but after sowing the bed should be gently firmed all over with a piece of flat board. Then lightly water the bed several times with a can that has a fine rose. Do not put on so much at one time that it will run in a small stream, but moisten the bed thoroughly.

If the soil is inclined to pack after sowing, scatter over the bed very lightly some fine, well-rotted horse manure. If it is anticipated that the soil is likely to pack in this way, the manure should be incorporated in the bed before sowing.

Raising the Plants.

The temperature in a heated frame should not be allowed to fall below 45 deg. Fah., *and only sufficient water given to maintain vigorous, hardy* growth. The water should have the chill taken off it before it is applied. To secure the best results the plants must be given all the sunlight possible by removing the sashes during the day, care being taken to replace them at night, or during cold winds or rain. By increasing the amount of direct sunlight given, the plants can be hardened-off for transplanting.

Where permanent frames are not in use it is necessary to cover the beds for protection against cold, the sun, and insects. A simple plan is as follows:—At the centre of each end of a bed drive one small post, leaving it about 12 inches above the ground level, and strain a length of No. 10 wire from one to the other; place a few small posts along the bed to take up any sag. Attach to the wire white hessian or cheese-cloth. This may be stitched

to the wire tightly with binder twine or string with the aid of a packing needle. The covering should be stretched tight and fastened to the sides by hooking over nails. The beds should be covered every evening and not uncovered until sunrise.

Keep the beds moist, but not wet, until the plants are well established. It is important that the beds should never be allowed to become dry on the surface while the seed is germinating. After the plants have reached some size it is better to water thoroughly occasionally—not too often, but *thoroughly* when it is done. This will reduce the danger from mould. No fixed rule can be given for watering, but do not water beds which are uncovered while the sun is at all strong.

Plants which come up too quickly in the seed-beds are apt to be weedy and spindly specimens, and should be thinned out so that each occupies an area of about a square inch. If plants are not coming on as fast as it is wished after they are up, a sugar bag may be filled with horse-manure, the neck tied, and the bag soaked in a cask of 40 gallons of water for a day. The liquid can then be freely used twice a week on the beds with a can that has a fine rose.

In about one month the beds will be ready to be uncovered, and the seedlings to be hardened off before transplanting. This should be done gradually. For the first few days, if the weather is very hot, cover up in the middle of the day until the plants can stand the direct heat of the sun.

If there is danger of the seedlings being attacked by "Stem Grubs" or "Tobacco Leaf Miners" they should be sprayed with arsenate of lead, as indicated on page 609. If the presence of cutworms is suspected, baits (see page 702) should be laid for two evenings before sowing.

Transplanting.

When the plants are from 6 to 8 inches in height and well hardened off, they are ready for setting out. The best plants are those which are most vigorous looking, and with short, broad leaves. Plants which are stunted and yellow, and which have long pointed leaves, should not be used. If the beds are dry and hard they should receive a good soaking some little time before the plants are drawn, so that as little damage as possible is done to the root system. The earth adhering to the plants should not be interfered with more than can be helped.

The best way to remove the plants is with a three-pronged fork. If the tap-root is long, it should be trimmed off with a pair of scissors to about 2 inches. The less handling the plants have the better, and after they have been drawn they should be placed, root downwards, in a cool place, and kept covered with wet bags. Only the plants that can be set out on the same day should be drawn at the one time.

It may here be stated that where the aim of the grower is to produce a fine-textured leaf, the plants should be set out close together, and although past experience must be taken as a guide, it will generally be found that a spacing of 20 to 24 inches in the rows 3 feet apart on light sandy loam will not induce heavy growth and coarse texture. This distance of 3 feet between the rows will allow of horse cultivation, and thus lessen labour.

The ideal weather for planting out is just before and during rain, so that the roots of the plants may have very little check, and growth may be established as soon as possible. Unfortunately, however, weather conditions do

not always suit the planter, and possibly owing to the lateness of the season he is forced to set out during dry weather. In this case holes should be made and filled with water, and the plants carefully put in and the earth well packed round the roots. Care should be taken that the roots are not doubled up, and that the hole is properly filled with earth. A simple test of planting is to pull the tips of the two top leaves gently in an upward direction, and if they break off in the fingers the plants are right. Another method where irrigation is not carried out, is to make a hole close to the plant and fill with water, and then cover up to prevent evaporation. If the weather continues hot after transplanting, the plants should be shaded with grass. Paper folded in the shape of a tent and held down by two clods of earth is also very effective. It may be necessary to water, and, if so, it is best done early in the morning or about an hour before sundown. Plants which have struck well, usually start growing in about ten days, and the covering may be removed.

If irrigation is carried out, a good plan is to turn two shallow furrows together with a light plough, and run the water so that the ridge gets a good soaking some little time before transplanting. The plants should then be set out on the shady side of the ridge, care being taken that the stem and leaves are high enough above the water to avoid being submerged. As soon as possible after transplanting it is advisable to run water through again to set the earth well around the bottom of the roots. After five or six days the crust around the young plants should be lightly stirred and broken.

Cultivation.

Tobacco quickly responds to cultivation, and the grower should aim at keeping his land in fine tilth, and free from all weeds up to the time the plants are ripening. During dry weather, by creating a dust mulch, excessive evaporation of moisture is avoided. The root system of the tobacco plant is largely near the surface, and for that reason shallow cultivation must be practised. As soon as a crust is formed, or the ground becomes hard, get to work with the horse cultivator and hoe, and when the plants are high enough, arrange the tines of the cultivator so that the earth is gradually drawn from between the rows towards the crown of the plants. Pronounced ridging will induce the drying-out of the soil, and should be avoided. Generally the crop should receive a thorough cultivation every week or ten days after the plants have started growing until such time as the horse cultivator cannot be used without damaging the leaves of the plants owing to their size.

Where irrigation is practised, cultivation must be carried out as soon as the ground begins to harden or crust. It is useless to water alone if good results are expected.

The bottom leaves, generally numbering from four to six, almost invariably become damaged and dirty, and should be removed. The sap will then be taken up by the leaves well off the ground.

Topping.

When the flower head or inflorescence has started to develop, the top length of stalk must be broken off. Plants which are strong and vigorous are topped high, and those which do not present these features are topped low. Experience and judgment are necessary to determine the number of leaves that

should be left on a plant, but for a normal season fourteen to twenty would seem to be about the number that should be left to mature. Where the entire plant is to be harvested, the planter should aim at obtaining as even ripening as possible to enable him to secure a good uniform cure and quality of product.

Suckering.

Soon after the plants have been topped, and sometimes before, suckers will appear at the junction of the leaves and at the bottom of the stalk. As soon as they are about 2 inches long, or large enough to be conveniently grasped, these must be removed. Care must be exercised that in breaking them off the remaining leaves are not torn or damaged. It will be found that early in the morning is the best time to carry out this work, as during the afternoon of a hot day they are tough and leathery. The operation of suckering will most probably have to be repeated each week. Particular attention should be paid to this work, because if suckers are allowed to go far, the quality of the tobacco will be seriously impaired.

Harvesting.

Some three to five weeks after topping, maturity will be reached, and there will be various indications that the time for harvesting has arrived. The varieties which have been distributed by the Department, if planted under suitable conditions, should show lighter shades of green, a golden sheen when looked at in certain lights, and in some cases a yellowish blotchy discolouration, or yellow spots on reaching maturity. When the leaf is folded between the fingers, too, it will crack across.

Plants should not be cut or handled while the dew is still on the leaves, or after rain, until the gummy feeling has returned to the leaf.

There are several methods of harvesting.

The "Priming" Method.

It will be observed that all the leaves on the plant do not ripen at the same time, but in all cases they start to mature from the bottom upwards. To secure the best results, and obtain an even cure, each leaf should be taken off separately as it reaches maturity.

The leaves are then placed in baskets or other suitable receptacles and taken straight to the barn to be strung in the shade, care being taken that after "priming" they are kept out of the sun as much as possible. The leaves are then made up into "hands" containing four in each. A 4-feet stick will take about twenty "hands," ten on each side. In each "hand" of four leaves two should face one way and two the other, the middle two having their backs together. When the tobacco is to be flue-cured, the "hands" should not be jammed up close together, but there should be a space of a few inches between each on either side of the stick. Where air-curing is practised, the leaves should be placed *close* together until they have assumed a yellow colour, after which they should be opened out as above.

The method of stringing it is somewhat difficult to describe. The stem-butts of each "hand" are strung with a twist of the string, to hold them together. The string, which is about twice as long as the stick, is held fast permanently at one end by being pressed into a slit in the wood, and when the required amount of tobacco has been strung, the loose end of string is run through another split at the other end, and made secure. The grower quickly finds out how it is done, after a trial or two.

Hanging may also be carried out by threading each leaf with a needle and twine through the midrib, but the process is a tedious one. Yet another method is to put fixed wires through the curing stick 7 inches apart and so that they project 5 inches on each side. The leaves can be hung on the wires by piercing through the stem-butts. Leaf so strung is very liable to damage by tearing when the stick is being handled, and it is not possible to bulk down without removing the leaves from the wires.

Harvesting the Whole Plant.

When the whole plant is to be harvested, a fine discrimination must be shown in order that the largest proportion of leaves shall be at the right stage to ensure a satisfactory cure afterwards. As stated above, the whole of the plant does not ripen at the same time, and where the whole plant is to be harvested and cured it must be cut when the middle leaves have matured. The plant should be split down the middle to within a few inches of the bottom, and then chopped off and placed astride the curing stick. The stick must be carried so that the leaves will be clear of the ground, as otherwise dirt may adhere to the leaves and depreciate their appearance and value.

The Method Recommended.

A combination of the two harvesting methods—the "priming" method and the whole plant—is recommended to growers as productive of satisfactory results without the labour involved by "priming" throughout. When the bottom leaves of the plants have come to maturity they should be primed off and strung, and the upper leaves left until they are ready, when they should be taken off with the stalk attached and strung, as in the case of harvesting the whole plant.

Curing Tobacco.

With very few exceptions, the methods of curing adopted in this State are not such as ensure the best results from the leaf as grown. It should be understood that mere cutting, scaffolding, and hanging in an open shed can never be expected to give good uniform results. Leaf so treated is just dried out. This State is subjected to rapid changes of climatic conditions, and tobacco which is left solely to the wiles of the weather invariably suffers.

What is termed "sun and air drying" has in the past been the method usually adopted, but it has rarely produced the bright or yellow tobacco now sought for by the manufacturers. Local buyers state that Australian tobacco so dried has an aroma which is peculiar, and not agreeable. Tobacco which has a pleasant aroma is usually agreeable to the palate, and it is this the grower has to cater for. All these remarks must be taken to refer to the curing of the bright and yellow tobacco, which it should be the aim of every grower to obtain.

Air-curing.

As tobacco is so easily affected by climatic conditions and rapid changes of temperature, it is necessary, if the leaf is to be air-cured, that the grower should have at his command a building which can be closed up or opened, as becomes necessary, and the ventilation of which can be perfectly

controlled. In continuous wet weather the grower must be able to allow a current of air through his barn; and if dry hot weather prevails, it must be possible to close the building up completely to prevent too rapid drying of the leaf, or to open the ventilators during the nights. If the leaf is showing signs of fungus, or "pole burn," and the weather is wet, charcoal or corncob fires should be placed in the barn, and the ventilators opened until the excess of moisture has departed.

Where curing is done in an open shed, the tobacco should be cut late in the afternoon, and hung on sticks close together. When it has wilted it will be possible to pack much closer. A scaffold should be erected close to the shed, the sticks of tobacco placed close together, and allowed to remain so until the leaf has assumed a yellow colour. When this change of colour has taken place, each stalk should be separated by a space of about 6 inches, and the stick taken to the barn. Growers should note that in the barn the sticks must have sufficient space to allow a free current of air to pass through the tobacco; it is a great mistake to let the leaf be crowded together in the shed. Tobacco which shows every promise on the scaffold of securing a good colour is often spoilt by neglect of this precaution, and the result is a dark and dingy coloured leaf.

See that when on the scaffold the leaf does not get burned by the sun. If it is not possible to place the scaffold in such a position that it will be shaded during the middle of the day, a covering of cheese-cloth should be passed over all the leaf to break the rays of the sun, so that it may go into the barn a yellow colour instead of a dark-brown. Tobacco on the scaffold should *never* be allowed to get wet, and a good cure cannot be expected if this happens.

Flue Curing.

To flue-cure leaf successfully, the grower must have considerable experience. Few barns of tobacco can be cured alike, and almost every one requires different treatment. In a very short space of time a barn full of leaf may be totally spoiled through neglect, lack of knowledge, or a little bad judgment.

To cure in this manner special buildings are necessary; they must be draught-proof, and so finished that heat and moisture cannot escape; and they must be erected of materials which will permit the interior to be affected by outside temperature to only a minimum degree. Iron structures, unless having double walls, are totally unsuitable, while brick is expensive. The building should be erected of wood or pisé. The inside dimensions of a building suitable to cure the crop of 6 or 7 acres would be 16 feet by 16 feet, and 17 feet high, with a spacing of 3 feet 6 inches vertically between the tiers on which the sticks of tobacco are hung when harvested on the stalk, and 2 feet when the leaves have been "primed." Two furnaces should be provided at one end of the building, and from it flue-piping of heavy Russian iron should run round inside, with the outlets between the two furnaces. Ventilators are necessary at both the top and bottom of the building, and may be provided by two rabbit-hutch types on each of the four sides at the bottom, and four ventilators at the top. Plans will be forwarded to any grower desiring to erect such a building on his application to the Department of Agriculture.

There are three stages in curing. They may be stated as follows:—(1) Yellowing, (2) fixing, (3) killing. No fixed formula can be given, but if the following is taken as a basis the grower will, after curing a few barns, be able to modify or vary the process in some respects to give him the desired results.

As soon as the barn is full, close the building right up, start the fire going, and bring the temperature up to 90 degrees Fah. Keep it at this point for eighteen to thirty-six hours, according to the condition of the leaf, limiting the time to the shorter period in the case of leaf that is quite ripe, and allowing the full period where the leaf is not so well matured. If the leaf is not yellowing as it should, place sacks on the floor and soak them with water to produce a moist heat; or, better still, if a boiler is handy introduce steam. When the leaves have assumed a nice yellowish colour raise the temperature to 100 degrees, at the rate of 5 degrees each two hours, and keep at this figure for some six hours. Then raise the temperature to 105 degrees and give a little ventilation top and bottom, opening the ventilators a few inches. In these directions it is presumed that the curing-room is one that has been erected in accordance with proper plans, such as would be supplied by the Department of Agriculture, as stated above. In such a building both temperature and ventilation could be controlled so as to produce the results desired.

Having obtained the temperature of 105 degrees with the limited ventilation mentioned, the conditions should be maintained for three or four hours. Then increase the temperature to 110 degrees, and also increase the ventilation to about one-half of the capacity of the ventilators, and hold at that for three hours. Do not raise the temperature above 110 degrees until the tips of the leaves have dried, however. Next, again raise the temperature to 115 degrees for six hours, giving *full* ventilation, and then again advance to 120 degrees for six hours with full ventilation. The most critical time is between 110 degrees and 120 degrees. If the heat is too fast the leaf will splotch or blister, and if too slow it will sponge. When the sweat can be observed on the leaf, and it will not go off at once, the temperature must be increased rapidly by 10 degrees, and all available ventilation given; but if ventilation is given as directed there is little fear of sponging.

After remaining at 120 degrees for six hours, leave the ventilation at full, and increase the temperature by 5 degrees every two hours to 135 degrees; beyond this do not further increase the temperature until the blade of the leaf has dried out completely. Then exhaust all moisture by raising the temperature every hour by 5 degrees to 180 degrees, and gradually decrease the ventilation until only a very little is left at the top. Keep at the latter temperature until the stems and stalks have completely dried out. Ventilation plays a *most important part* in successful flue-curing during the stage from 105 to 140 degrees, and growers should pay particular attention to this matter. The whole process will take five or six days.

Extinguish the fire as soon as the tobacco is cured, and open the doors and ventilators to cool it off for twenty-four hours. If the weather be very dry, the moisture content of the barn may be increased with the aid of steam, or by means of water thrown on sacks on the barn floor. When the tobacco is in a condition to handle without the leaves breaking, it should be taken down on the sticks and bulked until the grower is ready to grade and bale for market as opportunity occurs.

Stripping.

There are those who quite fail to realise the extent to which the quality may be influenced in the processes of stripping and bulking, and who are consequently disappointed at the eventual refusal of buyers to take the leaf at all or at the very low price offered.

As soon as the stem and stalk of the tobacco have dried, and the atmospheric conditions will permit, the leaves should be stripped from the stalks and made into "hands." *Each hand* should consist of twelve leaves, and should be made by binding the stem-butts with a leaf tightly and neatly passed twice around them, and by opening the hand in the centre and pulling the end of the binder through.

When stripping from the stalks, opportunity should be taken to sort the leaves into three classes, No. 1 containing only leaves that are of good bright or yellow colour, and undamaged: No. 2 containing the leaves that are reddish-brown and undamaged; and No. 3 containing dark leaves—those that are damaged and would not fall within either of the other two classes.

While not necessary with flue-cured tobacco, the hands of leaf that has been air-dried should be re-hung on the sticks, and given as much sun as possible for a few weeks on a scaffold close to the shed. Care should be taken not to put out more stocks at one time than can be removed to cover at the approach of rain. After each lot of sticks has been "sunned," the hands should be hung in the shed for a further period of about two months, after which they should be bulked down, each in its own class, for some six weeks at the beginning of the warm weather.

Bulking Down.

For bulking the hands, the leaf should not be moist, but in such condition that the tips can be squeezed together without breaking, and that a slight shaking will release one from the other. Opportunity should also be taken of straightening out the hands to improve their appearance before putting into bulk. Leaves with "fat stems" (stems not dried out) should not on any account be included in the bulk, or mould will very quickly appear.

"Bulks" are made by placing two rows of hands, overlapping by about one-third of their length, with the butts outward. The height should not be less than 4 feet. The length will be determined by the amount of leaf to be treated. The larger the bulk, the less it will be affected by outside climatic influences.

Growers are advised to cover each bulk as it is completed with blankets or tarpaulins, and to place weights on top, the object being to conserve the heat and moisture, and to avoid the drying out of the leaf. The prime cause of mould is the bulk becoming moistened and chilled, and every precaution should be taken against this. The bulk should be placed on boards well off the ground, so that air may circulate freely underneath.

Each bulk should be carefully examined every day, and if one is found to be too warm it should be broken down, and after each hand has been well shaken and lightly aired, should be rebuilt, those hands which were formerly in the centre being placed on the outside, the outside layers in the centre, and the lower layers on the top.

Leaf that has been through the bulking process satisfactorily shows an absence of gumminess, and also the presence of crystals, which, though minute, can be seen when the leaf is held up to the light.

Fungous Diseases of Tobacco.

Blue Mould.

This disease makes its appearance particularly in seasons when the rainfall is excessive. It is caused by a fungus, *Peronospora* sp. As in the case of most fungous diseases, a particular relationship must exist between the weather, the plant attacked, and the fungus before the latter can establish itself and spread with rapidity. Blue Mould especially attacks young plants in the seed-bed; and if it makes its appearance when the particular relationship above referred to exists, it spreads so rapidly that the whole seed-bed may be damaged in the course of a few days.

Fig. 1.—A young Tobacco plant infected with Blue Mould.
Note the shrivelling leaves.

Fig. 2.—The underside of a young leaf infected with Blue Mould.
Showing the production of spores. [Magnified.]

The fungus makes its appearance on the under surface of the leaves, which appear to be covered with fluff of a faint violet tinge. This fluff consists of fungous threads which come out from the leaf and branch freely, each branch bearing at its extremity a small oval spore; these spores are produced in millions. Another kind of spore (known as an oospore) is produced within the tissues of the host plant. It can remain dormant much longer than the other form of spore, hence old diseased plants should be burnt. The fungous threads travel in the tissues of the young leaf, absorbing nourishment and causing it to wither rapidly and die. Attacked plants early lose their bright green colour, and a practised eye can quickly detect the change.

Control Measures.—Methods of control must aim at preventing conditions favourable to the development of the disease. They may be summarised as follows:—

1. Prepare a number of seed-beds, suitably manured, so that the young plants may quickly become established.
2. Sow these beds at intervals of two to three weeks.
3. Do not over-water the young plants; excessive moisture favours the disease.

4. Conserve heat, as a temperature below 45 degrees Fah. favours the disease. Experiments conducted by the Department during the last few years indicate that if the temperature of the seedlings is not allowed to fall below 45 degrees Fah., and the surrounding atmosphere is not allowed to become humid, Blue Mould does not make its appearance.

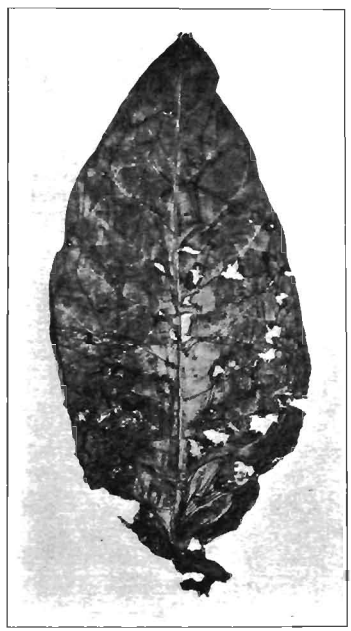


Fig. 3.—Adult leaf showing holes in places previously attacked by Blue Mould.

5. Allow the young plants plenty of air and sunlight.
6. Transplant at the earliest opportunity.
7. If the disease makes its appearance in any one of the beds, pull up and burn the infected plants immediately, and spray the remainder with Bordeaux mixture (2–2–50).

Black Root Rot.

This disease is caused by the action of a parasitic fungus—*Thielavia basicola*—which attacks the root system and the stem below the surface of the soil. In affected plants the root system is darker than normal, and is usually black in parts. In plants slightly affected the fibrous roots are more or less rotted away, but in severe cases the roots may be more distinctly rotted, with the result that only a blackened residue of the root is left. The result is that the plant is deprived of its usual supply of food and water and becomes stunted. This is most noticeable during the heat of the day, when affected plants may wilt. The leaves usually have a yellowish appearance, and the plants tend to bud prematurely.

A characteristic feature of this disease is the uneven type of growth throughout the crop. Often an extremely stunted plant is found adjacent to one of normal height; this is more marked than any similar effect caused by unfavourable soil or weather conditions. The development of the disease is determined largely by temperature—cool weather is particularly favourable for the disease.

Tobacco Crop at Tumut affected with Root Rot.
Note the very uneven stand which is a characteristic of the disease.

The disease is also found in the seed-beds, where rotting of the roots may occur. Affected plants show little vigour, and frequently wilt and die.

The fungus which causes Black Root Rot in tobacco also attacks several other different plants, *e.g.*, beans, peas, red clover, lucerne, cotton, watermelon, &c. Most of these plants are not affected as severely as tobacco, but their presence on the land enables the fungus to persist for a number of years on the dead organic matter in the soil.

It is apparent that Black Root Rot has been present in the tobacco soils of this State for many years, but it is rather unlikely that losses from this disease will be of frequent occurrence, since little or no damage occurs when temperatures are normal.

Control Measures:—

1. Seed-beds should be made of soil which has not grown tobacco or other susceptible crops for many years. As an alternative, the soil may be sterilised before use. It is particularly desirable that seed-beds be free from infection, since the disease is most disastrous during the cool weather, which is most likely to occur early in the season.

2. Only strong, healthy plants with a clean root system should be planted out.

3. Land which has carried diseased crops may be freed from the fungus by starving it out. To accomplish this the land should remain idle for from four to eight years, or some crop not susceptible to the disease may be grown for a similar period. Some such crops are maize, small grains, and those vegetables which are resistant to the disease.

The most promising method of control is the use of strains of tobacco resistant to Black Root Rot. Attempts are now being made to develop resistant strains in New South Wales.

Insect Pests of Tobacco.

Although a number of insect pests have been recorded attacking tobacco plants, the amount of damage generally caused is comparatively small. The most serious damage more often occurs in the seed-bed, where but comparatively few insects may destroy a whole bed of young plants and necessitate re-sowing.

Cutworms are perhaps the most serious offenders in this respect, but looper caterpillars or the small weevil known as the Brown Vegetable weevil may also cause damage. Occasional invasions of the seed-beds by the Corn Ear worm also occur, and considerable damage may result. In the field cutworms may also cause damage, but the most common pest is the Tobacco Stem grub, which may also attack the plants in the seed-bed. Thrips have also been recorded damaging tobacco in the field.

The practice of covering the tobacco seed-beds with straw is to be deprecated, as it affords excellent harbour for the various species of insect pests.

Cutworms (*Noctuidae*).

The caterpillars known as "cutworms" attack the plants both in the seed-bed and in the field. One "cutworm" in a seed-bed when the plants are small may cause so much damage that even re-sowing may become necessary. In the field the damage is caused by the cutworms cutting off the plant stems near the soil level soon after transplanting.

Poison baits, as recommended for cutworms under "Insect Pests of Tomatoes" (page 702), will control the cutworms in the seed-bed or in the field.

The Tobacco Thrip (*Anaphothrips striatus*).
[Much enlarged.]

In the seed-beds the poisoned bran bait should be scattered lightly, as the beds are frequently watered, and where excessive quantities of the bait are used the Paris green from it may be washed down on to the delicate roots and kill the young plants.

Brown Vegetable Weevil (*Listroderes obliquus*).

This weevil sometimes attacks young plants in the tobacco seed-beds; it is fully dealt with as an insect pest of tomatoes on page 697.

Thrips (*Anaphothrips striatus*).

Thrips may sometimes cause considerable damage to the leaves of tobacco plants. The leaves attacked become mottled, discoloured, and covered with excrement deposited by the insects. Where the insects are present in great numbers upon maturing leaves, a considerable reduction in the weight of the foliage may occur.

These minute insects, which develop very rapidly, deposit their eggs on the under-surface of the leaves, usually along the midrib. The immature thrips are white, or tinged with green or yellow, and have reddish eyes. The adults are of a yellowish colour, with darker bands across the abdominal segments. Their eyes are black or almost so; the wings are well developed and fringed with fine black hairs.

Control Measures.—For their control a spray of home-made tobacco wash, made by steeping 12 lb. of waste tobacco stalks in 30 gallons of water, or of nicotine sulphate, 1 part to 800 of water, should be used. As it is necessary to wet the thrips to kill them, the spraying is most successful when properly applied and carried out before they become winged and capable of flight.

The Tobacco Stem Borer (*Phthorimaea operculella*).

The tobacco stem borer is better known as the Potato Moth, under which heading it is fully described on page 517. It is also a pest of tobacco, the eggs being laid on the shoots and stems of the tobacco plant. On hatching, the young caterpillars tunnel their way into the stems and bases of the leaf stalks, where they feed and undergo their development. When fully fed they enter their pupal or resting stage within small cavities in the stems, and later emerge as adult moths.

Control Measures.—Spraying or dusting the plants, either in the seed-bed or the field, with arsenate of lead will control the pest. The spray should be made by mixing 1 lb. of arsenate of lead powder with 40 gallons of water, or the dust by mixing 1 lb. of arsenate of lead with 9 lb. of hydrated lime.

Clean cultivation is also a factor in the control of the pest. All rejected and waste tobacco plants and the remains of potato or tomato plants, after these crops have been harvested, should be cleaned up and burnt, so that any moths emerging from the drying tobacco stalks have little suitable food upon which to lay their eggs. If allowed to remain the material provides excellent breeding grounds for the pest.

BROOM MILLET.

Chiefly because these districts developed the industry first, and are able to supply the usual requirements of the trade, the growing of broom millet on a commercial scale is limited to portions of the Hunter, Manning, and Richmond rivers, and the Tamworth and Tumut districts.

Although there is much suitable land in districts of the State with favourable climatic conditions, little increase in area has taken place outside the districts mentioned. In part this may be accounted for by the fact that some experience is necessary for the successful handling of the crop, and a little extra equipment is necessary to handle it; furthermore, the demand is limited, as little export of either fibre or manufactured article can take place. Much depends on local and individual cost of production; this, considered in relation to crop value, will indicate whether the district or farmer can produce broom millet profitably, and can only be determined by individual trial by the grower. For these reasons the crop is mostly grown in those districts where the conditions are favourable for the production of good crops, and where labour conditions, particularly at harvesting, are satisfactory.

The following table shows the area devoted to broom millet, and the yield and value of the fibre produced, in this State, for the past six years:—

Year.	Area.	Yield.		Value.	
		Total.	Average per acre.	Total.	Average per cwt.
	Acres.	cwt.	cwt.	£	£ s. d.
1922–23	2,463	14,875	6·0	37,190	2 11 4
1923–24	3,746	19,076	5·1	33,380	1 15 0
1924–25	1,301	8,363	6·4	13,070	1 11 3
1925–26	1,662	8,616	5·2	23,480	2 14 6
1926–27	3,046	14,881	4·9	39,430	2 13 0
1927–28	4,047	19,343	4·8	44,490	2 6 0

Climatic and Soil Conditions.

The bulk of our broom millet crop is grown on alluvial soils in the districts mentioned. A warm climate and good soils are essential. Districts with too great a rainfall, especially in the autumn, are not favourable, and for this reason the lower parts of the upper North Coast rivers are not very suitable. Low-lying land subject to poor drainage should not be used, as there is too great difficulty in keeping the young crop free from weeds and grass, and encouraging a quick thrifty growth of the young plants.

On the Western Slopes the rainfall is a limiting factor in the production of broom millet. Unless irrigation can be practised, only districts with an annual rainfall of at least about 25 inches are recommended, and the lower the rainfall the more fertile and of greater moisture-holding capacity must be the soil. Even in the Tamworth district, with an annual rainfall of 28 inches, some dry seasons occur in which the crop is almost a total failure. Here it is possible that in normal seasons the rich volcanic upland soils will produce good broom millet, as well as the alluvial soils on the river flats.

Broom millet belongs to the sorghum family, but differs greatly from the sorghums in this respect—that while the sorghums may be grown profitably for fodder on poor soils, a good fertile soil is essential for producing a good yield and quality of broom millet. The crop can be grown on soils less fertile than are required for the production of maize for grain, but the quality and yield decline appreciably as the soil becomes poorer. Broom millet will grow good crops on rich soil on less rainfall than maize, but as just indicated a limit is quickly reached beyond which the crop is considerably affected.

Preparation of the Soil.

The factors of importance in preparing the soil for broom millet are conserving the winter rainfall in the soil, destroying weeds, and getting a good firm seed-bed for quick germination of the seed.

Early and deep ploughing is the first consideration—the earlier the better—for receiving and storing as much winter rainfall as possible. The earlier the ploughing or the moister the soil the deeper the ploughing can be (consistent with practicability), for then the soil more easily settles down before planting time. If the land is ploughed before or during the winter, it should be left open in the rough state till early spring.

In early spring the land should be reploughed only if it has become too consolidated or weedy, and should be cultivated or harrowed a few times before planting in order to create a mulch which will conserve the moisture already in the soil. These cultivations also have the effect of consolidating the seed-bed, and of encouraging weed seeds to germinate, to be killed by the subsequent cultivation or harrowing.

In the case of broom millet a firm and clean seed-bed is particularly desirable to secure good germination and to obtain unimpeded growth of the young plants.

Planting.

Like all sorghums, broom millet requires warm weather for its growth, and usually starts off slowly when sown in the spring. For this reason emphasis is laid on killing several crops of weeds if possible before planting, and also on not sowing until the soil is sufficiently warmed up to induce quick germination and growth.

A Crop of Italian Broom Millet.

No set time can be given for sowing. This must depend on the seasonal conditions, though after the weather has warmed up in September the best results are usually obtained by sowing in that month or early in October. Sowing may be continued, particularly on the coast, up till December or January, though very little broom millet is usually sown after October or November.

Sowing is made on the flat, or in shallow furrows made with a small plough or with a broad tine on a single horse cultivator. The last method is necessary where the land is infested with "nut grass," the subsequent cultivation gradually filling in the furrows and smothering the weed growth.

The rows are usually 3 to 3½ feet apart, and the plants should be from 4 to 8 inches apart in the rows, depending on the fertility of the soil, the closer planting being made on the richer soils. This planting distance is rather

important, as it affects the quality of the brush to a large extent. If too much space is allowed, the plants grow very vigorously, and produce brush which is coarse and not of the best market value. On the other hand, if the plants are too crowded, very poor, unsuitable branching fibre is produced. In the case of too thick a stand thinning is resorted to, but to save this tedious and expensive operation, good, clean, well-graded seed should be sown on even well-prepared land to get about the required stand. Sowing is best done with a maize drill fitted with a sorghum plate, and shallow planting should be the rule. About 2 to 4 lb. of seed per acre are required.

There is practically only one variety of long brush millet grown—White Italian.

A section of a crop tabled.

Note the difficulty that would otherwise attach to harvesting the heads of the standing crop.

Experiments with fertilisers have shown that the yield is not increased very greatly on alluvial soils, but superphosphate applied in the drill at planting at the rate of about 1 cwt. per acre has the effect of stimulating the young growth and giving the plants a quick start. This is especially desirable with early sowing, when broom millet otherwise makes slow growth, and on weedy land, where quick development of the crop has the effect of preventing the young plants from being overrun by weeds, thus saving much hand cultivation at this stage.

On land which has been under cultivation for some time, and which is becoming difficult to work on account of the loss of organic matter, a green manuring crop such as cowpeas, field peas, or vetches, either ploughed in or fed off by stock some few months before planting broom millet, has been found to be highly beneficial. Superphosphate, applied to this green manure crop or to lucerne previous to being ploughed out for broom millet, has been found to be decidedly advantageous to the broom millet crop, greatly increased yields having been obtained as the result of this practice.

After-cultivation.

If heavy rain falls shortly after sowing, the germination will be affected, owing to the formation of a heavy crust on the surface, and the field may require replanting, especially if the seed has been sown in furrows. If sown on the flat, light harrows can be run over the land to break the crust. It done in furrows, this harrowing might cover the seed too deeply. Harrowing has the effect of warming the ground and inducing faster growth. It should be done during the warmth of the day when the plants are supple. The crop may be harrowed till it is 6 or 8 inches high.

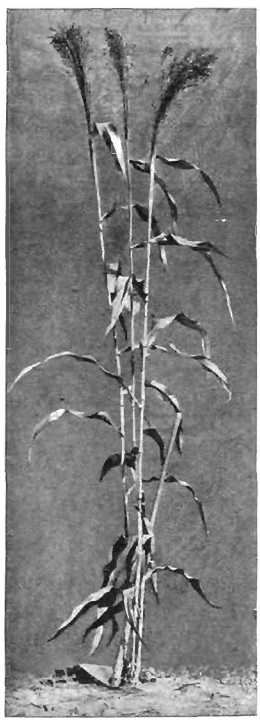
Brush cut and laid all one way on tables to field cure.

The first cultivation is best given with a narrow tine cultivator, working as close to the rows as possible to get rid of the young weeds. It is usually found necessary to go twice up the rows with this first cultivation, and it requires to be done carefully to avoid injury to the young plants. The cultivation should be continued until the crop is about half grown, and should be shallower with each succeeding cultivation to avoid damage to the roots. A double-row cultivator should be used for the later cultivation on larger areas. The amount of cultivation necessary is determined largely by the rainfall, and the growth of weeds. Keeping down the weeds is the most important object of cultivation.

Harvesting.

The correct time to harvest the crop is a matter concerning which there s no great agreement, even among experienced growers, but it is certain hat the best results are not obtained by harvesting in the flowering stage n the endeavour to get a green colour in the brush, which is supposed to e preferred by some manufacturers. The brush is fully developed while he seed is still in the soft dough stage, and it then still has a good tinge of reen. This is the stage at which some growers harvest, while others wait ntil the seed is just firm, when the brush has lost its prime colour but is till tough. The advantage of leaving the harvesting until this later stage s that some value then attaches to the seed, which is becoming increasingly

used on the farm, and is also often quoted on the market as a cheap poultry feed. If allowed to go too far, of course, the seed becomes dead ripe and the brush becomes yellow and dead, and loses its value altogether for manufacturing purposes.



A Broom Millet Plant, White Italian Variety.

The practice of bending the head over is one which used to be carried out by some growers in order to avoid the brush becoming bent and scraggy in appearance, and also to facilitate harvesting on account of the great height of the heads from the ground. The practice has now largely disappeared, and has been superseded by a more rapid and efficient method called "tabling," which not only makes harvesting easier, but helps considerably in the drying and subsequent handling.

This "tabling" method has been developed and is almost generally used by Manning River farmers, and the practice is spreading to other districts where broom millet is grown. The farmer, bending two rows at the one time, places each row diagonally across the other, forming a latticed table about 3 feet from the ground. The work is done by the operator facing the direction of tabling (*i.e.*, walking backwards as the work is done). He is then in a position to place the heads near the outside edges. The final operation of cutting is carried out by walking along the passages between the tables, and removing the head with about 6 inches of stalk, with a butcher's or some other suitable knife. The sheath enclosing the stem is removed at the same time. Besides hastening the process of drying, the removal of the sheath allows the reddish discoloured area to dry out better, and it also deprives aphis of shelter. The heads are then placed in moderately thin layers on the "table" to dry, which usually takes from thirty-six to forty-eight hours according to the weather and the maturity of the crop.

In order to retain some of the colour when the harvesting is in any way delayed, the final drying is best done under cover, away from the direct rays of the sun, in a shed fitted with racks or open shelves, on which the brush is placed in layers from 3 to 12 inches deep, depending on the amount

of moisture still being held by the heads. Curing takes longer in the shed than in the field, and may require attention in turning the layers over from time to time. Thorough drying is advisable, because hackling is rendered easier and the seed being more thoroughly dried is less liable to heat in storage, which is a common occurrence with broom millet seed harvested in an immature stage.

Hackling.

The brush is prepared for market by the removal of the seed. This is done by means of a hackling machine, which consists of a roller studded with small, narrow iron spikes mounted in a drum or concave, and turned speedily by hand or belt power. The brush is not fed into the machine, but is held in small handfuls into the machine so that the upper part of the brush containing the seed comes in contact with the roller, which strips the seed off clean.

A firm at Morpeth, on the Hunter River, specialises in millet machinery, and supplies hacklers for hand or belt power for about £5. Many farmers have home-made hacklers which well serve the purpose for small crops. One enterprising farmer on the Manning River drives his home-made combined hackler and winnower (to get rid of the dust) by power.

After hackling, the brush should be packed back in deeper layers on the shelves, and with all butts level, to cure further until baling time. This latter provision is an advantage in further handling at baling time.

Baling.

Grading is a process that farmers seldom practice, the millet being put up into bales which are called "self-working," being composed of all grades—"insides," "covers," and "hurl," and bent and inferior brush. Grading on the farm into separate bales involves much extra labour, and the growers contend that the extra price received for the graded article is not sufficient to justify grading. At the same time, a rough grading out of all millet which does not come up to the manufacturers' requirements, is distinctly advisable, and is reflected in a sufficiently increased price to justify the practice.

A lucerne or hay press can be adapted for baling broom millet. The best type is a box press (resembling a wool press), which keeps the butts even. The brush is laid with butts outward and the heads overlapping in the centre. A good pressure is desirable to reduce the bulk for the saving of freight on rail. Battens are placed on the top and bottom of the bales, which are secured by four to six strands of stout wire. A convenient size of bale is about 46 x 30 x 24 inches, weighing about 300 lb.

Requirements of the Trade.

Most of the largest broom factories are situated in Sydney, but there are also factories located in several country centres. Many different types of brooms are manufactured, according to the class of brush available to work with.

In the manufacture of brooms, three classes of brush are required—"inside," "cover," and "hurl." "Inside" millet is used for forming the inside of the broom, and for the best brooms is generally not more than

17 inches long. There is a type of dwarf broom millet, largely used for "insides" and for small brooms in America, which local manufacturers say they could do with here, but the yield is small and it has not yet been decided by experiments whether it will be profitable to grow this class of millet under any conditions in this country. In the meantime, "inside" millet is generally made up by the manufacturers from some of the poorly developed brush of the long White Italian variety.

"Cover" is the class used for covering the inside and also for forming the shoulders. For the best brooms it should be 17 to 20 inches long.

"Hurl" is the longest brush, ranging from 20 to 25 inches for good brooms. The best hurl is fine, even, straight fibre, and forms the outside of the broom to give it a nice finished appearance.

About 1½ lb. of brush are required to make an ordinary broom and the three grades are used in about equal proportions.

The manufacturer and the farmer need to be brought into closer touch, for many improvements could be effected by the farmer who knew the manufacturer's requirements. Some of the most important of these are:—

(1) Complete removal of the seed.

(2) Grading out inferior, broken, or badly bent or very coarse brush.

(3) Uniform length of stem cut with the heads.

(4) Uniform and good colour.

(5) Regular sized bales, well packed and pressed.

It is also to be deplored that dishonest practices exist among farmers, such as facing the outsides of the bales, filling with inferior material and rubbish, watering bales to increase the weight, &c.

Selection of Seed.

As a general rule, selection of seed is a much neglected operation. Many farmers still rely on the "scoop shovel" method of obtaining their seed from the heap after hackling. This method cannot be too strongly condemned. Its use leads to great deterioration both in the yield and quality.

The best growers select their seed in the field from the best heads. The number of heads required to sow a few acres is comparatively small and the selection of seed in this way is justified by the improvement effected in the yield and the quality of the brush. The most important points to look for in selecting seed heads are:—

(1) Fine, long, straight, round, abundant, uniform fibre with absence of thickened central stem.

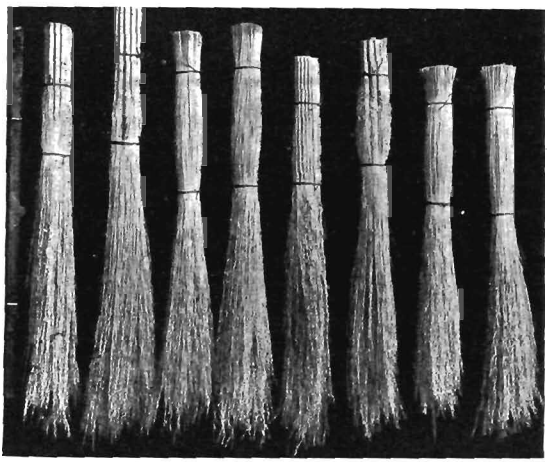
(2) Seed compactly situated mostly at the end of the brush (to facilitate hackling), the brush arising compactly in a close whorl from the stem and well exserted from the leaf sheath.

(3) Freedom from disease such as red stain (on the brush and in the stem) and smut.

(4) Good plump well-developed seed of light colour.

It is a good plan to have a special seed plot of broom millet where a few of the very best heads can be sown and in which improvement can be more quickly effected, as owing to the cross-fertilisation which occurs, plants with good brush may be cross-fertilised by plants bearing poor brush in the vicinity, and with a smaller seed plot the selection may be made more rigorously with less chance of including the poorer types. Then sufficient seed can be selected each year to sow both the seed plot and the field area, keeping a few of the very best heads for the seed plot.

In the seed plot the heads can be left until they are properly matured before harvesting, though they may require protection in the field from birds by covering them with a light muslin bag. After harvesting, the



Samples of Good Quality Millet Heads.

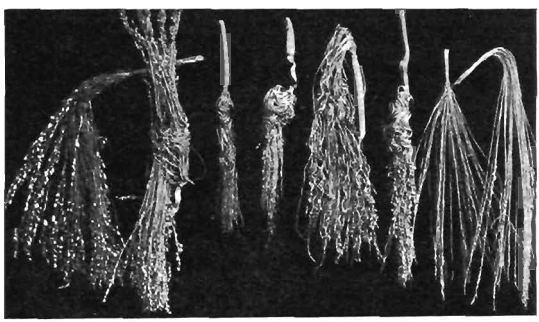
heads are thoroughly dried, hackled, and the seed cleaned and put away. Fumigation with carbon bisulphide and storage with naphthalene are recommended to secure the seed against weevils and grain moth.

Farmers are urged to take some measures for selecting their own seed, as it cannot be expected that growers will go to any great amount of trouble in selecting seed for other farmers' use. Purchased seed is generally "scoop shovelled" from the bulk, and in view of this, every grower would be wise to do his own selection.

Early sowing is almost essential for a good setting of seed, as late sowings are usually very deficient in seed.

Place in the Rotation.

From the point of view of disease alone, it is advisable that broom millet should not be sown on land which has grown broom millet, sorghum, or sudan grass at least the previous year. Quite apart from this, the best results are not obtained when broom millet is sown after these crops, because in each case they leave the land in somewhat poor physical condition, and if followed by a dry winter, it is found exceedingly difficult to work the land into a good seed-bed for the next crop. Broom millet does better after maize, but the best results are obtained when it follows lucerne or some green manuring or leguminous or root crop. On account of the poor physical condition resulting, especially in ground that has been under cultivation some time, it is advisable to grow a green manuring crop such as cowpeas, field peas or vetches on the land occasionally if it is to be cropped much to broom millet.



Typical Samples of Brush frequently seen in an average crop. Unsuitable for sale or manufacture.

Use of Seed.

The value of the seed of broom millet has become more widely recognised during *recent years, largely owing to the high prices which at times rule* for maize, wheat, and other grains. On the farm it is chiefly used as food for poultry and pigs (soaked in skim-milk when fed to the latter). For farm horses many farmers have found it a good substitute for maize, being nutritious and palatable when ground, but there should be no hint of damage by heating or trouble will be experienced.

As the grain is harvested in the immature stage, it has still a high moisture content, and as insect pests (weevil and grain moth) are, as a rule, particularly active at the harvesting period, special care is necessary to keep the seed any length of time. To store broom millet seed successfully it should be first hackled clean, taking every advantage of "wind winnowing" to get rid of the dust and dirt during the process. Spreading out in

thin layers on tarpaulins in the sun or kiln drying in a loft is then desirable to get rid of the excess moisture. Treatment with carbon bisulphide to get rid of weevils and moths may then be necessary before storage, during which thorough ventilation and free circulation of air through the grain is essential. Good ventilating devices are wire fly screens on the floor of the barn and distributed through the heap. Unless some such precautions are taken to dry the seed quickly, especially in coastal districts, it soon becomes reduced to a mouldy, worthless heap. The feeding value of good quality broom millet seed may be reckoned to be about three-quarters that of maize, so that some attempt to save the seed for feeding on the farm at least is justified.

Stalks and Leaves.

During dry times many farmers make use of the standing stalks left after harvesting the heads for cattle feed, either by cutting and carting out to cows or by turning them in on the crop. While feed is scarce there is some value in the bulk supplied in this way, the leaves, of course, constituting the best part of the crop, the stalks, which contain very little sugar or sap, consisting mostly of pith and fibre. Some farmers contend that there is some milk-producing feed in millet stalks at any time, but very little use is made of them when other feed is available, and they can only be looked upon as a somewhat useful standby when feed is scarce.

The stalks are best got rid of by cutting with a sled cutter, or a chopping roller, or by rolling down and chopping up with a disc-harrow, and ploughing under to improve the mechanical condition of the soil.

Yield and Prospects.

A yield of 10 to 12 cwt. of marketable brush per acre is considered very good, and the seed may give up to 30 bushels per acre in addition. In some seasons it is possible to get a fair "ratoon" crop; that is, after cutting and removing the stalks, a second growth is allowed to take place. This may yield a few hundredweight of moderate to poor brush; ratooning is seldom practical, however, and then usually without entire satisfaction.

In recent years the price of good self-working bales of broom millet has been from £40 to £60 per ton, with lower prices for poorer quality. One advantage of this crop is that it may be stored successfully for years without deterioration and sold when prices are good, but many farmers cannot afford to hold their crops too long, both on account of lack of storage accommodation and for financial reasons. The demand for broom millet on the Sydney market is limited and over-production would be easy. There is, however, profit in broom-millet growing for the grower who puts up a prime bale of the best quality for market.

Diseases of Broom Millet.

The most important diseases of broom millet in this State are those which are caused by fungous parasites and include Red Stain (*Fusarium* sp.), Kernel Smut (*Sphacelotheca sorghi*), and Leaf Spot or Anthracnose (*Colletotrichum graminicolum*). Each of these troubles has been discussed under sorghum diseases on page 470, where full details for control equally applicable to broom millet are given.

SUGAR-CANE.

The sugar-cane industry is one of considerable importance in New South Wales, but it has fluctuated in production to a greater extent than the majority of our standard crops, largely because world conditions affect profitable production and assimilation. The growing of sugar-cane is confined to certain localities on the three North Coast rivers—Tweed, Richmond and Clarence. These areas are restricted geographically by the commercial consideration, transport, in addition to such definitely limiting factors as soil fertility and suitability, frost occurrence, and drainage facilities. However, a large acreage of suitable land is available within requisite proximity to the mills.

Water carriage is the most satisfactory method of transport financially, as the crop is bulky and tonnage costs must be retained at as low a level as possible. A deep soil, high in fertility, thoroughly drained and provided with an adequate supply of humus, is required. A sufficient area of this type of land is available on both the hills and flats of the Tweed, and on the flats of the Richmond and Clarence. An ample and well distributed rainfall is an essential, and freedom from frost is particularly desirable, as the damage caused is considerable and largely uncontrollable; the Richmond River areas are fortunate in that their situation ensures them a minimum of frost injury.

Preparation of the Soil.

The land must be well worked and thoroughly prepared to ensure the necessary soil conditions before cane is planted. The average depth of soil cultivation is 8 to 9 inches, but care must be exercised to avoid bringing heavy clay subsoils to the top in too great a quantity; a gradual increase in depth is desirable on shallow soils, particularly on the Richmond, until the desired depth is secured. Subsoiling will be found profitable in many areas, as cane is of a deep-rooting habit, and requires ample root room for the production of its heavy yields.

When ploughing paspalum pastures for cane-growing, the total eradication of the grass must be aimed at, as otherwise it is a most serious weed. This is best achieved by shallow ploughing, turning the soil right over, and allowing the grass to die some time before commencing the preparatory ploughing. On some areas on the Clarence, the disc harrow is used and then a second harrowing is given across the first; the disc implements are usually weighted for this operation. Favourable opportunities must always be availed of for the purpose of killing paspalum.

Early preparation, as with most crops, is essential; the first ploughing should be given in the early autumn, and should be followed by cultivations —harrowing and ploughing—as necessary; the exact nature of these subsequent cultivations and the choice of the implements to be used to achieve the desired result must be left to the individual cane-grower to decide in relation to his own area. A deep, finely cultivated soil must be secured with entire freedom from weeds. The grower must realise that no later cultivation is able adequately to make up for incomplete preparation of the soil.

Drainage.

The satisfactory drainage of cane soils is of the greatest importance, and its value cannot be overstressed. An ill-drained area is quite incapable of good production. Obviously some of the New South Wales cane lands are well drained, but unfortunately large areas do not receive sufficient attention in this regard, and even where drains are already in existence advantage is not taken of them to provide subsidiary channels. When growers fully realise the restricting influence of faulty drainage on crop yields and crop behaviour generally, this matter will receive the attention it merits.

Selection of Sets.

Varieties are of necessity largely standardised periodically for localities owing to the restrictions imposed for purposes of disease control and by soil suitability, and of recent years growers have depended for their varietal information on the advice of those carrying out the important investigational work relating to disease. Thus the choice of variety is limited.

A Crop of Malabar Cane six months old.

Although it is considered that the higher eyes on the stalk are the most suitable for sets, commercially the whole stalk is used; it is the practice in some countries to utilise the tops for sets as they become available at cutting time, but our harvesting conditions prevent such a procedure, as growers are too busy to do the planting at that time. For providing seed a small plot of approximately ¼-acre is usually kept by growers and one-year-old ratoons should be used for preference. Stalks should be handled carefully, and the sets cut with a sharp knife to prevent shattering. Sets should each contain about three eyes and are usually 8 or 9 inches long; approximately 1½ tons of seed are required to plant 1 acre.

Planting.

The system of planting varies with districts, and is partly governed by soil demands and partly by custom. On the Clarence the sets are usually dropped on the square, and on the other rivers in drills; the square system undoubtedly has the merit that more thorough cultivations may be given.

The average distance between rows is about 4 feet 6 inches. Lightly covering the sets, which are dropped about 15 inches apart or less in drills about 6 inches deep, is to be preferred. In some districts growers plant deeply in the drills and cover lightly, while others cover deeply and rake off in about three weeks; a fairly heavy cover and raking-off is generally desirable as this practice does not smother the shoots and retard growth, but encourages the quick progress of the plant. Machines carry the sets, while the actual dropping is done by hand. Drills may be opened with a single-furrow plough, or preferably a double mouldboard drill plough. The *time of planting varies somewhat with locality, for whereas on the Clarence and Richmond the end of August or early September is the best time, September and early October are the most satisfactory times on the plains* and slopes in the Tweed district, while for steep hillsides a November planting is recommended, to catch the summer rains.

Later Cultivation.

Raking off a few weeks after planting has already been referred to. "Ploughing away" from the row is the next process; it is carried out six to eight weeks after planting to control weeds, to prevent the sets being too deeply covered, and to maintain the necessary soil texture. A mouldboard plough is customarily used, and a furrow is ploughed away from, and as close to, the sets as possible; in two or three weeks the furrow is ploughed back again. This operation is repeated throughout the early growing period. When the surface roots are maturing the ploughing must be shallower near the canes; if necessary shallow scarifyings must be given as the crop matures. Where the square system of planting is practised, ploughing away is only done in the direction in which the sets have been dropped.

Harvesting.

This process is standardised and carried out on a contract basis under supervision, and does not require any detailed reference here.

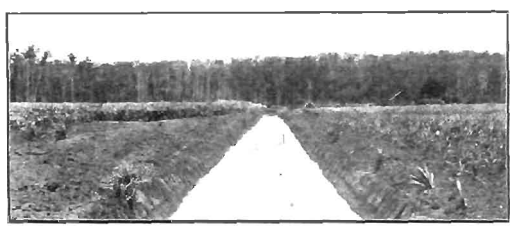
Trash Conservation.

The conservation of trash is of much value in improving soil texture—increasing the moisture absorption and holding capacities of the soil—as well as in increasing the plant-food content. It has been estimated that the trash from a 40-ton cane crop, which might approximate 40 tons when in the green stage, has a nitrogenous and humus value equal to a 10-ton crop of cowpeas when ploughed in. Weather conditions as to moisture and heat must be suitable for the efficient utilisation of the bulk of added material. The practice can be recommended almost generally. Condong, where peat soils occur, provides one exception, and the burning of trash on such types of soil is not unattended with danger, and must be done with care.

The practice of conserving trash at ratooning or "relieving" is also a good one, and is being undertaken by some growers; this necessitates a good deal of labour. A deep furrow should be ploughed in every second space

between rows, and the trash pulled into and packed over this furrow and left to rot. It is then, of course, only possible to cultivate from where the trash has been removed. The arduousness of the process, however, prevents its general acceptance.

On the Tweed River there is a quantity of new land under crop, and the necessity for soil improvement by trash conservation is less urgent; however, this is a method of soil improvement by means of material already available that in most cases could be turned to highly profitable advantage. It is advisable to turn the trash under as soon as possible after cutting, as the tops are then still green and more easily handled; a chopping roller will assist in somewhat compressing the material, and by turning in stock growers may utilise the paddock for feed purposes and have the trash trampled down at the same time. A rotary hoe, tractor-drawn, is coming into prominence in some areas for chopping and partially covering the trash, enabling the disc plough to work more satisfactorily; another method is to use a plough with a plate in front of and close to the disc to depress the material and enable the disc to work more easily on a compacted surface.



Richmond River Cane Land with Main Drainage Channel.

Cultivating Ratoons.

The first cultivation is a deep and thorough ploughing between rows; this ploughing is taken close to and away from the plants, and usually shaves away a portion of the stools, preventing them from becoming too large and producing an excess number of thin stalks, and opens them up and induces a fresh root growth. Continual cultivation for weed control and preservation of soil tilth is required until prevented by the growth of the crop. It is customary on the Clarence to ratoon once, and with some growers the plant crop only is used. On the Richmond it is usual to ratoon once, whilst on parts of the Tweed two ratoon crops are frequently harvested.

Manuring.

The first consideration in manuring is the growing of and ploughing in of green crops prior to cane planting. A leguminous crop, such as cowpeas, is the most suitable for the purpose, and the growth of such a crop is usually unattended with any difficulty. With cowpeas it is an advantage to sow immediately the trash is ploughed in, as a quick germination is usually secured, and the crop has time to mature and produce a big bulk of greenstuff. A crop of maize and a later sowing of cowpeas between the rows is

also suitable. For winter use, field peas or vetches may be used, but these cannot be depended on for *bulk* such as is supplied by the summer crops. Under trial on the Richmond River, cowpeas were calculated, on a 10¼-ton crop of greenstuff, to yield the nitrogenous equivalent of 540 lb. of sulphate of ammonia. When this is considered, without taking into consideration the other advantages of the green crops, such as their effect on the soil generally, the urgent necessity for green manuring on commercial lines is obvious. Satisfactory results have been obtained with nitrogenous fertilisers, chiefly sulphate of ammonia, and their application in many cases has caused a decided financial gain.

The conservation of trash, as already described, is, of course, of much use in maintaining soil fertility.

Summary.

The *chief* points in successful cane production might be briefly enumerated as follows:—

1. Use correct varieties.
2. Provide satisfactory drainage.
3. Thoroughly prepare the soil.
4. Maintain soil fertility by trash conservation, green manuring, and the use of fertiliser.

Varieties of Sugar-cane.

The importance of plant improvement in relation to sugar-cane is so fully recognised that seedling raising and variety testing receive great attention in all advanced sugar-producing countries. Marked increases in both yield and sugar content of the crops, combined with the control of important diseases, have resulted in many instances.

Australia has not lagged behind in this matter, for, although not much attention has been given to seedling raising, varieties have been freely imported from other countries. But, unfortunately, many of these importations were not attended by proper precautions, with the result that a majority of the known diseases of sugar-cane have also been introduced. At the same time, there has been a disposition to regard new varieties as the solution of all cane-growers' troubles. The variety has been blamed, when the fault lay with a disease, which frequently could have been better controlled by other means than by replacing the variety.

A fresh epidemic of gumming disease has lately rendered further cropping of several of the most favoured varieties unprofitable in the areas invaded. These are now being replaced, of necessity, with resistant varieties, which, in many cases, are otherwise inferior. The latter are therefore to be regarded more or less as stopgaps, either until gumming has again been got rid of, allowing the old varieties to be reverted to, or until they can be replaced with new resistant varieties equal or superior to the old susceptible ones. Besides being adapted to local conditions and resistant to gumming, the new varieties will also need to be resistant to other local diseases and—for a large part of the area—to frost.

Badila.—This variety, which is grown on about 15 per cent. of the area on the Clarence and over 90 per cent. on the Tweed, is recognised as the best for new rich land and other good quality soils. It responds well to fertilisers

and good cultivation, yielding heavy crops of high sugar content. It is typically a two-year-old cropper, although it succeeds well as a one-year-old ratoon crop on certain Tweed River areas, and, having broad and abundant leaves, it covers in quickly, checking weed growth. It is also one of the best frost resisters, and is resistant to most diseases. However, its susceptibility to gumming has prohibited its cropping on the heavy low-lying river flat soils on the Richmond, though it still proves moderately resistant to this disease on the free volcanic hill land at Cudgen (Tweed River).

New Guinea 16.—This variety at present comprises about 45 per cent. of the crop on the Clarence and about 20 per cent. on the Richmond. It is of similar habit to Badila, but being more vigorous in growth, is specially suited for the poorer classes of land, where it yields good crops of high sugar content. It cannot be recommended for rich land, on which rank growth and lodging occur, resulting in damage and low quality. It is a good frost resister, very highly resistant to mosaic, but only moderately resistant to Fiji disease, leaf scald and gumming. On account of gumming, its planting has had to be discontinued entirely on the Richmond, and is being curtailed on the Clarence.

Malabar.—On account of being highly resistant to gumming, this old-time favourite has again come to the front. It occupies about 5 per cent. of the area on the Clarence, 50 per cent. on the Richmond and 6 per cent. on the Tweed. On good land, it yields very heavy, erect crops of only medium, although reliable sugar content. It also shows some tolerance for defective drainage conditions. It does not do well on the poorer classes of land and is not suitable for areas subject to frost. Although highly resistant to gumming and leaf scald, it is rather susceptible to mosaic and Fiji diseases, both of which, however, are controllable in this variety by seed selection and roguing. Drill planting, with the sets spaced fairly closely in the rows, is preferable to planting on the square.

H.Q. 5.—Very high resistance to gumming is also the chief recommendation for this variety, which is now being grown on over 30 per cent. of the area on the Richmond and increasingly on the Clarence. It is a vigorous grower and yields good crops of only medium sugar content, on the poorer classes of land. But, like New Guinea 16, it is liable to produce heavy fallen crops of low quality on good land. It is also highly resistant to leaf scald and mosaic, but rather susceptible to Fiji disease. Difficulty in harvesting, due to the clinging nature of its trash, general tangled growth and hardness, is its most objectionable feature.

Q. 813.—So far (1928) experience with this variety under New South Wales conditions is too limited to state upon what classes of land it will yield payable crops. It is now being extended on all three rivers, because of its high resistance to gumming. It is also of good sugar content and resistance to leaf scald, mosaic and Fiji diseases, and to frost damage. It also seems suitable for cropping at one-year-old on good land.

Innes 131.—This variety is still grown on about 25 per cent. of the area on the Clarence and 2 per cent. on the Richmond—mainly on rather poor sandy or friable soils in localities where gumming is prevalent. Although yielding profitable crops, it is most undesirable because it aids in the dissemination of gumming, being susceptible to but tolerant of this disease. It is of good sugar content, and resistant to leaf scald and Fiji diseases, but highly susceptible to mosaic.

Mahona, D. 1135 and M. 1900 Seedling.—Although eminently adapted for certain New South Wales conditions in other respects, the susceptibility to gumming to these three varieties has rendered their cropping no longer profitable. Mahona has also been ruled out by high susceptibility to leaf scald.

New Guinea 14.—Although highly resistant to gumming and possessing many other excellent varieties, this variety has had to be dropped on account of its extreme susceptibility to Fiji disease.

Diseases of Sugar-cane.

Sugar-cane in this State is subject to an unusually formidable array of diseases, which have a marked effect on the crops, on the varieties grown and on the profits derived by the growers. As with many other classes of producer, the cane-farmer is disposed to regard somewhat lightly the appearance of disease until the effects have become manifest and serious loss has *been entailed.*

To intelligently combat cane diseases the grower must first know how to recognise each and how its spread may be prevented.

Gumming, leaf scald, Fiji disease and mosaic are the four most important diseases, to the control of which close attention is particularly necessary. They are therefore separately discussed in some detail below.

Other serious affections include red rot, at least two root fungous diseases —curly top and spindle top—each of which is associated with special types of soil and adverse weather conditions. On this account, their control lies chiefly in correcting soil deficiencies by appropriate treatment, in good cultivation, green manuring, drainage and other means of promoting good even, thrifty growth, and in choice of variety. The selection of healthy seed cane and the eradication of diseased plants, although helpful, are of but secondary importance with diseases of this type.

Gumming.

Gumming may be recognised by the yellow spots of gum which ooze from the cut ends of stalks at harvesting. In suspected mild cases, canes, freshly *cut into short lengths, should be enclosed in a can to sweat for about an* hour before looking for the gum spots. The canes to test may be indicated by reddened fibres, which are usually present in the tissues of affected canes, but which may be due to other causes.

The leaf streaks afford the best means of detection in standing crops, as they are the first symptoms to appear after a crop becomes infected. They are frequently present for a long period before stalks showing gum spots can be found. However, they are apt to disappear at certain seasons and in periods of dry weather, when the disease may be difficult to detect unless at an advanced stage. They are long, narrow, yellowish streaks, spotted with reddish brown, running parallel with the veins. The older portions of them broaden out and wither. They occur mostly on the older green leaves, especially towards the leaf tips, which tend to split up.

In advanced stages, numerous signs of ill-health appear, including white leaves, dead and dying canes, gum cavities in the stalks near the tops, &c.

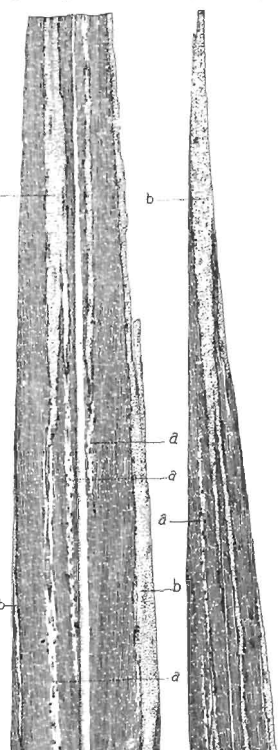
Gumming is caused by the organism *Bacterium vasculorum*. The bacteria are present in countless myriads in the leaf streaks and in the gum in

the stalks. When the leaves are wet, the bacteria ooze from the leaf streaks, and become rapidly disseminated by wind-blown rain, especially during violent storms. They may also be carried over long distances by ordinary flies. On thus reaching fresh leaves, they enter through minute wounds, caused by the friction due to wind, and develop, producing fresh leaf streaks. Dissemination by this means takes place so rapidly that it has proved impracticable to control the disease in susceptible varieties under New South Wales conditions.

Knife infection takes place when a diseased and then a healthy stalk are cut with the same knife. This is a means of spreading to be guarded against by disinfection of cane knives, particularly when preparing seed cane, or when the cutters are proceeding from a diseased to a healthy field. Precautions are similarly needed against spreading by means of farm implements, stock and workmen—particularly in wet weather.

The use of infected cuttings is by far the most important means of spreading, the disease having thus been carried from district to district and country to country.

The selection of healthy seed cane from even lightly infected fields—so valuable with Fiji disease and mosaic—is of little avail with gumming. Spreading often takes place so rapidly that the introduction of a single diseased set may cause infection of a whole field within a few months. Procuring seed cane from perfectly healthy fields, at least a quarter mile distant from, and usually to windward of, the nearest diseased cane, has proved necessary to ensure the obtaining of healthy seed in the case of gumming. Similarly the roguing out of individual diseased stools is of little value, as nothing short of ploughing out the whole field or fields concerned is effective.



Sugar-cane Leaf affected with Gumming.

(*a*) Yellow streaks with brown spots.
( ) Withered portions.

Thus, for the successful control of gumming in New South Wales, the cropping of highly resistant varieties is the first essential. Fortunately a number of these available and discussed above are so highly resistant that the disease can readily be eradicated from groups of farms cropped exclusively with them. However, they are liable to become seriously infected, even damaged, by gumming when any susceptible varieties are grown nearby.

Proper land drainage is also highly important, as the disease spreads more rapidly and damages the cane more severely where drainage is poor.

Every effort is needed to prevent the disease from spreading into localities in which it is not already present, by suitable quarantines and similar measures. This is particularly important because the available resistant varieties are, generally speaking, inferior to the more susceptible ones now being grown.

Leaf Scald.

Leaf scald occurs in two distinct forms. In one, whole stalks, sometimes whole stools, suddenly wilt and die. In the other, white or withered streaks appear in the leaves, and all the buds on the stalks sprout into side-shoots; the leaves sometimes partly turn white and show a tendency to wilt back to the tips. Either of these forms may occur without the other, or both may be found in different stalks of the same stool.

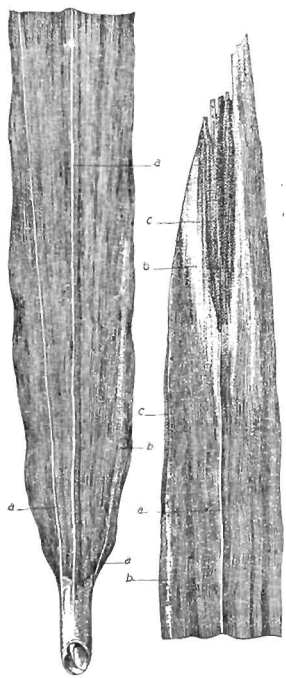
The peculiar streaks in the leaves provide the best symptom for its definite recognition. They are usually straight, narrow, even, well-defined, whitish streaks strictly following the course of the veins, one or several in a leaf, some of them extending through the entire length of the leaf blade and sheath. They broaden out and wither usually from the leaf tip downwards. The discovery of a streak in one single leaf is sufficient to diagnose the disease. In older cane, the streaks may often be found more readily in the leaves of the side shoots or small suckers than in those of the cane top.

Where the wilting form occurs alone, diagnosis may be difficult or even not immediately possible. In such cases small sickly suckers bearing the leaf streaks should be searched for at the base of the stool. These will usually appear, at any rate, after harvesting and ratooning.

The cause is a minute bacterium, not yet named. As in the case of gumming, the bacteria occur in myriads in the leaf streaks and in the stalks, the fibres of which are similarly reddened, although no gum will ooze. Dissemination occurs with similar rapidity, but in a rather different manner not yet fully understood. Spreading by the use of infected cuttings and by knife infection are also of similar consequence.

On this account, the methods of control are much the same as with gumming, except that the wide range of superior varieties available, highly resistant to leaf scald, makes its commercial control much easier and less costly.

However, it is more difficult to effect complete eradication, because some highly resistant varieties are liable to act as carriers. They carry the disease in a mild form without being appreciably damaged by it. Badila crops on the Tweed are a striking example of this.



Sugar-cane Leaf affected with Leaf Scald.

(*a*) Narrow whitish streaks.
(*b*) Creamy coloured areas.
(*c*) Withered portions.

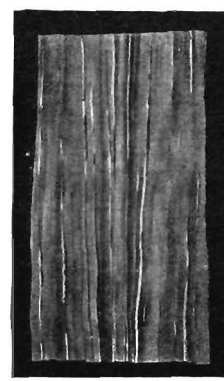
Fiji Disease.

Fiji disease shows itself in short, stunted growth with small, deformed, wrinkled leaves on some of which scalded patches occur. The buds on the stalks may sprout and numerous small suckers spring from the ground.

Peculiar galls are found on the underside of the leaves, in the form of small, elongated lumps or ridges, both on the midribs and on the leaf blades. These galls provide the best means for diagnosing the disease, especially as they may be found in its early stages while the cane appears otherwise healthy, as well as in all later stages.

Although evidently infectious, neither the cause nor the natural means of dissemination have yet been discovered. However, simple methods of control were devised and put into practice in Fiji, with the result that the

Cane Top affected with Fiji Disease.



Portion of Cane Leaf showing Galls caused by Fiji Disease.

After Lyon.

disease became of minor consequence in the course of three or four years without any change of variety. These methods prove equally effective in New South Wales, with growers who conscientiously carry them out.

Firstly, healthy seed cane must be selected for planting, because infected cuttings invariably produce diseased stools. As infected cuttings may be frequently obtained from apparently healthy stools in diseased crops, the selection is a matter of some difficulty. In addition to rejecting every stool showing symptoms—even a single gall—the best block available, *i.e.*, the one containing the lowest proportion of diseased stools, not above 5 per cent. at the most, needs to be selected for seed. And in this connection, seed from poor or stiff clayey land proves much safer than that from free alluvial loams or sandy soils and should therefore be chosen whenever possible.

In the second place, all diseased cane must be eradicated as soon as practicable. As infection spreads only from living diseased stools, and spreading is comparatively slow, except where the proportion of diseased canes is high, this is a most important and effective measure. In young plant crops grown from seed selected as outlined above, the odd diseased stools should be searched for and rogued out as soon as recognisable—during the first four or five months' growth—and replaced with healthy plants; similarly in young ratoons, if the proportion of diseased stools is not too high. Where the proportion of diseased stools is over about 5 per cent., roguing usually proves impracticable, in which case the whole field must be ploughed out after maturing and harvesting. Where a whole crop is rendered worthless, nearly every stool being diseased, as frequently happens in severely infected localities, it must be ploughed out and cleaned up without delay. The difficulty of handling crops not worth harvesting creates a tendency to leave the fields concerned to lie waste. Nothing could be more fatal to the successful control of Fiji disease in neighbouring crops.

No varieties which can be termed highly resistant have yet been discovered amongst thousands tested. However, the disease can be successfully controlled in the manner indicated in crops of the great majority of varieties, which should therefore be regarded as moderately resistant. Varieties like New Guinea 14, which is so susceptible that these measures do not suffice for control, are rare.

Mosaic.

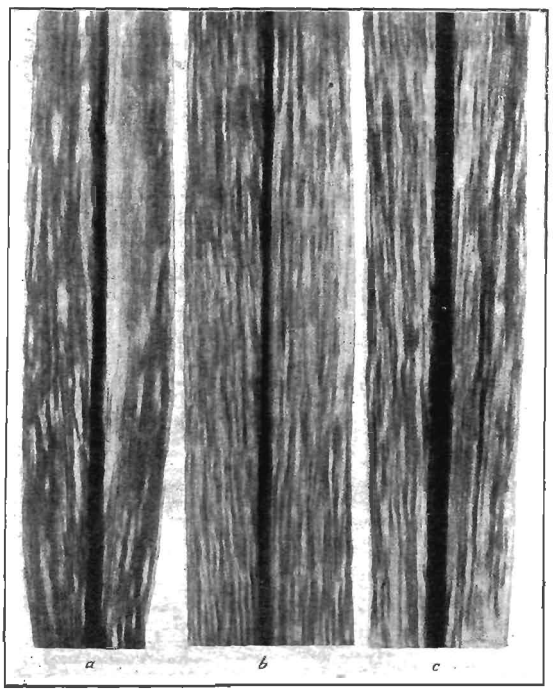
Mosaic, also known as "Yellow Stripe" and "Mottling" is prevalent in practically all cane-growing countries throughout the world, and has caused enormous crop losses.

Fortunately, it has not proved quite so virulent in New South Wales, where rapid spreading takes place more spasmodically, and resistant varieties are largely cropped. But the so-called "running out" of a variety has undoubtedly been due to this disease in many cases. Far from being destroyed, affected canes often appear to the casual observer to have nothing wrong with them. Yet the disease causes severe losses by reducing the vigour of growth, resulting in thinner, shorter stalks, fewer stalks per stool and much reduced crop generally. Where entire crops are infected, 25 per cent. loss in tonnage is common, and 80 per cent. and even 100 per cent. losses occur in some varieties. Its effects are cumulative, becoming more and more severe with each successive planting of diseased stock.

Mosaic is recognisable by a peculiar indistinct mottling of the leaves, by which their green colouring is reduced to a lighter more yellowish tint in numerous small oval or elongated confluent patches. This mottling occurs all over the leaves, but usually shows most plainly towards the base of the young, newly unfolded, green leaf blades. Mottled markings and cankers may also occur on the rind of the stalks in advanced stages.

It is one of the virus diseases and is disseminated chiefly by the corn aphis (*Aphis maidis*) which breeds rather on maize, sorghum, and several weed grasses, than on cane. Most of these other plants are also susceptible, and the aphis may carry the disease from diseased to healthy plants of either the same or a different species. Also as it is transmitted through

cuttings, but not through true seed, the cane plant may start off diseased. Thus, for spreading to take place, the requisite conditions are one or more diseased cane plants and some of these other plants growing nearby. Of these, sorghum and maize (being the most favoured hosts of the aphids) are usually the worst offenders.



Portions of Cane Leaves affected with Mosaic.

[After Lyon.

For control, the selection of healthy seed cane is the first essential. While clean fields are much to be preferred when available, the selection may be made from partly diseased fields, or even from partly diseased stools, if necessary, as infected cuttings are rarely obtained from apparently

healthy stalks in the case of this disease. The roguing of diseased stools from young crops, and the ploughing out of heavily infected crops must also be practised, as with Fiji disease. It is most important to avoid planting maize or sorghum nearby any but highly resistant varieties of cane, for the reasons explained above.

Fortunately, the disease can be effectively controlled by strictly observing these measures, even in rather susceptible varieties, like Malabar, the cropping of which is so valuable for the control of gumming. However, control frequently proves a very difficult matter in susceptible varieties like Innes 131.

An Insect Pest.

Sugar-cane Moth Borer (*Phragmatiphila truncata*).

The eggs of this moth are laid upon the cane, and the young caterpillars upon emerging, burrow into the stems, usually close to the ground, although any part of the stem may be attacked. The caterpillars are of a general light purplish colour, blotched with lighter markings. They attain a length of about 1½ inches, and when fully fed, pupate either in the centre of the damaged cane or outside amongst withered leaf sheaths or rubbish. The pupæ are brownish in colour and about 1 inch in length. The body of the adult moth is of a light brown colour. The wings are similar in colour to the body, and when outstretched measure about 1½ inches across. Near the tip of each forewing there is a row of minute black dots.

The caterpillars attack both young and mature cane, and the injury becomes very conspicuous in the field as the leaves of the affected part ultimately turn brown and die. As the caterpillars also bore in thick stemmed grasses and native rushes, clean cultivation is an important factor in the control of this pest. Sugar-cane left in the field also becomes a favourable breeding place.

Aphids and small leaf-hoppers attack sugar-cane by sucking the sap from the leaves and shoots. They are, however, of minor importance.

INDIAN CANE.

Indian cane is a variety of sugar-cane (*Saccharum officinarum*), though it is not grown here for sugar production, and it is not, as is commonly supposed, one of the sorghum family. It is a valuable stand-by in times of drought, though dairymen must not grow it for the express purpose of stimulating milk production, or they will be disappointed. Used as part of a properly balanced ration it has its place on the average dairy farm, and may be one means of preventing many of the losses that unforeseen circumstances or want of forethought sometimes incur.

The canes and leafy top form a valuable stock food. Unlike maize and other crops that die off upon reaching maturity, cane always remains green, so that if at any particular time of the year it is not required to be used it may be allowed to stand without danger of deterioration.

It prefers a deep, rich, well-drained soil, situated in a locality where there is abundance of heat and plenty of moisture. The steamy conditions which are so prevalent on the coast suit it admirably. At the same time it will succeed well on hill lands situated some distance from the rivers, provided

it is protected from undue exposure. Slight frosts will probably do little more than check the growth, but heavy frosts will kill the leaves, whilst a continuance of very heavy frosts will completely destroy the plant.

The plantings should be kept in the higher lands if possible, and special care taken to avoid depressions or hollows that are frequently met with on our alluvial farm areas. In hilly situations preference should be given to easterly, north-easterly, or northerly slopes, so as to obtain the maximum of heat and the necessary protection from westerly winds.

Planting.

Cane can be planted at any time during the spring and summer, from, say, September till January, but it is preferable to have the planting done during the first hot month, usually October. If planted earlier, the somewhat cold nature of the soil is not conducive to quick sprouting, and the spring showers favour a more rapid weed growth. It must have plenty of heat in order to promote quick growth, for during the early stages the plant is always more or less sluggish. Late plantings do not admit of the plant making enough headway before winter conditions set in.

In the choice of sets for planting, due regard should be paid to the selection of stalks having well developed buds. There should be at least four sound buds to each "hole." During growth these buds are protected by the dead leaves which may not have been removed, but it is not absolutely necessary to remove these at planting time unless it be to examine the buds. Otherwise such leaves afford protection from any injury that may occur in the ordinary handling and planting of the sets.

The sets should be planted fairly deeply, but only covered with a light layer of fine soil, so that they will get the full amount of heat to start sprouting. As the plants grow, the earth can be gradually drawn in around, and brought to the level of the surrounding soil, which will also smother any weeds at the same time. Shallow planting is not favourable to free stooling; droughty conditions affect the crop more readily, and it is more likely to break down from its own weight, or the effect of winds and storms.

The distance at which the sets are planted varies with different localities, and a good deal depends upon the situation and fertility of the soil. Close planting tends to develop longer and thinner canes than wide planting, and is of some importance when the product is not chaffed before feeding. In general practice, however, it is found that the best results are obtained by planting the sets 4 feet 6 inches or 5 feet apart each way.

Regular and constant cultivation is required while the crop is young, particularly to keep down weed growth, and also to bring about those favourable soil conditions that proper and systematic cultivation ensures. After a few months' growth the leaves of the rows should overlap, the soil between is completely shaded, and the crop looks after itself.

Cutting.

With an October or November planting, the crop should be fit for feeding to stock by the following winter, when there should be no difficulty in getting from 20 to 30 tons per acre. In particularly favoured situations, as high as 40 tons may be obtained from twelve months' growth.

The canes should be cut with a sharp implement (preferably a cane knife) slightly below the surface of the soil. Breaking the canes or cutting with blunt instruments damages the base of the stalks, and the surfaces do not heal as quickly as they should, whilst in addition the bruised or split portions favour the introduction of moulds, &c., which set up decomposition.

Later Crops.

In the ordinary course of harvesting, most of the dead leaf or "trash" will have been removed. The land should then be ploughed between the rows, or well loosened with the cultivator early in spring. As soon as the warm weather sets in the roots will stool again, young stalks starting from the buds at the base of the old canes. These will increase in number after each cutting, but will become gradually weaker. The first crop, termed "plant" cane, is usually the heaviest and best, whilst the succeeding cuts, known respectively as the "first ratoon, second ratoon," and so on, become gradually lighter until it is necessary to plough the whole area out. However, with ordinary precautions, a good crop of cane will last many years before it has to be replanted.

Feeding to Stock.

In the feeding of this fodder to stock there are certain dangers which must be guarded against. All well matured cane should be chaffed. Though much softer than many varieties of sugar-cane, there is a fair amount of hard or woody fibre.

Instances have been recorded where stock have been killed through eating cane. Post mortem examinations have revealed the presence of large accumulations of undigested fibre.

There is always a risk of fire from the presence of much dead leaves or trash, and for that reason care should be exercised in the selection of sites.

SUDAN GRASS.

Sudan grass (*Andropogon sorghum* var. *sudanensis*) is a rapid-growing annual, cultivated for green fodder, silage, or hay, or used for grazing purposes. Seed was introduced into New South Wales in 1913, and farmers in coastal districts grew this crop extensively for some years until it was found to be very susceptible to two fungous diseases commonly known as Blight and Red Stain. In consequence, the area cropped in these districts has been considerably reduced, farmers realising that sweet or saccharine sorghums give better results and larger yields for green fodder or silage.

Sudan grass, being a plant that thrives only under warm conditions, will not give satisfactory results in cold localities. It is proving a useful crop in the drier parts of the State, being grown chiefly for grazing.

Sowing.

As the grass is susceptible to frosts, sowing should be delayed until warm weather ensues; the seed will not germinate well if the soil is cold. In the drier parts of the State, September or early October plantings give best results, as the crops from later sowings are often choked out to a considerable extent by Fat Hen (*Chenopodium album*) and other rapid-growing weeds.

The land must be well prepared for Sudan grass or unsatisfactory results will be obtained. This crop will not satisfactorily re-establish itself from self-sown seed, and consequently should be sown each season on fallowed ground.

Planting through every grain run of the wheat drill gives better results than planting in widely-spaced drills, say, 28 or 35 inches apart. When closely sown, fine-stemmed plants that are readily eaten by stock result, and in addition, weeds are not able to thrive as well as is the case where the grass is grown in widely-spaced rows. The reaper and binder handles a closely-sown crop better than one in widely-spaced rows, and the cutting strain on the machine is more evenly distributed.

The method of planting usually adopted is to use 8 lb. of seed with 56 lb. of superphosphate per acre, sowing the mixture through the fertiliser box of the wheat drill.

If the land has caked on the surface the crop should be harrowed in the *opposite direction to sowing in order to create a mulch. This* work can be carried out when the plants are from 3 to 4 inches high.

Sow Pure Seed.

Care should be taken that only pure seed is used. Sudan grass and sorghum cross-pollinate very readily; young sorghum and sorghum-Sudan hybrid plants are liable to cause poisoning and death if stock are grazed on them. Farmers, therefore, should raise their own supplies of seed, and care should be taken to see that no plots of sorghum or broom millet are sown in close proximity to areas of Sudan grass required for seed.

A Crop of Sudan Grass from Impure Seed.
Note the broad leaves and coarse stems of hybrid plants in the foreground.

Farmers may readily identify undesirable plants. Sudan grass has a very open head, fine stems, and narrow leaves, while most varieties of sorghum have compact heads, coarse, thick stems, and broad leaves. The hybrid plants vary considerably in size and appearance, but in their young stages *of growth generally stool very freely*, their stems being much coarser and leaves broader than Sudan.

Sorghum and Sudan-sorghum hybrid seeds are more or less rounded in shape, whereas Sudan seed is flatter, more elongated, and somewhat pointed at ends.

Grazing the Crop.

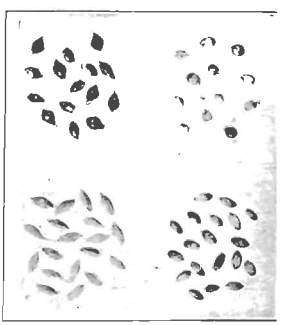
Provided pure seed has been sown, the paddock can be grazed any time after the crop is well established. If sorghum or sorghum-Sudan hybrid plants are present in large numbers, the crop should be allowed to come into head, and either cut for green feed or made into hay or silage. If only a few of these plants are present, and areas are small and required for grazing, any sorghum or sorghum-Sudan hybrid plants could be hoed out before the stock are turned into the paddock.

A Head of Sudan Grass compared with Heads of Sorghum-Sudan hybrids and Sorghum.
On the Left—Sudan Grass; *in the Centre*—Seven heads of hybrid plant; *on the Right*—Sorghum.

Sorghum Seed.

Upper pair, Milo: On the left, unshelled; on the right, shelled.

Lower pair, Planter's Friend: On the left, unshelled on the right, shelled.



Sorghum-Sudan Hybrid and Sudan Grass Seed.

Upper pair, Sorghum-Sudan hybrid seed: On the left, unshelled; on the right, shelled.

Lower pair, Sudan grass seed: On the left, unshelled; on the right, shelled.

[*Note that the Sudan grass seeds are elongated and flat, and inclined to be pointed at the ends.*]

Harvesting.

When harvesting for hay or silage, the best time to cut the crop is at the flowering stage, and the most suitable machine is the reaper and binder. For hay, small bundles should be tied, as bulky sheaves take a long time to dry and are difficult to cure into a good sample of hay, having to remain in the field until thoroughly dry, and thus being exposed to varying weather conditions. In wheat districts a good average yield of hay is 2½ tons per acre.

Sudan grass makes a good quality silage that is a most effective stand-by for all classes of stock. It is particularly valuable in the drier parts of the State, where it can be satisfactorily grown in good years and stored for droughty periods.

When harvesting for seed the grain must be thoroughly mature if the work is done with the reaper-thresher or combined harvester. It may be necessary to reduce considerably the draught from the fan blast of these machines, as the seed is light. All weed seed and other impurities should be removed from the harvested seed.

When Sudan grass is cut with the reaper and binder many weeds are often harvested with the crop, and winnowing after threshing is necessary in order to put up a clean sample of seed for sale.

A good average yield of seed is 700 lb., but up to 1,400 lb. per acre have been obtained in good seasons at the Cowra Experiment Farm.

Diseases of Sudan Grass.

In New South Wales Sudan grass is not attacked by many fungous diseases; Red Stain and Blight are, perhaps, the most common. An account of these and other diseases of sorghum which attack Sudan grass in certain other countries is given under "Diseases of Sorghum" on page 470.

RAPE.

Rape (*Brassica napus*) is a cruciferous plant with small yellow flowers, belonging to the same natural order as the cabbage and turnip. In the early stages of growth it closely resembles the Swede turnip, but usually attains a greater height than the turnip, and the root is not bulbous.

It is best adapted to temperate climatic conditions. In the New England and other cool districts it will grow best during the summer months; but in the coastal districts, and in many of the wheat districts on the Western Slopes, it does better as an autumn-sown crop. It is very rapid in its growth, and in favourable seasons is ready for feeding in from twelve to fifteen weeks. The growth by May is very luxuriant and fleshy, and may be eaten down by sheep or pigs when it reaches 6 inches in height. The advantage of feeding the rape crop down this month (May) is that a vigorous second crop follows. This naturally depends on the class of soil and the abundance of moisture. Sheep when eating the first crop, are liable to eat it off too close. This can be avoided by turning them off when they remove the first lot of leaves. They generally eat those first, and return to more closely remove the lower leaves and stems. Horses and cattle will eat rape, but in doing so they injure the plant and retard the second growth.

In every case very hungry animals, especially cattle and sheep, eat it greedily, and are liable to sudden attacks of hoven or bloating. It is advisable to break them into feeding it gradually, and after a week's attention allow them free use of the paddock. It is a good practice to feed all animals half on grass and the balance on rape. Hoven is more prevalent during wet weather or when heavy dews fall. Whilst on rape, cattle and sheep do best when given free access to rock salt. An average crop should feed ten to fifteen sheep to the acre, and fatten them for market in sixty days.

Pigs prove to be more thrifty and in healthier condition when fed with rape than when fed with grain alone. Considerable saving in labour is effected in grazing pigs on rape. Moreover, the ground is enriched from the excreta of both sheep and pigs. Experience has shown poultry-farmers the need for a green feed of a heterogeneous character as a substitute for more expensive nitrogenous foods, such as bran and pollard, and rape is most valuable for the purpose, as repeated trials have fully demonstrated. Milking cattle should not be grazed on rape.

As a change crop in the wheat belt, and as an adjunct to fattening sheep in conjunction with wheat-growing, practical experience at Bathurst Experiment Farm has proved it to be a nutritious fodder for sheep. In moist seasons it may err in being over-succulent and thus induce scouring. Trouble in that direction may be minimised by feeding dry grass, chaff, &c., in conjunction with it. In the laboratory, analyses have shown that rape contains a fairly large proportion of nitrogenous substances.

As a sheep food it is extremely valuable, especially for ewes suckling lambs and for the topping up of broken-mouthed sheep. When the ordinary pastures are dry, the corrective effect of the rape is exceptionally desirable. In districts with temperate winters, ten to twelve sheep may be depastured per acre throughout the winter.

It also is a good cattle food, excepting for its liability to cause bloat and to taint the milk of dairy cows.

For pigs it is very desirable, as they are not liable to hoven. When fed in conjunction with grain for topping off, excellent results are obtained.

Stock, when unaccustomed to feeding on rape, will not take to it readily at first and confine their attention to any grass or cereal crops that may be in the paddock. But once they acquire a taste for rape, they eat it with great relish.

Value as a Soil Renovator.

Besides its value as a fodder, rape is extremely valuable as a soil renovator, and it may be ranked next to vetches as a green manure crop in orchards. Its vigorous root system penetrates the subsoil for several feet, and comparatively large air-channels are formed upon the decay of the tap-roots, which assist materially in the amelioration of the soil.

Rape, in common with other plants having broad leaves, obtains comparatively large quantities of carbon from the atmosphere which, when ploughed under, increase the humus of the soil, so essential to the beneficial micro-organisms of the soil that are indispensable to fertility. It also ensures the physical condition necessary to circulation of air. Soils deficient in humus readily get out of condition with heavy rains.

On account of the vigorous growth allowing numbers of stock to be carried for several months of the year, large quantities of readily soluble plant-food are returned to the soil in the forms of liquid and solid excreta.

After the crop has been grazed off, the land should be ploughed and the residues turned in. Humus is thus added to the soil, and this, together with the improved physical condition, allows the soil bacteria free scope for the discharge of their functions. Plant-food is thus rendered available to give the following wheat or other crop the fillip in the early stages that is so necessary to vigorous development.

Some indication of the quantity of feed that rape will supply is afforded by an experiment conducted at Hawkesbury Agricultural College. Five different plots were planted on the 30th March, and on 15th May, less than seven weeks later, various plots gave yields (computed) of 5 to 11¼ tons per acre.

Suitable Soils and their Preparation.

The soils best adapted for rape are the rich, friable loams. Those which grow maize and potatoes profitably are very suitable, but with good cultivation rape does well on ordinary wheat land.

The land should be ploughed, whenever practicable, some time before sowing, to allow such necessary tillage as harrowing, &c., to be given. Areas cut for hay can be ploughed earlier, and time allowed for the proper preparation of the soil. Better still, however, is the devotion of a small portion of the fallowed land to rape growing. It can easily be understood that a crop of rape will do very much better on fallowed land than on non-fallowed land.

The surface should be worked down fine prior to seeding to ensure that the seed shall be covered uniformly from ½ inch to 1 inch deep. In addition to the thorough working of the land, a roller should precede the drill (especially in dry districts), so that a more even germination may result. The seed, being small, does not germinate when covered too deep.

In numerous experiments with different varieties, Dwarf Essex has in every instance given the best results from a fodder point of view, and it is the one that must be recommended to farmers.

Sowing and Manuring.

In the absence of a seed attachment to the drill the best results are obtained by mixing the seed with superphosphate and sowing through the manure box. Regular and thorough mixing of seed and fertiliser is necessary, as the seed is apt to work to the surface with the vibration, and cause uneven sowing.

Where it is intended that rape shall be cut as green fodder and supplied to stock, it is advisable to make the sowing much lighter than where it is to be grazed by either sheep or pigs. The drills should then be made 2 feet 6 inches to 3 feet apart, instead of 7 inches, and 1½ lb. to 2 lb. of seed per acre sown instead of 4 lb. Everything being equal, drilled rape grows higher than broadcasted rape, which is an advantage in cutting the fodder.

Almost throughout the State, the end of February or the beginning of March is the best time to sow. In cold districts like New England a spring sowing may be made, and poultry-farmers near Sydney can sow a succession of small patches in the spring and again in autumn, but as a grazing crop in wheat districts early autumn is the most profitable season for sowing.

When grown in small areas there is nothing equal to ordinary farmyard manure for this crop. Unfortunately, this material is produced in limited quantities, and large areas, if manured, must be treated with fertilisers, preferably superphosphate.

When rape is sown in rows better results can be ensured by keeping down all weeds by cultivating constantly between the rows. The effect is not only to remove the competition of the weeds, but to conserve moisture.

Feeding-off.

If the season proves favourable, rape should be fit to graze in about eight to ten weeks after sowing. If there are several paddocks, they should be grazed alternately, one being grazed, say, for a fortnight, and the others

A Crop of Rape, Bathurst Experiment Farm.

allowed to recover. Continuous hard grazing is not satisfactory. If there is only one paddock, it should be subdivided and treated as above. Spring-coil netting makes an excellent temporary subdivision for sheep, and areas of any size may be operated upon, very little labour being entailed in shifting the fence.

Sheep Depastured on Rape.

In cold districts growth may be suspended throughout the colder months. Upon clay soils in districts of heavier winter rainfall, the tramping of the stock would interfere with the satisfactory conditions of the soil for its growth. Under such conditions, the sandy friable soils would be preferable for winter grazing.

KALE.

The several varieties of kale belong to the same family as the cabbage, but do not form hearts like the latter plant. The open leaves and tender stalks possess considerable feeding value, whether used for soiling cattle or for grazing sheep. Kale is also an excellent feed for pigs and poultry, or as a green vegetable for humans. It thrives well in districts which are sufficiently cool and moist, but its cultivation is not recommended in the hotter and drier parts of the State.

A well-drained soil should be selected for the crop, and the land brought to a fine tilth. Seed should be sown in drills as soon as the frosts have ceased; or plants may be raised in a seed-bed and transplanted. The latter method requires less seed, but, of course, entails much more labour. Green fodder will be obtained from April to October of the following year. To avoid tainting milk, it should be fed to dairy cattle just after milking.

The best known variety is Thousand-headed. Jersey Tree is a tall-growing sort, and fairly well liked. Both these are preferable to Marrow Kale (Chou moellier), which has too large a proportion of stem to the leaf growth.

LINSEED.

This crop is grown for two main purposes:

(1) The production of flax (the fibre used in the manufacture of linen), and

(2) The production of the seed for oil.

The Department of Agriculture is anxious to promote and encourage its cultivation in New South Wales, but the experiments carried out so far are not promising.

Most authorities on linseed culture agree that it is necessary to have light but frequent falls of rain during the growing season, and a humid atmosphere to give the best results.

As at present cultivated in Europe and other parts of the world, the limitations as to climate are rather sharply defined. Generally speaking, linseed grows best in the colder parts of the temperate regions.

In North America the bulk of the linseed is produced in Canada and the northernmost limits of the United States (where the climate is distinctly cold).

In New South Wales the experiments with linseed have been largely conducted in the wheat districts, because the machinery used on the wheat farm is necessary for dealing with the seed crop. In most of these districts the rapid increase of temperature and diminution of the rainfall which characterise the spring and which are so favourable to the production of an excellent sample of wheat, do not seem to be so well suited for the production of linseed.

Some years ago experiments with linseed were carried out in twenty-three centres in the State, and in the following year in forty-one centres.

The results of these trials were by no means encouraging, although it must be added that both seasons were unfavourable. In most of the trials only a few pounds of linseed per acre were obtained, and even in some favoured localities where 25 bushels of wheat per acre were harvested, only 3 or 4 bushels of linseed per acre were obtained.

At Yanco, under irrigation, linseed was tried for several years, and the best crop obtained was 14 bushels per acre. This yield, however, is not considered profitable in comparison with other crops which can be grown on this area under irrigation.

Although most of these experiments have been made to determine whether profitable crops of linseed can be raised in this State, the crop for fibre or flax has also been kept in view, but no hopeful results have been obtained in this direction, few of the crops making more than 12 or 18 inches of fibre at best.

Experiments with linseed are still being continued by the Department with a view to determining those districts in which profitable or hopeful results can be obtained. Seed will be supplied gratis to anyone who would like to make a trial with this crop. Application should be made to the Under-Secretary, Department of Agriculture, Sydney.

SECTION IX.

Vegetable Crops.

In this section only those crops that are grown by farmers under what may be called field or extensive conditions are dealt with. Hence it is that only a limited number of crops are discussed, and in a manner that presumes production on a fair scale, though the alterations in method where only a small area is contemplated will really be few.

For convenience, certain crops are included in Section VI, "Root Crops"—the potato because it is grown on such a large scale as to make it the most important of all roots, and others, like the turnip, the sweet potato, and the artichoke, because they are grown even more extensively as food for stock than as vegetables for human consumption. Sweet corn is treated in conjunction with maize, to which it is closely related.

CAULIFLOWERS AND CABBAGES.

With the ever-increasing population of Sydney and inland towns, it would appear that the cultivation of these crops can yet be extended with every likelihood of profitable returns to the growers. Apart from the metropolitan markets, there are many instances in which cultivation for local requirements could be extended. Even in the most fertile division of the State—*i.e.*, the North Coast—it is common to see large quantities of these vegetables on the boats from Sydney. Also in many of the inland towns, where the conditions are suitable, the quantity grown is not sufficient for requirements. At Goulburn, for instance (which by virtue of its situation should be on a level with the Bathurst district in production), consignments are sometimes brought from as far back as Wagga.

Many people are under the impression that the growing of these vegetables for Sydney market is confined to the Chinese; but such is not the case. In the vicinity of Sydney most of the market gardens are controlled by Chinese; but in inland districts, where the gardens are not of such a mixed character—where practically only one or two varieties of vegetables are grown—the areas cultivated are chiefly worked by Europeans.

The advent of motor transport and the increase of good roads are playing a part in developing vegetable growing areas. Many districts within 30 or 40 miles of the metropolis have developed largely of recent years, through the facilities offered by motor transport, which has also resulted in a greater number of local farmers giving more attention to vegetable crops.

Cauliflowers.

Although belonging to the same family as the cabbage, the cauliflower is not grown to nearly the same extent. This is due chiefly to the necessity for more favourable conditions during the growth of the plant than are required by other members of the same order.

The district in which the greatest area in this State is devoted to cauliflowers is in the vicinity of Bathurst, including Esrom, Orton Park, Perthville, Campbell's River, and White Rock. The crop is also grown fairly extensively in the Hunter River Valley, mainly to supply the Maitland and Newcastle markets, and a large area is also grown in the Windsor district.

Good cauliflowers are produced in many other districts, but their cultivation is not so extensive as in the districts named. One of the chief limiting factors in the success of the crop is the need of a quick service to market. It is essential, if best prices are to be obtained, that the produce should be placed on the market within twenty-four hours of harvesting.

It is preferable to grow this crop so that the flowers form in the cool months. The ideal climate is one in which the days are fairly warm and the nights cool, such as is experienced in the tableland districts.

The Soil and its Preparation.

The soils most suitable for cauliflowers are alluvial flats that are fairly rich in organic matter, due to periodical flood deposits. These soils are usually fairly loose in texture, and, being situated on the banks of rivers and creeks, are generally well drained. As a rule the rental value of land of this character ranges from £2 to £6 per acre.

The land should be well prepared, and this is best effected by working a rotation on the farm. A crop such as early potatoes could be harvested in time to allow of cauliflowers being planted out. Again, the cultivation during the growth of potatoes reduces the soil to a suitable tilth, and renders it free from weeds. By employing such a rotation, the land is in use during the spring and early summer months. On account of the risk of reducing the amount of available moisture in the soil by the growing of a crop during the spring months, the practice is not recommended in districts where irrigation cannot be carried out and the rainfall is scanty. If it is desired to bare fallow the land before planting, the soil should be ploughed in spring and cultivated during the summer months to kill weeds and conserve moisture. If it is intended to apply farmyard manure, this should be ploughed under when the spring ploughing is carried out.

Varieties.

Early Snow White and *Snowball* are suitable early varieties which should be ready for harvesting towards the end of May if seed is sown in mid-December.

Good later varieties are Phenomenal, Autumn Giant, and Late Metropole.

Use Good Seed.

The use of good seed is most important, and most growers are fully aware of this fact. Bad seed is dear at any price, because, no matter what attention is paid to the crop during growth, there will always be a large proportion of useless plants. Many growers undertake the growing of seed for their own requirements; they select desirable types of plants from the main crops, these plants are marked and allowed to run to seed, the balance of the stumps and poor types being removed or ploughed under so that no poor types will produce seed. Such a course for securing good seed is recommended to all growers.

Good seed should give a 90 per cent. germination, and should not be kept for more than three years after harvesting. As there is little difference between one- and two year-old seed, it is advisable for the grower to buy his supply of seed one year in advance. This allows of a small portion being planted, so that its relative value may be gauged one year in advance.

Cauliflowers at Campbell's River Lagoon.

Raising the Plants.

For main crop sowings, the plants are put out from the end of December to the end of February, the seed being sown about six weeks prior to the time of transplanting. The seed-beds should be made where they will be constantly under observation, and where every care can be bestowed upon them. The beds should be wire-netted, as it does not take long for a rabbit or fowls to cause almost irreparable damage.

The beds should not be too wide; they should allow of half being weeded from each side; a suitable width would be about 4 feet. A bed large enough to produce plants for one acre when seed is broadcasted would be 20 feet long and 4 feet wide. It is always advisable to put in sufficient seed to raise more plants than are actually needed. This allows for loss by pests, faulty germination, and the transplanting of healthy plants only.

Two or three ounces of seed is more than sufficient to supply plants for one acre.

The best method of raising plants is to sow the seed in drills in the seed-bed, allowing about 4 inches between the rows. Plants raised in this manner are usually sturdy, and differ from the lanky plants obtained from beds where the seed has been broadcasted. The seed should be sown thinly, and each ounce of seed should sow a length of about 200 feet.

Another method sometimes adopted is to sow the seed broadcast in boxes, and when the young plants have two good leaves on they are pricked out and planted into other seed-boxes in rows about 1 inch apart, where they are left until they obtain their fourth leaf. After this the plants are transplanted into rows 4 inches apart in the beds, remaining there until

ready for transplanting, being then about 4 or 6 inches high. This method is more often employed for cabbage when seed is raised during the winter months.

The seed-beds should have a north-easterly aspect, and should be protected from the westerly winds. The young plants should be watered occasionally in the seed-bed, but should not be forced so as to make them spindly.

The soil in the seed-bed should be of good texture, and, if possible, a quantity of well-rotted farmyard manure should be incorporated. The organic matter supplied by the manure regulates the water-holding capacity, and also offers less resistance to the tender roots in their development. After the seed has been sown, it is advisable to scatter dry, finely pulverised manure lightly over the surface of the bed. This acts as a mulch, and prevents caking of the surface soil, thus offering no resistance to the young plants when germinating.

Transplanting.

If possible, a dull day should be chosen, but with a large area it is impossible to choose so carefully. If the weather is very hot and the planting cannot be postponed, it should be done during the latter part of the afternoon. When this is the case part of the morning can be employed in lifting the plants in readiness for afternoon planting. The plants when lifted should be laid straight and covered with wet bags.

Unless the soil is very dusty and hot, the dibber holes are better left dry until after planting, but the roots should be covered with puddle (liquid mud) to prevent injury. After the soil has been pressed firmly round the roots, a quantity of water should be applied in order to give the plants a fair start.

The quickest method of planting by hand is to have a boy dropping the plants a few holes ahead of the man planting. The boy can then carry the plants in a bucket, so that the roots are constantly in puddle.

If the plants are somewhat large, it is wise to screw the tops off the leaves. This considerably reduces transpiration, and the roots are able to keep up the supply of moisture needed.

For early varieties the planting is usually closer than for the later varieties. For the former the distance is usually 3 feet x 2 feet 6 inches, requiring about 5,800 plants per acre, and for the latter 3 feet x 3 feet, requiring 4,840 plants per acre.

Manuring.

It is essential that soils for this crop should be well supplied with organic matter. Unless frequent applications of organic manures are made, the supply of this constituent is soon depleted, and the grower wonders why his soil does not produce profitable crops. The tendency of European growers is to grow these crops until the natural fertility of the soil has been considerably reduced, and then abandon cauliflower cultivation.

Most of the river flats are rich enough to grow several crops without the application of farmyard manure, and where the land is subject to periodical floods and benefits by flood deposit, there is scarcely any need for heavy manuring.

Where the soil is not naturally rich and the crop requires stimulating, the following application of artificial fertiliser will usually be found to be productive of good returns. Apply a mixture of dried blood, bonedust, and

superphosphate in equal quantities at the rate of not less than 6 cwt. per acre, and later (usually just before the heads begin to form) a top-dressing of sulphate of ammonia or nitrate of soda at the rate of 1 cwt. per acre. Care should be exercised in making this top-dressing, and it is advisable to mix these nitrogenous manures with a bulk of earth or sand in order to facilitate distribution. The application should be made to the soil between the rows and contact of the manure with the plants avoided.

Cultivation.

Cultivation between the rows with the horse cultivator should be continued at short intervals, until the plants are too big to allow of it being carried on. If plants are not planted on the check system, which allows of cross cultivation, chipping-hoes will have to be used to keep down weeds, and establish the earth mulch between the plants.

Tying.

The practice of tying the outside leaves over the plant to protect the flower from weather influences has its drawbacks, and is seldom adopted in this State. The chief difficulty is the trouble of determining whether the plants are ready to harvest. Some growers use a different coloured band each day, so that when examining for fitness for market they can pick out the mature heads by the various coloured bands. This method is a satisfactory one, if the development of the heads is even.

It is very important that the flower should be kept clean and white. While the head is small, it is well protected by the young leaves surrounding it, but when the coral head begins to grow rapidly, it must be covered in some manner to protect it from sun and frost. This is usually accomplished by breaking off some of the largest outside leaves, and placing them amongst the other leaves so as to cover the head properly, or it may be done by bending over some of the larger inner leaves.

Harvesting.

As soon as any of the plants become fit for harvesting, examination of the field must be made daily, and heads must be cut before they show signs of the flower stalks breaking away, thus giving the head an uneven, loose appearance.

The cutting is usually done with a large knife, the plants being cut about 3 inches below the head, keeping all but the outside, dirty leaves to avoid damage in transit. The plants, when cut, may be carried to convenient heaps round the field; or, if the waggon or cart can be taken through the crop without damaging the growing plants, they may be loaded direct.

The weight of cauliflowers, as marketed, varies with the size, ranging from fifteen to twenty dozen per ton.

Yield and Returns.

The yield varies considerably, according to the season and the variety grown. When good seed has been used, and irrigation has been practised, the yield from main crops can be reckoned at about 400 dozen per acre. This *flows of very few misses, but this yield is frequently obtained under the* above conditions, even when planted 3 feet x 3 feet apart.

With cauliflowers selling at 5s. per dozen, a yield of 400 dozen per acre would give a gross return of from £100 per acre. This return should allow of a substantial profit being made after paying all expenses.

The prices taken for the purpose of showing the probable return are the average prices obtained for medium grade. Prime cauliflowers would average at least 6s. to 12s. per dozen, while the small ones would not bring more than 2s. 6d. per dozen. This latter grade is often sold to the local pickle factories.

Care should be taken not to plant a greater area than can be properly attended to. By attempting too much, many a grower has failed. The area to be worked per man should not exceed 3 or 4 acres.

The cost of transport by road to rail can usually be estimated at 1s. per ton per mile.

Cabbages.

The cultivation of this crop is practically identical with that of cauliflowers, and it will only be necessary here to deal with any points of difference.

The largest cabbage-producing district in this State is undoubtedly Burrawang, situated about 9 miles from Moss Vale, and in the surrounding localities, including Wilde's Meadow, Myra Vale &c., and extending to Robertson and Kangaloon. About 300 tons are consigned from Moss Vale Station every month during the season, and large quantities are also sent out of this district from Bowral. Large areas are also grown in the suburban gardens, as well as at Gosford and in the Maitland district.

The crop can be grown in practically every district in the State. Nearly any soil will grow cabbages successfully if sufficient manure and decaying vegetable matter are added to keep it in good physical and chemical condition.

As a rule, in the Burrawang district, the rich volcanic soils are chiefly used for the winter crop, and the lower land for the summer crop.

This vegetable has, perhaps, a wider range than any other, being more or less successfully grown in the hot interior and on the cool tablelands. It is essentially a cool climate plant, and when grown in the hot districts must be planted so as to mature before the heat of summer.

Varieties.

Succession (*Henderson's*).—This is a very popular variety, and the one most largely grown. It is fairly early, has large flat heads, closely packed, carries well, and is a favourite on the market. It stands the heat of summer fairly well, and does not run to seed quickly. The best all-round variety grown.

St. John's Day.—This is one of the best for hot climates. It is very early and produces a firm heart. A small cabbage.

Improved St. John's Day.—This is the best of summer cabbages, and altogether distinct from the small St. John's Day, being somewhat later and larger.

Enkhuizen Glory.—This is a variety which has come into favour of late years. It forms a very solid heart which holds well. This is not a large cabbage, but is of a size suitable for market.

Savoy.—This is a very crinkled type of cabbage, having a very dark green colour and a distinct flavour. It is especially suitable for the cooler portions of the State, being planted in February so as to mature during autumn and winter, flavour being considered best after exposure to frost.

London Market.—This is a good crop main variety for autumn planting.

Early Jersey Wakefield.—An early sort, and largely grown in small gardens. It has a very pointed heart, and should be cut as soon as ready for use, otherwise it will run to seed.

Pickling Cabbage.—The cultivation of this class of cabbage is identical with that for the other varieties. Most are red in colour.

Cultural Methods.

In some portions of the State, and chiefly during the winter months, cabbage plants are raised from seed in hot-beds, and gradually hardened off before planting. As with cauliflowers, the seed should be sown six weeks before the plants are required in warm weather, but during the cooler part of the year two months should be allowed.

The distance varies according to the variety used. For the smaller varieties, such as St. John's Day, 2 feet 6 inches x 2 feet is sufficient, and for larger sorts, as Savoy and Succession, 3 feet x 2 feet. If the soil is of poor quality the plants should be given more room, and should be planted 3 feet x 3 feet. When planted at this latter distance on rich soils, the tendency is for the plant to become too large.

The time to harvest is when the heart is fully developed, and does not yield to pressure from the hand.

Cabbages being planted closer than cauliflowers, the yield is, consequently, larger in number of heads, and a yield of from 500 to 600 dozen per acre can be expected in average years.

Diseases of Cabbage and Cauliflower.

The organisms causing most cabbage and cauliflower diseases are able to live over, often for a number of years, in the soil on which diseased crops have been grown. For this reason every effort should be made to prevent the introduction of disease into the field with the seed or with diseased seedlings. Seed treatment before planting is effective in preventing the introduction of some diseases. In all cases new soil should be used for the seed-bed each year. When this is not possible the seed-bed may be sterilised with steam or with a solution of formalin, using 1 quart of commercial formalin to 12½ gallons of water, and watering the solution on the beds before sowing at the rate of ½ gallon per square foot. The soil should then be covered with bags, heavy paper, or other impervious material for twenty-four hours, and allowed to stand for five to seven days after the removal of the covering before the seed is sown. An infected seed-bed may cause numerous infected seedlings, which will carry the disease to the field.

Black Rot.

Black Rot is a vascular disease caused by the organism *Bacterium campestre*. It results in dwarfing and rotting of the plants, spotting and blighting of the leaves, and in severe cases death of the plant. In addition to cabbage and cauliflower, kale, kohlrabi, rape, turnip, and most other

cruciferous plants are liable to attack. The plants are attacked in all stages of growth, from the youngest seedling until the time of harvesting. When young plants are attacked severely they may be destroyed in a few weeks. The severity of the disease varies with the season; in warm, moist weather it may destroy an entire crop, whilst in ordinary weather the plants may survive throughout the season.

The earliest symptom of the disease, especially in cabbages, is usually a yellowing of the foliage, beginning at the margin of the leaf, together with a characteristic blackening of the leaf veins. Infection commonly occurs through wounds made on the leaves by insects and slugs. The organism passes down the veins of the leaf, causing them to become blackened to the main stem, from which it may pass into healthy leaves and up into the centre of the head. Often a part of a leaf, or one side of a plant only, will be attacked, resulting in a one-sided development of the plant. Leaves of an affected plant will wilt, turn yellow, and dry up, finally falling off in succession, and leaving, in bad cases, a more or less elongated stem, covered with leaf scars and crowned with a tuft of small leaves. Dwarfing is one of the common effects of the disease. In advanced stages of the disease the stalks of affected leaves, or the main stem on being cut across, will show a brown or black discolouration.

Black Rot frequently opens the way for invasion by other bacteria which cause a destructive soft-rot which may spread throughout the head and transform it into a black, slimy, foul-smelling mass.

In cauliflower, the leaf injuries commonly dry up without spreading, and the dead tissues may fall out, leaving irregular perforations in the leaf.

The source of the primary infections in any outbreak of the disease may be from contaminated soil or from bacteria which are carried on the surface of the seed. Manure containing diseased refuse may contain the parasite, and in such material, or in ordinary soil which has produced a diseased crop, it may persist from one season to another.

Control Measures:—

1. If the seed to be used is not known to be taken from a crop free from disease, it should be dipped in a solution of corrosive sublimate (1 in 1,000) for thirty minutes, as recommended for Black Leg (see page 654).

2. Care should be taken to use in the seed-bed only soil on which cabbages or related plants have not been grown for at least five years previously, and to avoid the use of manure from animals which have grazed on diseased plants. If the same seed-bed must be used year after year it can be sterilised with steam or formalin.

3. The disease may be carried from field to field by surface water, by live-stock, &c., and good cultural and sanitary practices will serve to minimise the disease. Black Rot is spread by insect pests to some extent, and attention should be paid to their control. Pull and destroy diseased plants as soon as they are detected, but do not throw them on the manure heap.

4. The disease may live over in the soil of infected areas for some time (four to five years), and a rotation of crops omitting cabbage, cauliflower, and related crops and weeds, such as mustard and Shepherd's Purse, is recommended where possible.

5. Late planting is recommended where possible, especially for cauliflower. Black Rot is a warm-weather disease, and can be avoided by planting late enough so that the crop develops during the cool autumn months.

Club Root.

The causal agent of this disease, which is able to attack practically all cultivated crucifers, is a slime mould fungus—*Plasmodiophora brassicae*. The disease derives its name from the distortion or swellings, sometimes as large as two fists, which are produced on the roots of affected plants (see illustration). The swellings are usually somewhat elongated and finger-like—sometimes they are globular. Few or no lateral roots are formed. The distorted roots fail to absorb nourishment from the soil, with the result that the plant declines in vigour and frequently wilts and dies. Diseased seedlings have a stunted and sickly appearance, and seldom grow to maturity. Plants attacked in the field are usually not so badly affected. The swellings may be confused with root-knots caused by eel-worms, but the latter are, as a rule, not so large as the malformations associated with Club Root.

Club Root of Cabbage.
(Plasmodiophora brassicae.)

The parasite lives within the cells of the roots, and its presence stimulates the cells to very active growth, thus producing the remarkable enlargements of the underground portions of the plant. When the swollen roots decay towards the latter part of the growing season the parasite is liberated in the soil, where it is able to live for from three to six years, or to attack succeeding crops planted on the same ground, or from whence it may spread to new fields. The disease is spread by the use of infected seedlings, by drainage water running from contaminated to healthy soils, in contaminated manure, on farm implements and on the feet of animals. Unlike most cabbage diseases, Club Root is not carried with the seed.

Control Measures.—The various practices bearing on the control of the disease are as follow:—

1. Care should be taken to prevent the introduction of the disease into clean areas by planting only healthy seedlings. Seedlings should be carefully examined when transplanting, and if they show signs of Club Root should be destroyed.

2. If Club Root is known to be prevalent, precaution should be taken to make the seed-bed on uninfected or, at least, on sterilised soil. Diseased roots should be thoroughly boiled before feeding to live stock, as the spores of the organism will survive passage through the digestive tract of animals, and might be carried to clean fields with contaminated manure.

3. Club Root is likely to increase in severity until the entire soil becomes heavily contaminated if cabbages are grown year after year on infected land. A rotation of crops for as long a period as possible (three to six years) should therefore be practised. Cruciferous weeds should also be destroyed.

4. The use of lime has long been practised with success, and it should certainly be adopted for contaminated soils on which rotations of sufficiently long durations are not practicable. The application of 2 to 4 tons of air-slaked lime per acre is recommended. It should be thoroughly worked into the soil to a depth of 6 to 9 inches three to six months before planting.

5. The direct application of farmyard manure is favourable to the disease, hence it should be applied to the crop preceding a cabbage crop, but not to a cabbage or turnip crop itself. The same remark applies to acid-producing fertilisers.

6. An excess of moisture in the soil is favourable to the development of Club Root, and low-lying or poorly-drained soils should be thoroughly drained, and the physical condition of the soil improved as much as possible.

7. The transport of the disease from infected to healthy fields by drainage water, in diseased refuse and manure, on farm implements, and on the feet of animals should be guarded against as much as possible.

Wire-stem.

Wire-stem of cabbage, cauliflower, brussels-sprouts, and kale is caused by the fungus *Rhizoctonia* (*Corticium vagum*). It is first evident in the seed-bed when the seedlings are 1 to 2 inches high as a typical damping off. The stem becomes watersoaked at the surface of the soil, and the plant may fall over and die. Usually most of the seedlings recover partially, and their characteristic appearance suggests the name of the disease. The cortex of the stem is usually partly destroyed in such plants, causing a marked constriction at the base of the stem, which often extends over an inch above the soil. A crooked, dwarfed plant with a peculiar tough, woody, wire-like browned or black stem results.

Control Measures:—

1. The seed-bed should be changed from year to year and general sanitation practised.
2. Where clean or sterilised soil cannot be used in the seed-bed, the disease may be checked by watering with corrosive sublimate at a strength of 1 oz. to 10 gallons of water. Five applications at weekly intervals, beginning as soon as the plants are through the ground have given good results. One gallon of the solution is at first sufficient for about 40 feet of row; when the plants are older 1 gallon to 20 feet of row is necessary. Corrosive sublimate is a deadly poison and should be handled with care. It should be mixed only in earthenware, wooden, enamel, or glass vessels. A more dilute solution is required for cauliflowers (1 oz. to 15 gallons).

Downy Mildew.

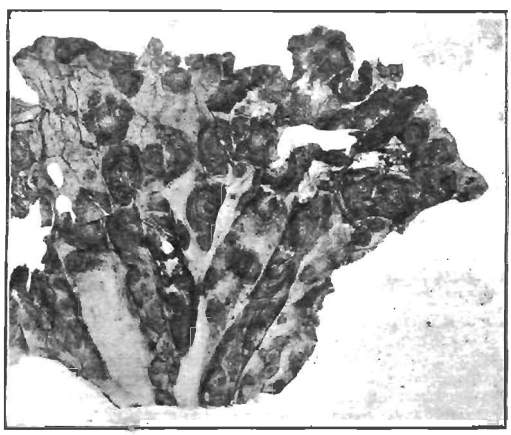
This disease probably occurs wherever cabbages are grown, but seldom causes any serious loss except in seed-beds. It is caused by a fungus, *Peronospora parasitica*, which is able to attack probably all cruciferous plants. The mildew first appears in the seed-bed as a whitish mould in isolated spots on the under surface of the leaves. It may also occur on the stems. The parts of the leaf immediately surrounding the diseased area appear yellow, and later turn brown and dry up. Frequently light areas occur in the centre of a dark ring, which in turn is surrounded by a light or yellow area, thus presenting a mottled appearance. The diseased spots may be of any size varying from a quarter inch to several inches in diameter. The larger spots are usually irregular and are bounded by the leaf veins. On young seedlings the whole leaf may be mildewed. The fungus lives over from season to season in old diseased plant parts. The disease is favoured by the presence of moisture.

Control Measures:—

1. The seed-bed should be changed from year to year, and the plants should not be grown too thickly or kept too wet in the seed-bed.
2. If there have been frequent losses due to the disease, the plants in the seed-bed should be sprayed about every ten days with Bordeaux mixture (6-4-50 strength), commencing before the disease appears.

Black Leg.

This destructive disease of cabbage, cauliflower, and related cruciferous plants, such as brussels sprouts, kohl-rabi, rape, kale, turnips and radish,



Cabbage leaf affected with Black Leg.

is caused by the fungus *Phoma lingam*, which may invade the root, stem or leaves of the plant, the worst damage occurring when it attacks the roots of young plants either in the seed-bed or the field. The first symptom is *usually a sunken, brown, oval area on the stem near the surface of the ground.* The disease spreads around the stem and downwards into the roots, causing a decay of the roots, resulting in wilting and finally the death of the plant. Affected stems become dark in colour, and the fibrous and lateral roots are killed, suggesting the name Black Leg (see accompanying illustration). The edges of the leaves of affected plants often turn a bluish-red or purple colour. When the stem and roots decay late in the season the weight of the head may cause the plant to fall over. As seen in the field after transplanting, *the root-rot does not affect that portion of* the root just below the soil, and brace roots are often produced from this area which enable the plants to recover partially if the upper layers of soil do not dry out.

Cabbage Root affected with Black Leg (*Phoma lingam*).

Brown spots are also produced on the leaves (see illustration on page 654). These are at first circular, but sometimes run together later, forming elongated dead areas, the spread of which laterally is checked by the main veins of the leaf. *Seed stalks and pods are also attacked.*

Soon after the diseased areas appear on the plant they become dotted with numerous small, black specks,—the fruiting bodies of the fungus. The presence of these fruiting bodies serves to distinguish this from other cabbage diseases.

The parasite may be carried either inside or on the surface of the seed. A few infected seeds may result in serious development of the disease in the seed-bed. When once introduced into a field, the fungus lives over from season to season on fragments of diseased stems and leaves, which may persist for two or three years until they have fully decayed.

Control Measures:—

1. The first precaution lies in the use of clean seed and of clean soil in the seed-bed. New soil, free from cabbage and cauliflower debris, *should be used for the seed-bed where possible.* If old or doubtful soil must be used, it should be sterilised. When seed is not obtained from plants known to be free from disease it should be dipped for thirty minutes in a solution made up of 1 part of

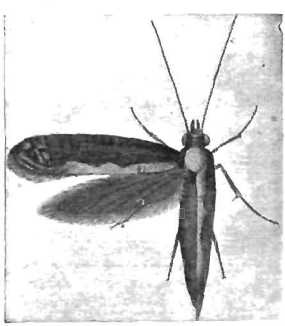
corrosive sublimate to 1,000 parts of water (approximately ½ oz. to 3½ gallons of water), after which it should be thoroughly washed in clean water and dried. The seed can be tied loosely in a piece of hessian or cheesecloth, allowing sufficient free space inside the sack for agitation of the seed. Corrosive sublimate attacks various metals, and the solution should therefore be made up in an earthen-enamel, glass or wooden receptacle. It is extremely poisonous and should be handled with great care.

2. In the case of the development of the disease in the field, crop rotation should be practised, and, in general, sanitation measures should be adopted. These involve such precautions as can reasonably be taken to destroy or keep diseased material from scattering. Diseased plants should not be placed on the manure heap or fed to animals. A rotation of crops omitting cabbage, cauliflower and other susceptible crops for at least two or three years should be used where possible.

Insect Pests of Cabbage and Cauliflower.

The Cabbage Moth (*Plutella maculipennis*).

Under the name of "cabbage grub" or "cabbage worm," the caterpillar of the diamond-backed cabbage moth, once a European turnip pest, but now world-wide in its range, is well known to Australian cabbage and cauliflower growers, as well as to the consumer who finds the little green worms among the leaves of his purchase.



Diamond-backed Cabbage Moth, viewed from above. [Enlarged.]

The life-history of this moth may be briefly outlined as follows:—The minute eggs are deposited usually on the under surface of the leaves. The eggs hatch in from three to six days; the larva or grub stage occupies about nine to twenty days, and the pupal stage in the tiny cocoon occupies about six to twelve days.

The newly-hatched grub or larva is a minute pale-green caterpillar with a dark head. At first these grubs do not eat right through the thick, fleshy leaf, but remove the lower surface only, leaving the upper epidermis to appear as a glassy spot in the leaf.

As they increase in size, they become slender, bright-green caterpillars (popularly known as "cabbage worms") which feed upon the leaves and gnaw holes right through them. At first they confine their attention to the larger outer leaves, but as they increase in numbers they gnaw all through the plant, and if they are allowed to reach this stage the cabbage

or cauliflower is soon of no marketable value. The caterpillars are active little creatures, and if touched they roll away or drop from the leaf to the ground, often hanging suspended on a silken thread, and thus may escape their many enemies. When full-grown they spin a lace-like, elongated cocoon of silken threads, attached to the under-surface of the leaf, often along the midrib, and there they pupate. The pupa is at first green, but changes to dull brown, and finally reveals all the delicate outlines of the coming moth, enclosed in the pupal skin.

The adult is a minute, slender moth, greyish to brownish in colour, and measures about five-eighths of an inch across the outspread wings. It has a row of angular, pale-yellowish markings along the upper margins of the folded wings. It is because of these markings that it was named the diamond-backed cabbage moth.

Prevention and Remedies.—Clean cultivation is an important factor in the control of cabbage moth, and one that cannot be too strongly emphasised. It is often the practice to leave all unsaleable cabbages or cauliflowers, or the stumps from which the "heads" have been cut, in the ground long after the crop has been harvested. This provides a continuous breeding ground for the moths, which infest the young plants as soon as they are put out—very often alongside the abandoned plot. All useless plants and stumps should, therefore, be cleaned up and properly destroyed as soon as the crop is harvested. Many insecticides have been tried for this pest, but tobacco dust and lime, kerosene emulsion, and arsenate of lead have given the best results.

Tobacco dust and lime is applied to the plants as a dust in the proportion of one part of tobacco dust to four parts of lime. The dust is best applied in the early morning while the dew is on the plants. It is important that the plants should be dusted several times, or whenever necessary, particularly in early stages of growth.

Kerosene emulsion made according to the directions contained on page 658 (see Cabbage Aphis), should be sprayed on to the plants regularly, one application being insufficient.

Arsenate of lead is considered the most efficient for the control of cabbage moth. The arsenate of lead (powder) is used at the rate of 1 lb. to 40 gallons of water, with 2 lb. of laundry soap added to make the spray adhere to the surface of the leaves. Both the kerosene emulsion and the arsenate of lead should be applied, in the main, on the younger plants, commencing even while they are still in the seed-bed. It is considered that if regular early sprayings are carried out these will protect the young and middle stages of growth of cabbages and cauliflowers, reduce the infestation of moths, and obviate the need for late sprayings, which are not desirable, especially when applying poisons such as lead arsenate.

Cabbage Aphis (*Brevicoryne brassicae*).

This insect breeds rapidly and sucks the sap from the leaves, giving most trouble on plants which are not making rapid growth. The young aphids are yellowish-green in colour, while the mature forms, which may be either winged or wingless, are of a dull greyish-green, covered with a grey bloom. During the early winter months egg-laying females are developed which usually deposit their small, black eggs in clusters on the stems.

Control Measures.—Spraying with nicotine sulphate (40 per cent. nicotine) 1 part in 800, plus 1 lb. of soap to 25 gallons, or kerosene emulsion is recommended. The proportions of nicotine sulphate and soap, expressed in small quantities, are 2 tablespoonfuls of nicotine sulphate plus 3¾ oz. of soap to 5 gallons of water. The soap should be dissolved in a small quantity of hot water before mixing.

Kerosene emulsion may be prepared from the following materials:—Hard soap ½ lb., kerosene 2 gallons, boiling water 1 gallon. Dilute or dissolve in 22 gallons of water. To make, dissolve ½ lb. of hard soap in 1 gallon of boiling water; then remove the vessel from the neighbourhood of the fire, add the kerosene and churn for ten minutes. One essential condition of success in making this emulsion is that the liquids should be as warm as possible. It is also necessary that the water be as soft as possible.

The main trouble in preparing this compound is in getting a true emulsion, which can only be done by thorough agitation. This is best done by pumping the mixture into itself for some minutes. When this creamy mixture becomes cold, it gets thick and almost solid, and there should be no trace of free oil on the surface. If there is still unemulsified oil, the best plan is to add some more boiling soap solution and pump again. Free oil destroys the foliage. Care should be taken to use the best kerosene and good soap.

Kerosene being highly inflammable, particular attention should be paid to the directions for mixing well away from the fire.

Kerosene attacks india-rubber, consequently the tubing, and indeed the whole spraying outfit, must be well washed with hot water directly after use.

Sometimes it is of advantage to prepare a quantity of emulsion as a stock, for use as required. When this is done and it is necessary to dilute it to make up a spray, this should be done by adding boiling water to it, and not by melting it over the fire, which is dangerous, especially indoors.

Cutworm and Rutherglen Bug.

Cabbages and cauliflowers are also attacked by these pests. Suggestions for the control of cutworms are given in connection with tomatoes on page 702, while Rutherglen bug is dealt with as a pest of potatoes (page 520).

ONIONS.

In view of the large quantities of onions that are annually imported into New South Wales from other States (notably Victoria and Tasmania), and of the natural facilities for the production of the crop which portions of our own State possess, the development of onion-growing into a substantial local industry would seem to be long overdue. New South Wales has ample land of a suitable type, a climate that is particularly well adapted to the crop, and a season several weeks ahead of the southern States, which gives the New South Wales grower a great advantage in marketing. The crop is successfully grown in small commercial areas in many parts of the State, such as Wellington, Goulburn, Bathurst, Ben Lomond, Nowra, Taree, the Hunter River district, Dorrigo, and the Murrumbidgee Irrigation Area. It is thus adaptable to conditions which are typical of a great area of the agricultural districts of the State.

Our farmers are, unfortunately, loth to undertake onion culture, mainly because of the tedious work involved in keeping the crop free from weeds, though weeding is not arduous if care has been taken in the preparation of

the land and a deep preliminary ploughing is followed by a succession of harrowings extending over some months. By this means the work after planting is reduced to a minimum. The use of wheel hoes will be found to lighten considerably the work of controlling weeds during the growth of the crop, and will leave very little to be done by hand hoeing.

Soil and Climate.

The ideal climatic requirements for onions are warmth, ample moisture, and absence of strong winds. Owing to a comparatively deep-rooting habit, however, the crop will withstand excessive heat, and will weather dry conditions longer than most others. The soil chosen should be well drained and of a loose, friable nature, and the best crops are obtained on black or red volcanic or dark sandy loams. The keeping quality and size of the bulbs is largely determined by the nature of the soil. Onions grown in sandy soil mature quickly and are of large size, but they are of poor keeping and carrying quality, while those grown on chocolate or black soils of a stiffer nature have thick skins, keep and handle well, and are of a greater substance and solidity of flesh.

The well drained alluvial soils found in many of our inland and coastal districts are eminently suited to the culture of onions, while large areas of red and black volcanic soils also give good returns without much attention in the way of manuring. On soils which are not naturally rich but which have a good texture, such as many of the light granite soils or those of sandstone origin, good onion crops can be grown provided liberal applications of well-rotted farmyard manure are given and supplemented with dressings of artificial fertilisers.

Varieties.

Hunter River Early Brown Spanish.—A very early variety, round-shaped, a medium keeper, of good flavour, and is particularly suitable for districts of short season for early sowing.

Brown Spanish.—An excellent main-crop variety, large, firm fleshed, a good keeper, and of excellent flavour.

Extra Early Golden Globe, is large and of the shape indicated by its name, matures a week later than Hunter River Brown Spanish, has skin of a golden colour, fine flavour, a good appearance, and is a good keeper.

Market Model (a main-crop variety) is large, even, and brown-skinned, an early maturer, a good keeper, and of good eating quality.

Brown Globe.—Very similar to Brown Spanish.

Extra Early Yellow Globe is large, early, globular, of a nice brown colour, mild flavour, and an excellent keeper.

Brown Spanish (Derwent strain) is thick, brown-skinned, large, an excellent main-crop variety, and an excellent keeper and eater.

Mammoth Silver King is a fine, white, large onion, a medium keeper, with firm flesh, and a mild flavour.

Ailsa Craig is of exceptionally large size, has light-brown skin, mild flavour, and keeps fairly well.

Silver King is an early variety largely grown for the early market.

Early Barletta is the variety largely grown in the Western Districts for early, white bulbs. This variety responds well to transplantation and irrigation.

Manures.

It is essential that when farmyard manure is used it should have been composted to destroy all weed seeds and to convert the plant-food into a condition in which it is readily available to the plants. Heavy dressings of fresh, rank manure are undesirable, producing crops less resistant to disease and favouring the development of "bull-necked" plants. A dressing of 20 tons of well-rotted manure is not excessive on many soils, while little or none is required on the better quality soils naturally well supplied with humus. The use of artificial manures is also recommended. In most cases, superphosphate and bonedust in equal quantities, applied at the rate of 3 cwt. per acre of the mixture will be found beneficial.

Sowing, Transplanting, and Thinning.

Onions may be sown between the end of February and the end of August, according to the variety used and the earliness of the district. To ensure the crop ripening before the heat of summer in short-seasoned districts, early sowing of early-maturing varieties is advisable. The seed-bed must be fine and moist at sowing time and must have a firm subsurface. The seed may be sown *direct* (by hand or by machine) in drills 10 to 18 inches apart at a depth of ½ to 1 inch according to the looseness of the soil, or in nursery beds for transplanting. The latter method is to be preferred, as it ensures a more even stand, larger bulbs, and a considerably increased yield. Transplanting should be done when the plants are 3 or 4 inches high, and it is advisable to cut the tops of the young seedlings to within an inch of the crown, *and to trim the roots in order to encourage deep rooting*. About 3 lb. of seed per acre is required if it is to be drilled in, and 1 to 1½ lb. if it is to be sown in the seed-bed. Only seed that is fresh should be used, for it *quickly loses its vitality*. *The after-cultivation of the crop consists of hoeing* and hand weeding, and this should be commenced as soon as there is no danger of covering the plants with soil. It is essential that all weed growth be kept *absolutely in check*.

When the seed is sown direct in the field, thinning is usually necessary if all good sized bulbs are required. The work of thinning is a very slow and tedious job and does not appeal to many farmers, though while the area under onions in this State remains small, a good market is reasonably assured for small bulbs for pickling purposes. If care is taken in regulating the sowing of the seed, and soil conditions are satisfactory, a fairly good stand can usually be obtained without much labour being given to thinning, or a crop may even be produced without an undue proportion of picklers without any thinning at all. On poor soils it would not be advisable to attempt the culture of the crop on these lines, but on better class soils good results are obtained with a minimum of labour.

Transplanting onion plants has much to commend it and is almost essential in coastal districts where the growth of weeds is so rapid, but in other districts, such as in the more elevated portion of the State, the labour of planting onions is accompanied by much discomfort, owing to the work having to be done during winter weather. As weeds are not nearly so troublesome in these parts, the sowing of the seed direct in the field will appeal to growers.

Harvesting.

Onions take from six to seven months to develop completely. When the crop ripens normally, the necks shrivel and the tops fall over while still green. Plants which ripen from the top down are poor keepers and should

be eliminated from the crop when harvested. With normally ripening onions, the falling over of the tops is followed by the leaves yellowing, and if left long enough, eventually becoming dry. It is usual to harvest the crop as soon as the yellowing stage is reached. The bulbs are pulled by hand and put into heaps in rows, in which they are allowed to remain until the tops can be easily detached from the crowns. The length of time they must be allowed to remain in the windrows depends upon the temperature prevailing, and if the weather is very hot, care must be taken to prevent the scalding of the bulbs. It is also particularly desirable that the bulbs as soon as ready be placed in good storage and removed from all possibility of becoming wet through rain or dew.

One of the main difficulties of the grower of spring-sown onions in the tableland districts is the trouble of drying the crop off after pulling. If drying has to be done in the field it is found that the autumn dews are so heavy as to prevent proper drying off, and consequently the bulbs quickly begin to show signs of sprouting and are of little value except for immediate use. Where onions are grown under these conditions a good deal of shed room is required for the curing of the crop, and as it is not advisable to spread the onions in layers of more than a few inches in depth, a system of slatted shelves may have to be provided for in order that the curing can be properly carried out.

Before bagging for market the tops and roots should be trimmed off, leaving about an inch of the top on the bulb; sheep shears are very suitable for the purpose. Great care should be taken not to bruise any of the bulbs, for decay sets in quickly.

The Production of Onion Seed.

Onions are selected for seed production at the end of the summer; the ones chosen are the good keepers—ascertained by pressing the top and butt to see if sound—and those that are true to type. They are planted about June or July, a cross being cut on the top of the onion about half the depth in order to allow the resultant growth from the centre plenty of room. The onions are planted in rows about 3 feet apart, about 18 inches separating each onion in the rows, half the onion being buried in the soil and the earth heaped over the other half.

Numerous shoots are sent up, and each bears a seed head, which, if in a sheltered place, is perfectly safe from shattering, but under exposed conditions needs some support. When the heads are formed and the thin sac enclosing the seed bursts, the heads are ready to harvest and should be hand-picked each day as they mature. The cleaning of the seed is usually performed by the agency of hand sieves and the wind, the seed being dropped from a height in order that the chaff may be blown free.

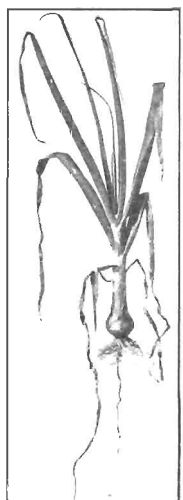
The same onions should be available for seed for three or four years, the tops being cut off and the rows cultivated to keep away the weeds. Seed more than one year old should not be sown until proved sound by a thorough test for germination. A rough and ready test is to immerse the seed in water. That which sinks is held to have good germinating power, the remainder being discarded. A more satisfactory test can be made by putting some seed between sheets of blotting-paper kept moist in a fairly warm place.

Diseases of Onions.

Downy Mildew or Blight.

This disease is caused by a parasitic fungus, *Peronospora schleideni*. It is very erratic in its appearance, often causing quite severe losses one season and then failing to appear for several years; or there may be a continuous epidemic in successive years.

The first symptom of the disease is a purplish, downy, discoloration which may be seen in spots on the leaves when covered with dew in the early morning. Within a day or two the infected spots enlarge and become watersoaked, the leaves become pale green and finally yellowish, the downy growth becomes more widespread, and the diseased leaves collapse, shrivel and die (see illustration). The killing of the leaves in this manner, although it may not entirely kill the plants, reduces growth and the bulbs remain small. If dry weather follows an outbreak, the plants, especially if young, may partially recover.



Onion Plant affected by Downy Mildew.

The disease commonly starts from one or a few isolated plants in a field, and in favourable weather, with plenty of moisture, warm days and relatively cool nights, it will spread with extreme rapidity. When such a combination of weather conditions occurs, an epidemic may be expected wherever the fungus is present. Dry weather checks its progress. The disease can be spread by wind, rain splashing, and in cultivation. The fungus is able to live over from year to year in diseased refuse and in the form of resting bodies in the soil. It may also be carried in bulbs from diseased plants.

Control Measures:—

1. Sanitation and the rotation of crops. All diseased material should be collected and burned at the close of the season. Where the disease is prevalent in the field, the land should be sown to some other crop for from three to four years.

2. Onion beds should be made in situations where the air drainage is good, so that excessive dew and fog may be avoided. The soil should be well drained and precautions taken to remove wind barriers and shade in order to aid the tops of the plants to dry during the day.

3. Good results have been obtained by spraying with Bordeaux mixture (6—4—50) with a spreader. There is considerable difficulty in making the spray adhere to the smooth surface of the leaves unless a spreader such as resin-fish-oil-soap is used with the Bordeaux. The spray must be applied before the disease has attacked the plants. The number of applications necessary will depend on weather conditions. If the weather is moist and the atmosphere humid, it will be necessary to spray at least once a week.

BEANS.

There are a number of species of beans, all of which can be grown in this State. The best known are the Broad bean, Kidney or French bean, and Runner bean. The first named, which is grown for the seeds, does best in the cooler portions of the State, or in warm districts as a winter crop. The Kidney or French and Runner beans are esteemed for the edibility of their pods, and can only be grown in the warm seasons of the year, being very susceptible to frost.

The crop is influenced to a considerable extent by the quality of the soil, a light, shallow soil giving much inferior returns to a rich alluvial one. Bean plants of all kinds respond readily to dressings of fertiliser. As with all other legumes, there is little necessity for nitrogenous manures, but some advantage in the use of lime. Excellent results have been obtained by the use of basic superphosphate. The crop, to farmers, is an excellent soil-renovator, and it is particularly valuable in a rotation.

Kidney or French Beans.

The first thing to take into consideration in bean culture is the preparation of the soil. It should be thoroughly ploughed twice, and harrowed; if the season is inclined to be dry, and the land cloddy, the roller may be used to advantage before planting.

The soils best suited for growing beans differ considerably with the conditions and the time of sowing. For instance, if an early spring crop is required, a rich loam is found very suitable, as this class of soil is generally sweeter in the spring than the low-lying lands. But if a summer crop is required, then the lower lands are found to produce very prolific crops.

Beans should be planted in rows 2 ft. 6 in. apart, and from 3 to 6 inches apart in the rows, according to the quality of the land, the thicker sowing being made in the richer soils. Heavier sowings are also made early in the season, owing to the poor germination of the seed due to the cool conditions prevailing. The seed should be covered to a depth of 2 inches, though shallow planting is essential for early crops as the soil is cold, and the seedlings, being weak, are unable to push their way through any depth of soil. The usual practice is to strike out shallow drills with a plough, and then to drop the seed by hand at the intervals named. The covering can then be done with an ordinary light harrow or hoe. Some growers have had a special plate made to fit the maize planter, and sow their seed in that way. The plate requires to be a very thick one, in order to save the grains from being cracked. Under ordinary conditions, from $\frac{3}{4}$ bushel to 1 bushel of seed is required per acre.

When the plants are a few inches high they should be worked through with the hoe. On low-lying land the beans may show a pale green colour, and a furrow should then be taken away with the plough, and left open for a couple of days if the weather will permit. This allows the ground to sweeten. The cultivator should be put through as often as possible, until the plants are tall enough to be hilled with the plough, and the middle should then be cleaned out. If the weather is dry or a heavy downpour or rain comes, the cultivator can again be used to advantage, breaking the crust, and also checking any weeds that might spring up after rain.

On land that does not answer to the description "low-lying," the cultivation can be confined to intertillage between the rows with a cultivator of an ordinary type.

French beans may be planted at any time on the North Coast, while in districts further south, such localities as the Hawkesbury River, August and September are the most reliable months for early sowings. Growers around Gosford make it a practice to keep planting small areas, from June until the end of August. September and October are months usually avoided for planting, as the resultant crop comes on to a well supplied or glutted market. These growers resume planting at mid-November, continuing on till early January. The yields obtained from these later planted crops are usually very heavy. They are ready to be picked when the heavy supplies are beginning to go off the markets, and the result is that the price obtained is usually fair to good. Considering the heavy yields obtained the returns to the growers are very satisfactory. Planting is again suspended from early January to late February, as the bean fly makes its appearance on beans planted at this time, doing considerable damage. On the tablelands it would be risky to plant before, say, the end of October or beginning of November.

Successive sowings can be made in all the localities mentioned until just sufficient time is allowed to enable the crop to mature early enough to miss the first frosts of autumn.

Harvesting must commence as soon as the pods are of sufficient size, and should continue at frequent intervals. If the pods are allowed to become too ripe, not only is that particular picking spoiled, but the cropping power of the plant is considerably reduced. Beans are usually forwarded to market in full chaff bags, and delivery must be effected as quickly as possible, in order that the produce may reach the market quite fresh.

Of varieties, that most esteemed for commercial purposes is Canadian Wonder.

Diseases of Beans.

Anthracnose or Pod Spot.

This disease is caused by a parasitic fungus *Colletotrichum lindemuthianum*, and occurs on field and garden varieties of beans.

All parts of the plant, except the root, may be attacked. The disease may be carried in the seed and often presents itself in the seedling stage, appearing in the form of brownish or purplish specks on the primary shoot and cotyledons.

Dark, more or less circular, sunken spots, with reddish or yellow raised margins are produced on the pods. These may attain a quarter of an inch in diameter and in some cases run together forming irregular diseased areas. The centres of the spots frequently collapse and dry up, but during moist weather they may become pinkish in appearance, due to the development of the spores of the fungus. Similar spots may be formed on the young stems. On the leaves the spots are mostly confined to the veins and leaf-stalk.

The parasite often penetrates through the pod and attacks the seeds, which are often shrivelled, and on which dark brown or black areas, usually bordered with a brownish tinge, are produced. This diseased seed may thus carry the disease over from season to season.

Rain and high humidity favour the development of the disease, and heavy, low-lying, poorly drained land is said to predispose plants to attack. The spores which spread the disease are produced in very large numbers, and are readily spread from plant to plant, especially during damp weather or when the plants are wet with dew.

A number of strains of the fungus have been discovered, and it has been shown that a variety of bean resistant to one strain may be susceptible to another. A particular variety of bean in certain districts thus may be free from infection, while only the strains of the fungus to which it is resistant exist in the locality. If another strain of the fungus is introduced by means of seed, the variety so far resistant may succumb to the new strain of the parasite. Such resistant varieties are known to exist in types which are grown for the use of the seed only. No resistant variety of the pod type is known to exist here.

Control Measures.—Seed treatment is useless because the fungus is internal. The use of any fungicide sufficiently drastic to kill the parasite would probably injure the seed itself.

It has been shown that spraying with Bordeaux Mixture may give a certain amount of control if done early, but there appears to be difficulty in effectively applying the fungicide to this crop in the field.

Bean Pods affected with Anthracnose.

The following control measures are of value in minimising losses from this disease :—

1. Select seed from a clean crop or from unspotted pods.
2. As far as practicable, burn all diseased material.
3. A rotation of crops is advised.

4. Grow varieties which show the greatest amount of resistance to the disease in your district.
5. Select for seed any plants in a diseased crop which show immunity.
6. Do not cultivate or pick beans during damp weather or when the plants are wet with dew.
7. The development of disease-resistant varieties is the most promising method of control, and a number of types are at present under test.

Rusts.

Several species of rust fungi, belonging to the genus *Uromyces*, affect varieties of beans and peas. In New South Wales our commonest species is probably *Uromyces appendiculatus*, which occurs upon the ordinary varieties of our garden beans (*Phaseolus vulgaris*) and also on the cowpea. The fungus usually appears late in the season and is destructive to foliage, and may thus result in an earlier ripening of the crop as well as a reduced crop.

Bean Rust (*Uromyces appendiculatus*).

Spots appear on the leaves (especially on the under surface though occasionally on the upper), at first blister-like and small. These rupture and the spores produced give an iron rust colour to the mass. The fungus is harboured by the old leaves and vines.

Control Measures.—Burn all refuse. Neither throw any on the manure heap to be returned to the field, nor turn any under with the soil. Spraying or dusting for the control of bean rust has not proved satisfactory. As a rule, climbing beans are more susceptible than bush varieties, and the green pod types are also more susceptible to the disease than are the wax pod types.

Leaf Spot of French Bean.

This disease has such a characteristic appearance on the foliage that it has long been recognised; but it is seldom of sufficient importance to warrant attempts to control it by spraying. It only causes damage late in the season.

The markings on the leaf take the form of small, angular, brown spots, limited by the veins, and are usually very numerous. The causal fungus, *Isariopsis griseola*, produces fruiting bodies which form a brown, mouldy covering over the dead areas on the under surface of the leaf. The spots on the pods are very conspicuous, brown to black in colour, with red or brown borders, and they may unite to cover the whole width of the pod. The stems are more rarely attacked.

Control Measures are not usually necessary. All diseased plants and plant parts should be collected and destroyed.

Dry Root Rot.

Root Rot of beans may be initiated by various organisms, but the most important is *Fusarium martii phaseoli.* This fungus is able to attack practically every cultivated variety of bean. It does not affect the pea but another variety of the same fungus does cause a root rot of peas. The disease frequently causes very heavy losses in areas where beans are grown continuously without rotation with other crops, and especially in early crops, and where large quantities of farmyard manure are used.

The whole of the root system and the base of the stem may be rotted. Infection may be evident soon after the seedling is out of the ground, or not until the plant has attained considerable size. A most characteristic feature of the disease is the bright-red colour which may be produced over the entire surface of the tap-root and base of the stem even while the tissues remain firm and turgid. The lateral roots are killed, leaving only the bare, dry and shrivelled tap-root. Such plants are often also attacked by the bean fly and other insects, fungi and bacteria. When the tap-root is killed the lower part of the stem may become pithy and hollow.

In severe cases many plants are killed outright, leaving only a series of missing hills in the row. When the advance of the disease is slower new lateral roots may be formed near the surface of the soil, but the bushes show the stunting effects of the loss of root surface to a greater or lesser extent. At podding time there is an apparent checking in growth of the entire plant, an unhealthy colour, early maturity, and few pods frequently with undersized seeds.

Control Measures.—This disease is produced by an organism which is able to live over in the soil for a number of years, and is difficult to combat. Particularly is this the case since commercial growers find it most profitable normally to grow beans continuously year after year as the sole crop on their areas. Such measures as rotation with other crops, *e.g.*, tomatoes and cucumbers, and the removal and burning of the dead bushes after harvest, will undoubtedly aid in reducing the amount of loss, but will not meet all requirements. The only recommendation that can safely be made at present is that the grower plant beans until the "disease sick" soil no longer produces profitable yields, then change to other crops for as long a period as possible up to five or six years.

The best hope of successful control of the disease lies in the production of resistant varieties. Selections have been made and are at present under test.

Bean Mosaic.

Bean Mosaic, one of the most important diseases of beans, is becoming increasingly prevalent in bean-growing areas in this State. Leaves affected with Mosaic show the characteristic mottling or Mosaic effect common to diseases of this type. Irregular light-yellow areas, merging into dark-green patches, are present in the leaf. The darker areas develop faster than the yellow ones resulting in the leaflets becoming much puckered, especially along the midribs, and the margins of the leaflets become cupped downwards. Affected plants are stunted and may have a sickly, yellow colour, but nevertheless remain alive until the end of the season. Early infected plants rarely form pods, so that the yield may be greatly affected. Plants infected late in their growth will mature seed, but much of this seed is infected and would serve to carry the disease over to the following season

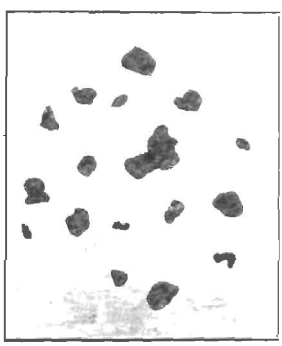
The disease is caused by an extremely minute organism or virus which may be carried from one plant to another in any manner in which plant sap may be conveyed, but the most common method of spread is by means of sucking insects. The virus spreads to all parts of the plant, including the pods, so that diseased individuals usually bear infected seed. The development of the disease is favoured by high temperature and humidity.

Control Measures.—As no methods are available for killing the virus in the seed, only seed selected from healthy plants should be employed. Seed taken from a field which showed Mosaic in the previous season should be avoided.

It is recommended that a special seed-plot be maintained by each grower to supply his needs. In such a plot, which should be isolated, regular inspections should be made and diseased plants uprooted when observed.

Sclerotium Diseases.

A disease that is common to very many different plants, including beans and peas is caused by the fungus *Sclerotinia libertiana*. It may be serious during a cool, moist period. It attacks the stems, commencing as a white mould at the ground line and working upwards. After the fungus has developed for some time the leaves become yellow, and wilt, and finally the stem collapses. When the stem of the host is hollow the mycelium is produced in considerable quantity in the cavity, and forms numbers of lumps or sclerotia that are white at first, then black externally. When the stem is solid the sclerotia are formed in its substance and become visible on the outside. These sclerotia, which vary in size, some being as big as a pea, form a resting place of the fungus. They remain either free in the soil or in decaying plants, and subsequently produce spores which are able to infect a new crop.



Sclerotia or Resting Bodies produced in Cabbage affected with Watery Soft Rot.

Although the initial infections occur in the field, most of the damage occurs after the crop is harvested and during the period of transit to market. The development of a soft, watery, odourless decay is characteristic of the disease. The disease has, however, an effect of intensifying the natural odour of the plant, but this is entirely distinct from the disagreeable odours usually associated with decaying vegetable matter.

Another form of wilt, caused by the fungus *Sclerotium rolfsii*, attacks beans, rhubarb, potatoes, and occurs on snapdragons, carnations, and other garden plants. The fungus affects the root system, covering it with

a felt-like whitish mould which may ascend the stem somewhat. The plants die, and then tiny brown sclerotia, slightly larger than a pin's head, are found in the webbed growth of the mould.

Control Measures.—Plants affected with either disease should be burned and not allowed to lie on the ground. The sclerotia lying dormant in the soil are difficult to deal with. In small gardens the top few inches of soil can be removed and replaced by fresh soil mixed with quicklime. If all infected plants be pulled up and burnt as soon as the first indication of disease is observed, the formation of sclerotia may be forestalled. As an additional precaution it is useful to spray the infected area with Bordeaux mixture (6—4—50) or with a 2 per cent. bluestone solution, though the latter is not practicable on a large area.

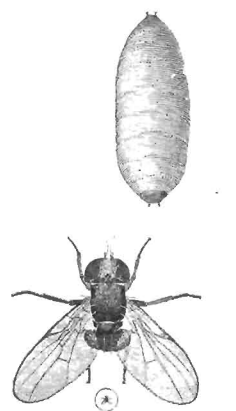
Insect Pests of Beans.

French Bean Fly (*Agromyza phaseoli*).

This small black fly, which is about one-twelfth of an inch in length, causes heavy losses in mid-season and late bean crops in coastal districts north of Sydney. It lays its eggs in the leaves of the plants as soon as they are clear of the ground, and the tiny maggots burrow down the leaf stalks to the stem. In badly infested plants the stems are first flabby and swollen; then they crack and turn brown just *above the ground*; finally the leaves turn yellow and the plant withers and dies.

The bean fly has been found in the pupal stage during the winter months, but larvæ infesting the late autumn crop have also been found in the field *developing into adult flies, up to the* last week in August. These flies were observed to infest the first spring crop which was planted during the second week in July and which was well above the ground on the 19th July. The initial infestation was only 25 per cent. of the whole crop, but after the flies from this brood had hatched and laid their eggs, every plant was infested. Individual plants are not, however, *heavily infested in spring crops*, whereas in summer and autumn crops they are; early autumn crops are frequently destroyed.

Control Measures.—An infested crop is often saved by "hilling" the plants. This encourages the stems to put out *fresh fibrous roots above the damaged* parts.



French Bean Fly (*Agromyza phaseoli.*)

The life of the adult fly in the field does not exceed three weeks; it is of the greatest importance, therefore, that the remains of the autumn crops, which are usually left lying about the headlands, should be burned at least three weeks before the spring crop is planted. When collecting the crop for burning, a good deal of litter containing pupae is always dropped on to the ground. For this reason the land should be ploughed in the early winter so as to bury as many of the pupae as possible; it is considered unlikely that the adult fly would be able to push its way up through several inches of soil.

In districts like Gosford, where two main crops, spring and autumn, are grown each year, growers should clean up and plough in after the spring crop in the same manner as for the autumn crop. Allowing the old crop to remain on the ground until just before the next crop is to be planted provides a ready source of infestation. For commercial growers it would be better not to grow a small patch for home use during January and February. The aim should always be to start off the first crop of the season under conditions which will ensure it being as lightly infested as possible.

It has been observed that the flies are always attracted by a young crop in preference to a crop in flower or in bearing, and the growing of "trap" crops would undoubtedly give good results. Small patches should be planted at intervals throughout an infested crop. The flies would prefer the young plants in these plots to the older ones of the main crop for egg-laying, and every ten days the trap plants could be collected and burnt. In this way the larvae would be destroyed before the flies had time to emerge.

Bean Leafhopper (*Empoasca flavescens*).

These jassids are small, very active, sucking insects, one-sixteenth to one-eighth of an inch in length in the adult stage, and of a pale, greenish-yellow colour. The earlier stages are wingless and very minute. The jassids congregate and feed mainly on the under-surfaces of the leaves, and the adults fly readily when disturbed. The injury is manifested by a mottling of the leaves due to the disappearance of the green colouring matter from the areas where the pests are feeding, and later the leaves may curl and wither.

When present in large numbers and causing injury, the plants should be sprayed with nicotine sulphate at the rate of 1 in 800 (*i.e.*, half a pint of *nicotine sulphate to 50 gallons of water*), *particular care being taken to* spray the lower as well as the upper surfaces of the leaves.

The immature wingless stages can be much more readily controlled than the mature (winged) insects; growers should therefore examine the leaves for the presence of this pest in its early stages, and spray at once, if it is discovered. The early stages often occur when the bean plants are quite small and can be readily sprayed.

Bean Aphid (*Aphis rumicis*).

Small, green aphides develop through the summer months on various plants, including the many varieties of beans. At this time they are all females, some winged, but many wingless, and they give rise to their young without the aid of males, the young aphids being born viviparously (extruded alive).

The aphides are born in rapid succession, and the numbers increase with amazing rapidity. The effect of these thousands of tiny insects each sucking up sap by means of its little beak is to cause the plants to weaken and wilt. Towards the end of summer, winged forms occur more numerously, and the aphides spread. Winged males now develop, and they fertilise the egg-laying females which lay the over-wintering eggs; these hatch the following spring to start the broods of that season.

Control Measures.—Spray with nicotine sulphate 1 in 800, tobacco and soap wash, Sunlight soap wash, or even dilute kerosene emulsion, say one part of kerosene to 30 parts of water. If kerosene emulsion is used, the oil must be thoroughly emulsified with soap to prevent injury to the tender parts of the flowers and foliage.

Peas are attacked by an aphid which may be controlled in a similar way.

Bean Thrips.

Thrips are minute, active, slender insects, usually under one-sixteenth of an inch in length, and generally black or brownish in colour. When examined under a strong magnifying glass they are seen to have narrow wings bearing a fringe of fine hairs. They are found commonly in the flowers of most plants, and can be most readily observed by shaking them from the blossoms into the palm of the hand, though they also occur on the leaves, stems and fruit. They feed by chafing and piercing the surface of the plant tissue, and in this way may injure the reproductive parts of flowers, and the surfaces of fruit, stems and leaves. When present in very large numbers in bean flowers, they prevent a percentage of the pods from setting and are responsible for numbers of stunted and twisted pods.

When thrips are present in sufficient numbers to cause damage to bean crops, spraying with nicotine sulphate (half a pint nicotine sulphate in 50 gallons of water) both before and during blossoming is recommended, and in the latter case care should be taken to direct the spray into the flowers as well as on to the leaves and stems. As the thrips overwinter in weeds, grass, and rubbish, clean cultivation is also an important factor in their control.

Bean Caterpillars.

Zizina labradus.

These bright-green caterpillars, about half an inch in length, are the larvae of a small, dark-blue butterfly. They occasionally attack beans and peas, usually feeding on the pods in which they bore a number of circular holes. Generally this pest is not sufficiently harmful to warrant control measures.

Phytometra argentifera.

The moth of this species is dark-brown in colour, with conspicuous silvery markings on the forewings, and is about 1¾ inches across the outspread wings. The larvae are bright green, active caterpillars about 1¾ inches in length, and move with a looping action. When fully grown they pupate in loose silken cocoons which they spin on the foliage and stalks, and sometimes on the ground. These caterpillars feed on the foliage of beans, peas, and other vegetables, and, should it become necessary, they may be controlled by spraying with arsenate of lead mixed at the rate of 1 lb. of powder to 40 gallons of water, but this spray should not be used on beans when the pods are approaching maturity.

Other Pests.

The Red Spider (*Tetranychus telarius*) and the weevils (*Bruchus* spp.) which are described in connection with peas on pages 677 and 678 respectively, are also pests of beans.

Cutworms which attack beans as well as a number of other crops are discussed in connection with tomatoes on page 702.

GREEN PEAS.

Although the pea crop requires a temperate climate for its best development, the range of conditions in New South Wales is such that the crop can be harvested in one part or another of the State during every month of the year. In the cooler portions of the State the season of growth is during the summer months—a period when the cultivation of the crop is limited in other districts owing to the heat. Whilst the plant itself is seldom injured by frost, the flowers and pods are not so hardy. Young pods that have been frosted and that are unlikely to develop may be distinguished by a characteristic white mottled appearance on the outside skin. During autumn and spring, when frosts are sufficiently severe to cause damage to the crop in cool, elevated districts, the conditions are then suitable for its growth in warmer districts, while in the frost-free regions bordering on the sea peas can be harvested in midwinter. Damage from frosts may be only partial, and a later crop of bloom on plants previously "nipped" may form up without further trouble in this respect.

Growing for Seed when Market is Glutted.

There has been a considerable increase in the area planted of late years, so much so that gluts are not infrequent. This is due largely to the high monetary returns which are at times secured during crop shortages inducing greater interest in the crop in following years. It is always impossible to foretell what the season will be, and as the crop is one largely grown without irrigation fluctuations will always occur.

During periods of glut many consignments realise less than the picking and forwarding costs, and are then a direct loss to the growers. Under these circumstances it would be advisable for growers to consider the question of maturing the crop for seed. If this were done a good deal of expense of future crops would be saved, and, apart from supplying one's own requirements, there should be little difficulty in disposing of further supplies should the quality be satisfactory. While the growing of seed for the market demands that care should be exercised in eliminating strangers, &c., it has been proved that seed grown in this State is equally as good as that produced in other States. As the supply of pea seed is now almost wholly imported, it is in the interests of the State and producers generally that greater attention be given to this aspect of the pea-growing industry. The possibilities in this direction should certainly not be lost sight of during periods of glut, particularly in the tableland districts, where very large areas are at times under cultivation.

A Good Soil Improver.

A sandy loam is most suitable for the crop, but almost any soil of fair average quality will yield good results. As with all legumes, the supply of nitrogen in the soil is a matter of less moment than that of phosphoric acid, potash and lime, and hence it is that in some localities dressings of fertilisers that contain the last three have a material effect upon the yield. The crop has the strong recommendation that, in addition to yielding profitably, it contributes to the fertility of the soil for the purpose of subsequent crops by increasing the store of nitrogen, and by enabling the farmer to add to the soil a considerable quantity of top-growth of a kind that humifies readily when turned under. It does well on newly broken land, and can be used as a preparation crop.

Varieties.

The variety favoured for field culture is Greenfeast, and most commercial growers are now well acquainted with its merits. It is a large-podded variety, with a curved end, usually containing about nine peas. It is a favourite on the market, being sold, as are some other varieties, under the trade name of Wonders. One of the advantages of this pea is that it retains its colouring during transit, whereas some of the varieties previously cultivated were inclined to become rather pale, which is a bad feature in the marketing.

Other varieties which also find favour are Richard Seddon and Witham Wonder, both large-podded sorts, and also sold under the trade name of Wonders. Richard Seddon is favoured by many growers in the County of Cumberland for growing for the autumn crop, as it is the general impression that it will pod better in cooler weather than most other varieties.

The old popular favourite, Yorkshire Hero, is yearly becoming less popular owing to the small size of its pods in comparison with other varieties previously mentioned. It is, however, a fairly hardy sort, and can generally be relied upon to crop well.

Sowing and Cultivation.

The water requirements of a crop of peas are considerable, and the preparation of the soil should be commenced early enough to enable a supply of moisture to be stored. The land should be cultivated as required to conserve all rain that falls, to destroy weeds, and to produce a good tilth in which the roots will find favourable conditions. Every endeavour should be made to induce germination of weed seeds before the crop is planted. If this is done the subsequent cleaning of the crop will be much easier. During the picking season there is often little time to attend to destroying weeds, hence the necessity for thorough cultivation during soil preparation and early stages of growth. A good strike of weed seeds can usually be controlled by harrowing, which is so much quicker than inter-cultivation work, which would be necessary once the crop was planted.

The sowing of seed by seed drills is not favoured by many growers, as the seed is sown in a narrow drill only one seed wide, resulting in a crop which is almost sure to lie over at a very early stage of development. It is much *the more common practice to open up shallow drills, drop the seed by* hand, and to cover to a depth of about 2 inches by means of a harrow, light cultivator, or hand hoe. When sown by hand in open drills the rows are wider and greater support is given by one pea plant to another, and hence the crop stands up better than when sown by drill. In sowing it is *a good plan to plant the rows at a distance of 6 to 9 inches apart, dropping* the seeds 2 to 3 inches apart in the rows, a space of 2 feet 6 inches to 2 feet 9 inches being left between every pair or rows. This system of planting assists the plants in maintaining themselves in the soil. About 1 bushel to 1 bushel 1 peck of seed is the usual rate of seeding per acre.

The seed should only be covered to a shallow depth, but in hot months it may be necessary to make sowing drills deeper in order that the seed be planted in a moist layer of earth. When this is done greater care will need to be exercised in covering. Seed so planted is then at a disadvantage should rain or thunder storms occur, as water quickly lodges in the drill *depressions, and more than likely results in a poor germination. Pea seed* often fails to germinate when heavy rain falls after sowing, and for that reason once the seed has been sown it is always the aim of the grower to obtain germination before applying water. In coastal districts in frost-free situations planting may be made from March to October. The *Christmas market can be catered for by planting the first week in October.* On the tablelands plantings are made from September to a time—usually December or early January—likely to catch the Easter market. Plantings are made later, but risk of frost is great.

Fertilisers.

In practically all districts of the State the application of basic superphosphate results in increased yields, and the usual quantity recommended is from 1 to 2 cwt. per acre. Heavier dressings than these have come under notice, and even as much as 5 cwt. per acre has been profitably employed. *Such heavy applications, however, are not recommended, especially where* the grower is dependent on natural rainfall for the moisture supply. A mixture of bonedust and superphosphate in equal quantities, at the rate of 1 to 2 cwt. per acre, has also given good results in many districts, but of late years the use of basic superphosphate has given results which justify *growers testing this fertiliser with the crop. Basic superphosphate may* be prepared on the farm by mixing with each 100 lb. of superphosphate 17 lb. of air-slaked lime.

Yields.

Yields of from 60 to 80 bushels are fairly general, while even 100 to 200 bushels are also common. Under particularly suitable conditions 4 tons of green peas (320 bushels) is not looked upon as extraordinary. One grower in the Ben Lomond district repeatedly secures yields as high as this.

Harvesting and Marketing.

Pods should be picked as soon as the pea kernels are full and give the pod a tight feel, but before any loss of colour occurs, such as is the case when on the turn to maturity. Twenty-eight pounds of green peas is the usual trade recognition of a bushel weight. Growers sending their peas long distances must always allow for loss by shrinkage in transit, and in some cases it is usual to reckon on a 2 lb. loss per bushel.

If the peas have to be stored on the farm overnight or for any time before despatch it is advisable that they be spread out on the floor of a shed rather than left in bags. Sweating in heaps in the shed will not be harmful to the same extent as would be the case in bags, particularly when done up in full chaff bags. The usual method of marketing is in small bags—about 2 bushels in size—which are made by the grower or supplied by the agent who is to dispose of them. For local markets it is often an advantage to do up in small lots of 7 lb., more or less, in order to cater for family supplies.

Picking costs vary with the crop. The usual price is somewhere about 1s. 6d. per bushel, but with high yields it may be possible to secure pickers at a lower price. When the yield is low the price increases proportionately, and under these conditions it is only possible for the grower to bear such an expense when market prices are high. A careful watch should be kept of the pickers to see that only the full pods are harvested. Immature and discoloured pods should be eliminated from any consignments marketed.

Fungous Diseases of Peas.

Pod Spot.

This disease, which is caused by a parasitic fungus *Ascochyta pisi*, may result in severe damage to the pea crop in seasons favourable to its development. Other host plants on which it has been recorded are vetch, haricot bean, French bean, and wild plants belonging to the pea family. Leaves, *stems and pods may be involved in the attack.*

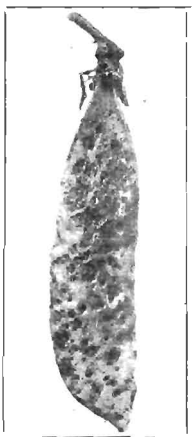
The disease appears on the leaves in the form of oval to circular spots, gray or ashen-coloured in the centre, with a dark-coloured margin. Elongated diseased areas appear on the stems. These may run together and completely girdle the stem, causing wilting, and the ultimate death of the parts above the point of attack. The symptoms on the pods are similar to those on the leaves, but the diseased areas frequently develop into small sunken pits.

The disease may completely penetrate the pod and infect the enclosed seeds. *Such seeds will be found to adhere to the pod.* Sometimes, however, the seed may carry the fungus and yet be so slightly affected as to escape detection. Diseased seed germinates poorly, and a large proportion of the diseased seedlings never reach maturity.

The variety American Wonder is said to be very susceptible to "Pea-spot," while Alaska (a canning variety) is very resistant. No table variety is known to show any outstanding resistance over other varieties.

Control Measures.—The following control measures may be expected to reduce losses caused by this disease:—

1. Secure seed from a locality or crop known to be free from disease. Reject all seed showing any suspicious condition.
2. Practise a rotation of crops, excluding those liable to attack.
3. Where practicable, spray with Bordeaux mixture (summer strength, 4–4–40).



Pea Pod affected with Pod Spot Disease.

Leaf of Pea Plant affected with Pod Spot Disease.

In moist seasons favourable to the development of the disease, it may be advisable to anticipate an outbreak and make the first application before the disease appears. Subsequent applications will depend on weather conditions; fortnightly sprayings may be necessary. For the preparation of Bordeaux mixture, see page 500.

Seed treatment is of no value as the fungus is carried within the seed.

Root Rot.

This disease is prevalent in many localities where peas are grown year after year on the same ground, and will eventually render an area unsuitable for pea cultivation. In certain seasons it may occasion serious losses.

Root Rot is caused by a parasitic fungus *Fusarium martii pisi* which lives in the soil and is spread by any agency (implements, vehicles, drainage water, &c.) that carries soil from one field to another. The fungus causes a rotting of the roots and the base of the stem underground. Diseased roots become soft and watersoaked, and the outer layers rot off, leaving only the central core. Roots thus damaged are not only unable to function normally, but are prevented from making further growth. The aboveground parts of affected plants lose their healthy colour and may wilt, or in severe cases shrivel up and die. Both the amount of rotting of the roots and the rate of resulting stunting and shrivelling of the plants are influenced greatly by weather and soil conditions. Warm soils favour the development of Root Rot, so that date of planting is of importance in ground infected with the disease.

Control Measures.—As the fungus parasite causing Root Rot lives in the soil, there is little that can be done to eliminate the trouble after a field becomes badly infected. Long rotation of crops and good drainage aid in reducing the loss, but the final control measure must be the development of resistant strains of peas. At present no varieties are available which are resistant to this parasite. The aim of the grower should therefore be to keep his fields as free as possible from infection. Soil from infected fields should not be allowed to contaminate disease-free areas, and the growth of peas year after year on the same ground should be avoided if it is possible to adopt a rotation of other crops.

Sclerotium Disease.

A disease caused by the fungus *Sclerotinia libertiana* also attacks peas. Control measures are discussed in connection with beans on page 668.

Insect Pests of Peas.

The Red Spider (*Tetranychus telarius*).

This mite is of world-wide distribution, and feeds on a very wide range of plants. Peas and beans are among the favourite host plants of the pest, and in some seasons it may cause considerable damage. The eggs of this mite, which are deposited on the under-surface of the leaf, are spherical, transparent bodies, too small to be detected by the naked eye. The young mites upon emergence from the eggs commence feeding, and increase in size by a series of moults until the adult stage is reached. The earlier stages are yellowish in colour, while the adult mites, which are just large enough to be seen by the naked eye, vary from a dull yellow to a brick red colour.

The presence of the mite can be detected by a mottling of the leaf (pale areas first appearing along the veins and later spreading out into irregular patches) and by a fine webbing on the under-surface. Badly infested leaves may eventually wither and die.

The mites appear first in early summer, and increase rapidly in hot dry weather, but are checked by cool weather and rain. In hot weather a fresh generation is usually produced every ten days, and as each female lays on an average sixty eggs, the mites may increase in numbers very rapidly.

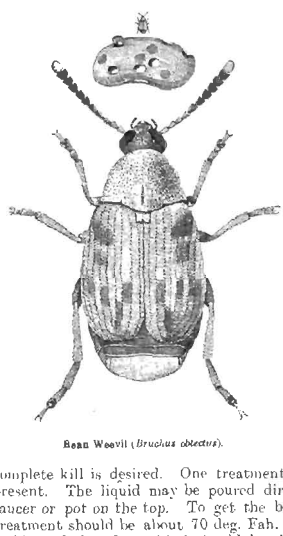
Satisfactory control of this pest can be obtained by the use of sulphur sprays, which should be applied particularly to the under-surfaces of the leaves. For this purpose a lime-sulphur solution, mixed at the rate of 1 gallon of lime-sulphur to 30 or 40 gallons of water, atomic sulphur at the

rate of 1 lb. to 10 gallons, or any similar sulphur preparation which will not injure the foliage, may be used. Since it is not desirable to spray beans when the crop is approaching maturity (owing to the fact that the pods may be tainted by the spray), control measures in this crop should be undertaken when the pest first appears, and a close watch kept for the mite in the early stages of growth of the plants.

With peas control measures are most effective if undertaken when the infestation first appears, but there is no danger of tainting peas if spraying has to be carried out when the pods are ready to pick.

Pea and Bean Weevils.

The grubs and adult beetles of several species of the genus *Bruchus* commonly attack various pea and bean seeds. Though these beetles may lay their eggs in the field, their ravages are not generally sufficient to be noted until after the crop has been gathered and stored. Then the grubs become full grown, pupate, and change to the adult form within the seed. This brood lays eggs on the seeds around them, and the infestation is thus increased and with it the damage.



Bean Weevil (*Bruchus obtectus*).

Fumigation with carbon bisulphide is generally the most satisfactory method of treatment. The seed should be placed in an airtight container (such as a tank or barrel) or room and treated with the liquid at the rate of 5 lb. to 1,000 cubic feet for a period of twenty-four hours. Fumigation should not be continued for more than this time, however, or the germinating power of the seed may be affected. As the eggs may not all be killed by fumigation, a second treatment, say, three weeks later, should be given where a very complete kill is desired. One treatment should kill all beetles and grubs present. The liquid may be poured directly over the seed or placed in a saucer or pot on the top. To get the best results the temperature during treatment should be about 70 deg. Fah. As the fumes are highly inflammable no light of any kind should be allowed near where the fumigation is being carried out.

Other Pests.

Thrips and the caterpillars of *Zizina labradus* and of *Phylometra argentifera* attack peas. They are discussed in connection wtih beans on page 671, while cutworms, which also attack peas, are described as pests of tomatoes on page 702.

TOMATOES.

The tomato has only been extensively cultivated in recent years, but it has advanced so rapidly in public estimation as a useful, wholesome, and delicious fruit or vegetable, that very large areas are annually planted with it. In this State the production of early tomatoes for domestic use and of mid-season crops for the manufacture of sauce is a distinct and profitable business, occupying considerable areas. Our markets consume some thousands of tons of tomatoes annually, the greater bulk being used by the various factories at which sauce and preserves are made. The method usually adopted is for growers to contract with the manufacturer for the quantity of tomatoes required.

The Soil and its Preparation.

The best land for tomatoes is rich mellow loam, with a little sand in the upper layer, and a good clay subsoil. The main consideration is that the soil should be of good texture. A good textured soil, even if of poor quality, can largely be built up with fertilisers, and will make a satisfactory medium. Poor and medium quality lands will frequently give early crops but not heavy ones. Where this plant is to be grown in quantities for manufacture or the open market, when quantity is of more consequence than earliness, the soil must be either naturally rich or artificially made so. For early crops a northern aspect is desirable. Having selected the land for this crop, it must be prepared during the autumn previous to planting in the spring. If new land be taken it must be broken up and thoroughly prepared.

Varieties.

There are several good varieties from which the grower can make his selection. Sparks' Earliana is an excellent early tomato that has done well where the vines are trellised. Chalk's Early Jewel is favoured by many growers for the early crop, and Money Maker has given good results in the Hunter River district. Matchless is largely grown under field conditions in the Bathurst district for the purpose of the sauce-making trade. A strain of Bonny Best variety obtained from Canada has been extensively tested by the Department during recent years, and has proved a particularly good sort. It is a coreless variety of good shape, well fleshed, and carries well. It is an early variety, being a selection from Chalk's Early Jewel. Norton is a good main crop variety, and well suited for the requirements of the sauce trade, and also for marketing through the usual channels in the fresh state. It is of good shape and colour, and travels well, being a strain of Stone variety.

Cultural Methods.

Planting in the open cannot take place until the district is clear of frosts unless means be taken to shelter the young plants every evening. For early crops the young plants must be got ready in a frame with bottom heat, in order that they may be planted out as soon as the weather has become favourable.

The Seed-bed.

The seed- or plant-bed may be made any desired size, according to the extent of cropping, and a frame of the required size may be built on the plot. Fig. 1 shows an economical frame of large capacity. The seed may be sown in shallow boxes under cover, or in the frame, and covered with a sprinkling of fine loamy soil. One or two ounces of seed will produce more than sufficient plants for 1 acre.

As soon as the plants are large enough to handle (2 or 3 inches high) they should be transplanted into the frame, the soil in which by this time should have been worked up to the finest condition and tilth. The plants may be set out in rows 3 or 4 inches apart with the same distance between plants, setting each plant opposite the space in the previous row. Here they remain and grow until time for transplanting into the field: and by removing the covering, giving them air, light, and sunshine on fine days, and covering up in the evenings or during cold spells or frost, they should

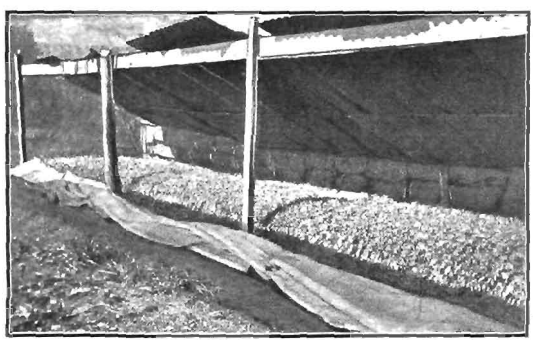


Fig. 1.—An Economical Frame of Large Capacity.

presently become stout and stocky plants. After they are once set out, do not give them much watering, or they may be inclined to draw up and become lanky and tender.

The main points in a frame or bed of this character are to keep it dry and warm and to protect it from winds, which cause considerable damage. In transplanting into it, care must be taken that the plants are not much lower than in the seed-bed, as the deeper they are set the more liable they are to damp off. If any plants have got rather down in the seed-bed, and become long-shanked, they should be laid slanting, just below the surface, and they will take root along the stem, and become stout and stocky plants. The drier the bed is kept (with discretion) the better. Any suckers that may appear should also be removed if it is intended to grow for early fruit.

For successive crops seed may be sown at intervals in the open after the frosts are gone. Prepare a seed-bed plot of rich soil, and strike out drills not more than half an inch deep. Sow thinly, cover lightly, and water

sparingly. The young plants should show up within a week, and if it is *desired to push them along for early fruit, transplant into a nursery* bed when they get their third leaf, putting them 3 or 4 inches apart as previously advised, and then follow on as before. Seed may be sown from June to end of January, and crops may be grown for eight months in the year—in some favoured spots even longer.

Propagation Frames.

The grower about to construct frames should give a good deal of thought to their situation, as this largely governs the amount of labour necessary in working the beds, and also contributes considerably to the success or failure of the venture. In the first place the frames should be located in a position with a northerly aspect to obtain the maximum amount of sunlight. If possible, a well drained piece of soil in close proximity to the water supply and manure heaps should be selected, and full advantage should always be taken of any windbreaks or buildings as protection from southerly and westerly winds. Before starting the construction of any type of hot frame, attention should be given to surface drainage; suitable conditions in this regard can nearly always be obtained by digging open drains.

Hot beds actually consist of a well-prepared seed-bed enclosed in a frame of some description, covered with either a sash of glass or some easily adjustable material, and the whole artificially heated. The heat is usually obtained by the fermentation of organic matter, of which the most common form is fresh horse or poultry manure, though suitable substitutes, such as a mixture of green leafy crops and manure, are sometimes used. The supply of organic manure in sufficient quantities has become very unreliable in parts of New South Wales, and growers of early tomatoes on a large scale are seeking something more dependable, and hot air frames are coming into use in some districts.

Fermentation Frames.—To obtain the best results with horse manure, it should be piled in a large heap about two weeks before being transferred to the frames. This heaping encourages uniform fermentation and heating. Before it is placed in the frames the manure should be turned over into another heap, and if dry, damped with a little water. Under no circumstances should the manure be over-wet, as this prevents the material from fermenting. The manure heap should at all times be protected from rain. The best results will be obtained if only a small amount of manure is placed in the frame at a time, and then thoroughly trampled. The trampling prevents uneven heating and also any danger of the bed sinking later on. The addition of straw bedding to horse manure increases the bulk and encourages rapid fermentation. When using substitutes for horse manure, it must be remembered that the material must not be too wet or too dry, and that when placed in the frame it must be thoroughly compacted.

After the manure is placed in the frame it will set up a high temperature that will probably destroy any seeds; it will therefore be necessary to wait until the temperature recedes to about 85 degrees Fahrenheit. The soil in which to plant the seedlings should be prepared, and an endeavour made to produce an open mixture with plenty of organic matter. This can be obtained by mixing equal parts of loam, sand, and decayed leaf mould or rotted organic manure. A very small amount of superphosphate can be added. It is usually advisable to place a layer of about 6 inches of soil

immediately over the manure. The seed can be sown in rows direct in this soil or placed in shallow boxes above the soil layer. When boxes are used only 3 inches of soil are used to cover the manure.

The usual type of hot frame is illustrated in Fig. 2. They are usually temporary structures and can be shifted each year. The covering is made movable to allow of convenient working, and also ventilation. Glass is sometimes used in the coverings, although a most serviceable substitute is oiled calico.

Another very satisfactory type of frame may be built by the farmer himself from corrugated iron (see Fig. 3). Seven sheets, each 8 feet in length, are used—two sheets in the front, four at the back, and the remaining one, cut in halves, for the ends. The uprights, 3-inch by 2-inch hardwood, are let into the ground. Rails for supporting a roller blind are made of 1-inch by 1-inch hardwood, bored and fitted with one nail at the top to allow them to be moved. The bottoms of these support rails are let into slots cut on the bottom

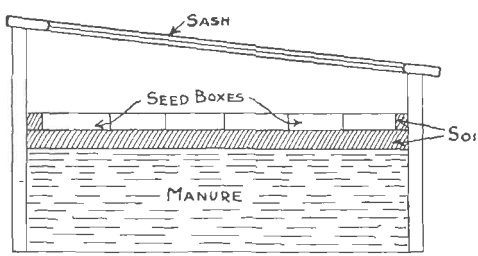


Fig. 2. Section of a Frame Heated by Fermentation.

plate. The blind may be made of wheat bags opened out and sewn together and attached to the roller at one end, the other end being attached to the top plate. At one end the roller should be fitted with a windlass handle to allow the operator to adjust the blind with a minimum of trouble. As the half sheet of iron does not completely enclose the end of the frame, a single bag must be used during frosty weather.

Hot-air Frames.—Practically all the frames other than those deriving their heat from the fermentation of organic manure are hot-air frames. The chief advantages these frames have over the old types are that control of temperature and humidity is obtained, that owing to the absence of organic matter the danger of insect pests and diseases is reduced to a minimum, and that once the bed is established the grower has no expenses in connection with it until renewals are necessary. With the old type of frame a good deal of expense is necessary each year in obtaining new heating material, &c., and in thoroughly sterilising the frames after each season.

A handy and easily-constructed hot-air frame, which can be made of wood, brick, or concrete, so long as there are no cracks, is illustrated on page 595 in connection with the raising of tobacco seedlings. The hot-air

pipes, which are about 4 inches in diameter, may be of any fireproof material or can be replaced by brick flues. These pipes conduct hot air and fumes from a small coal fire under the seed-beds to the chimney. The fumes first go into a chamber 3 feet by 9 inches against the inside of the seed-bed, so that the pipes do not come into contact with the fire. The covering usually consists of glass sashes, usually about 6 feet by 3 feet, and so constructed that they can be taken off. It is necessary to cover the pipes with sand in order to hold the heat, and either well-prepared soil or seed-boxes are placed above this sand. The fire pit is about 2 feet deep, and usually contains a small fire grate.

In the working of this type of frame it must always be borne in mind that over-heating is fatal; if in doubt, therefore, always under-heat. Apply the heat slowly for a few days before planting the seed, in order to allow the heat to penetrate thoroughly and settle down to the required temperature. *By using a thermometer over this period the grower will be able to note the* variation in temperature and gain experience of this type of frame.

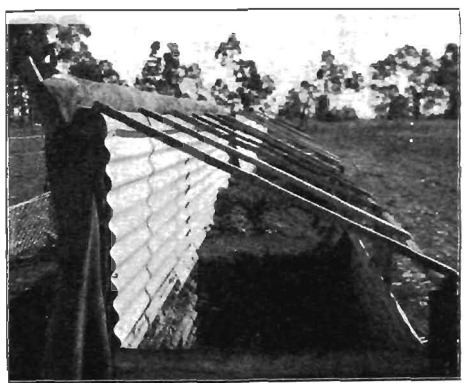


Fig. 3.—A Hot Frame, showing Depth of Manure used for Heating Purposes.

The type of material used in the construction of the frames and the insulating material around the pipes, &c., are factors which must be borne in mind when controlling heat. Outside conditions should always be considered. Under average conditions prevailing in New South Wales it is found unnecessary to apply heat during the day, except when very cold windy weather is experienced. During mild weather very little heat should be applied, even at night. *Small smouldering fires, which can be banked at* night, should always be used. Large fires alter the temperature too rapidly and shock the plants, while there is also the danger of over-heating with large fires. It is found that a frame 20 feet by 6 feet only requires between 7 to 10 lb. of coal per night to maintain the correct temperature.

As no two seasons are the same, it is recommended that commercial growers have two or three frames, and plant each one at an interval of about ten days. An advantage of this system is that it spreads the work out over a longer period, and thus enables the grower to more economically and efficiently handle a larger area. It is also found that, by having several plantings, the mistakes made in the early plantings can be rectified or avoided in the later beds.

Normally the seed should be planted in the frames about eight weeks before the usual time of planting in the field; by having seedlings at various stages of growth, advantage can always be taken of an early spring. As it takes some time to prepare the beds, it is necessary to start work a few weeks before seeding time in order to have everything ready for planting at the correct time.

After the tomato seedlings have reached about 1½ inch in height, they should be thinned out in the rows to at least 1½ inch apart. It is the usual practice to transplant the seedlings from the hot frames into cold frames before finally transplanting to the field. The purpose is to give the seedlings more room in the cold frame to enable them to be successfully hardened off.

Transplanting.

If it is desired to raise fruit for the early market, it is usual to set out stakes or erect a trellis to which the plants are tied. This should be done before transplanting commences.

Fig. 4.—Tomato Plants tied to Stakes and Pruned to a Single Stem
Irrigation by Overhead Spraying.

A useful trellis may be made by erecting straining posts of 4 inches by 2 inches timber (6 feet long, with 4 feet out of the ground) at the ends of each row, and posts of sawn or round timber about 2 inches by 2 inches and 5 feet 6 inches long (driven 18 inches into the ground) every 20 feet. Two wires are strained along the row at heights of 1 foot and 3 feet above the ground and stapled to the uprights, and on these wires, bamboos or light laths 4 feet in length are secured by tie-wire every 15 inches, the ends of the laths being allowed to rest on the ground, thus assisting to stay the trellis. The plants are, of course, set at the foot of the laths.

For early plants which are staked and pruned to a single stem the rows should be 4 feet apart and the plants 15 to 18 inches apart in the rows, and for later plantings which it is intended to grow on the "gooseberry bush" *principle, it is better to plant in rows 4 feet apart and to set the plants not* less than 3 feet apart in the rows. The land should be kept clean between the rows and plants; some growers plant on the square to allow of cross *cultivation.*

When all is ready for removing the young plants into the field they should have a good watering the previous day, so that the roots will retain hold of as much soil as possible. Plant at least 1 inch deeper than in the frame, and if the quantity is not very large, evening is the best time for moving them, or after showers.

Manuring.

Under most conditions it is as well to apply fertiliser at the time of plant*ing out. Superphosphate will be found of benefit almost generally, and in* many cases a complete manure has been found profitable—particularly for the production of early fruit. Where irrigation is practised, a top-dressing of a nitrogenous manure will be found to be of advantage after the fruit has set.

Pruning and Tying.

Pruning is a most important operation in the production of early fruit. It is no exaggeration to say that, by careful pruning, the tomatoes are made to ripen a month earlier than they otherwise would.

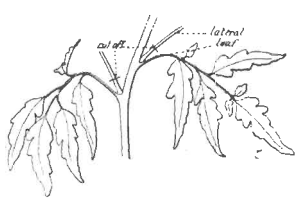


Fig. 5.—Diagram showing where laterals should be pinched out.

All lateral growth of shoots is pinched off, leaving only the main stem, which is trained up the lath. A lateral shoot starts from just above a leaf on the main stem. The leaf is not interfered with, but the shoot is pinched off as close to the stem as possible without damaging the leaf (see Fig. 5).

The trusses of bloom which give the fruit are thrown out along the main stem. Care is to be taken not to injure these when pruning. Whenever laterals appear they are pinched off, but when the plant reaches the top of the stake the laterals are allowed to remain.

Pruning and tying can be carried out at the same time, but during the early portion of the season it may be necessary to do one pruning before the first tying of the plants to the bamboos or laths takes place. As the season progresses the tying up, using hay bands or other available material, will be necessary at intervals of every foot of growth. When tying make certain

that the string is sufficiently tight to prevent the plant swaying about with the wind and becoming injured or breaking off, and yet loose enough to prevent choking as the plant expands in growth.

The tomatoes start to ripen from the base of the plant, and the ripening proceeds gradually towards the top.

Picking, Packing, and Grading.

Care should be taken when gathering the fruit that it be not bruised, or it will decay rapidly. Tomatoes that are to travel long distances, or occupy days in transit, should be picked when they begin to colour at the blossom end, or even when they take on a light green colour.

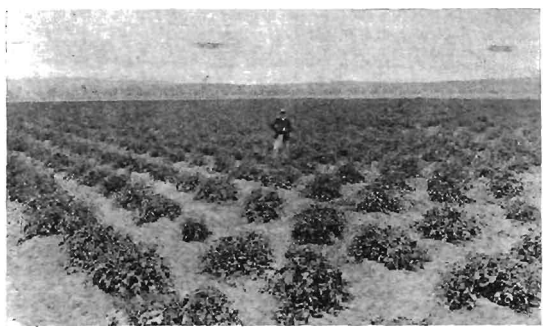


Fig. 6.—Tomatoes on the "Gooseberry Bush" System.

When packing, the fruit should be graded according to size and ripeness, all in each package being as nearly alike as possible. The grading should be as follows:—

1. Large ripe fruit.
2. Small ripe fruit.
3. Large medium ripe.
4. Small medium ripe.
5. Large green fruit.
6. Small green fruit.

The fruit will thus look better, sell better, keep better, and pack or travel better; the arrangement will be found advantageous to the buyer and more profitable to the seller, besides establishing a reputation for the brand amongst buyers. Each package must have the contents and quality faithfully marked on the outside, so that buyers may learn to rely on the brands without wanting to overhaul the fruit.

Culls should not be marketed, but fed to pigs or destroyed, as is done with other refuse fruit.

Production by the Ridge System.

A system which, it is contended, has advantages over the more common method of training to a single stem on a stake, the chief of which is that *one man can cultivate a much larger area, increasing the returns per man*, is that known as the "ridge system." The aim of each grower in districts where this system is in vogue is to plant and tend an area of 4 acres, which approximates 20,000 plants. Long hours and a good deal of effort are entailed. Should a grower succeed in planting the acreage mentioned, the covering up each night and uncovering in the morning of some 6 miles of tomatoes is necessitated, in addition to the work of carrying water and weeding, &c., after the crop is planted. As against this, however, if a grower succeeds in producing a satisfactory crop, the returns are usually worth while, even though the earliest of the fruit may not realise more than £1 per bushel case. Yields of 600 to 700 bushel cases to the acre are common, in addition to tomatoes suitable for use at pulping factories.

Preparation of the Land.

The first essential in this system of cultivation is early preparation of the *land in autumn, so that ridges of the necessary height can be formed* with soil of a satisfactory tilth. The ridges are made at distances of 4 ft. 6 in. to 5 ft. from crown to crown, and with a height of approximately 2 feet. The method adopted is to "back up" with the plough, doing two rounds to each ridge. The home-made ridger (see Fig. 7) is then drawn twice along each clean-out left after the plough, the handles being held high for the first round and lower for the second. A good ridge is essential, and it cannot be made if the ground has not been given a thorough preparation beforehand.

Fig. 7.—A Home-made "Ridger."

This implement is drawn twice along each clean-out left by the plough, the handles being held high *for the first round*, and lower *for the second*.

Fixing the Boards and Bagging.

After the ridges have been made it is usual to prepare the "hole" for the position of each plant on the face of the ridge. This is done with a narrow type of spade, the operation consisting of placing the spade in the face of the ridge in a vertical position, pulling it slightly forward, and then withdrawing it. These holes are usually made 14 inches apart. Boards 10 inches wide and 1 inch thick are then placed in position, one edge resting almost on the crown of the ridge, and the front supported by small stakes about 13 inches long driven into the front of the ridges about half way down. The boards used are usually discards from the sawmills, and cost about 10s. per 100 lineal feet.

The next operation is to place in position bagging, which is so spread on the board that sufficient overlaps for letting down over the front edge for protection of the plants. A little earth placed on the edge of the bagging at the crown of the ridge will hold it in position and afford protection from the cold on that side. The bags used are good quality, "once-used" Chapman sacks, free from holes; they are slit down both sides, thus producing a covering sufficient for about 6 feet of row.

Fig. 8.—A View of the Bags in Position.
When the plants are a fair size it is not necessary to cover them at night.

Planting-out.

Seedlings raised in the ordinary way are planted out on these ridges.

With a 2-ft. ridge the plants would be set about half the distance up, which really represents the normal ground level. The balance of the ridge and the boards and bags afford protection to the plants, which are thus only exposed on one side, usually the northern, which allows full benefit from the sun throughout the whole day.

With the development of the young plants, growth is to the light on the northern side, and a time arrives when the letting down of the bagging at night will cause injury. At this stage the covering flap of the bag must be raised by the use of longer stakes, which have a nail driven in the top end on which the bagging is fastened.

The board and bag coverings are left in position until about October, by which time it will be found that the plants have made growth towards the bottom of the ridges. It is then necessary to move the top growth in such a way that the foliage of one plant is over the base of the plant next to it. All is then ready for breaking down the ridges, which is largely accomplished by the use of a plough operated on the southern side of the ridge; where irrigation is practised a small channel is left alongside the rows.

Diseases of Tomatoes.

Early Blight.

The fungus *Alternaria* (or *Macrosporium*) *solani* that causes this disease may attack plants at any stage of their development. The first sign of attack is the presence of small brown or black spots on the leaves, especially the lower ones. At first these spots are scattered and inconspicuous, but later they increase in size and number, and finally cause the death of the leaves. Spots may develop on the stem, and are brown or black, more or less circular, and slightly depressed. These spots have also a concentric ringed appearance when viewed from the upper surface. Fruit may become spotted either on the plant or after picking. The disease may grow into the interior of the fruit and rot it.

Abundance of spores are produced on the dead spots, and they frequently spread the disease from the centre where infection started. The fungus passes from one season to another on old diseased parts of the host plant.

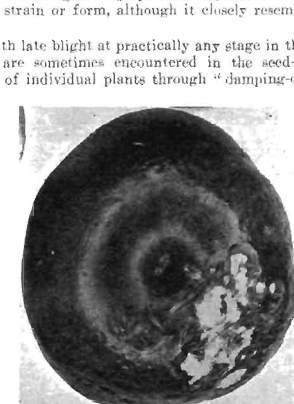
Control Measures.—In the control of this disease the destruction by burning of all parts of old plants is the first consideration. Very often the refuse of old plants is turned under, and in this way a resting place is afforded for the fungus. Spraying with Bordeaux mixture* (4—4—40) should be regularly carried out to prevent infection. If the disease is serious in any year a rotation should be practised, but potatoes should not follow nor precede the tomatoes.

Late Blight.

This disease is caused by the fungus *Phytophthora infestans*. This fungus, however, is a distinct strain or form, although it closely resembles that on potatoes.

Tomatoes may be affected with late blight at practically any stage in their development. Serious losses are sometimes encountered in the seed-bed owing to the total destruction of individual plants through "damping-off," and at a somewhat later stage from stem rot. An examination of affected plants will frequently reveal a darkened area on the main stem at or near the ground level. The tissues at this spot soon become shrivelled, and the whole plant falls over and withers. Although other fungi may cause somewhat similar symptoms, the late blight fungus is one of the most important in this connection.

The appearance of the disease on the tomato foliage of older plants is similar to that described for potatoes (see page 498). The general appearance is often such as to suggest the action of frost.



A Tomato affected with Late (or Irish) Blight.

*The method of making Bordeaux mixture is described on page 500.

The developing fruit may also become affected. Dark greenish, somewhat water-soaked areas appear on the surface of the fruit, and the fungus may later develop on the affected tissue in the form of small downy outgrowths.

Control Measures.—Follow the same general lines as recommended for potatoes (see page 499). Every effort should be made to keep a coating of Bordeaux mixture (4—4—40) on the foliage of the plants. Clean soil only should be used in the seed-bed, and the seedlings should not be watered excessively. Overcrowding and excessive watering are the most frequent causes of trouble at this stage.

Bacterial Wilt.

This disease is caused by *Bacillus solanacearum*, the same organism which causes Wilt or Bacterial Brown Rot of potatoes (page 506). The symptoms of the disease are very similar to those of Fusarium wilt, described below, except that instead of being a general wilt from the beginning, a single branch or leaf is first attacked and the disease then rapidly spreads through the whole plant. The disease causes an early development of a great number of incipient roots which remain in the form of nodules on the stems. Stems, when cut across, show a black discolouration of the sap-conducting tissues, and a bacterial slime is usually exuded at the cut surface. A soft rot accompanies the usual wilting and in the later stages the whole plant becomes a rotting mass. The bacillus may gain entrance through wounds, not only in the roots, but also in the stems and leaves. The disease may also be carried over in the soil of fields which have grown a diseased crop.

Control Measures:—

1. The seed-bed should be made of new soil, or should be sterilised with steam or formalin.
2. A rotation of crops omitting potato, tomato, and related solanaceous plants should be practised where possible.
3. Affected plants should be removed and burned.
4. Attention should be paid to the control of insects with biting mouth parts, which may carry the disease from plant to plant.

Fusarium Wilt.

Fusarium Wilt or Sleeping Sickness of tomatoes is caused by the fungus *Fusarium lycopersici*. A somewhat similar disease is caused by the fungus *Verticillium alboatrum*. The fungus invades the stalks from the soil by way of the roots, thereby bringing about a wilting and slow death of the tops. Plants are liable to attack at all stages of growth.

Young plants, when attacked, fail to keep pace with the healthy ones in growth; their leaves assume a sickly colour, and the lower ones fall. Other plants show the effects of the disease when the first cluster of fruit is about to ripen, and it is seldom that any plants obtain a greater development, the last symptom being a complete wilting, and death quickly follows. Affected stems and roots show a brownish discolouration of the water-conducting tissue, which can easily be seen by making a slanting cut through the stem or root. The roots of affected plants are destroyed by a dry rot. In all cases the crop is greatly reduced.

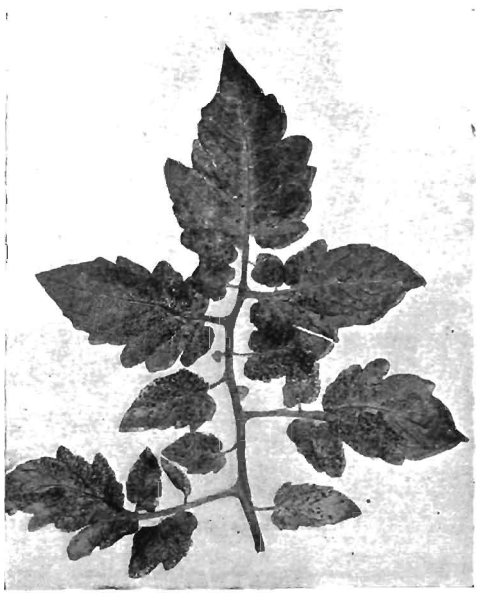
The fungus lives in the soil, often for years, and plants set out in an infected soil readily take the disease. Very often the plants are attacked in the seed-bed, but the effect of the disease is not noticeable until they approach maturity.

Control Measures:—

1. Seed-beds should be isolated and made on clean soil. The seed-bed can be sterilised, if necessary, with steam or formalin.
2. Crop rotation should be practised.
3. The most satisfactory method of control is the planting of resistant varieties. A number of reputedly resistant types are at present being tested out.

Spotted Wilt.

The Spotted Wilt or Bronzed Wilt disease is distinct from all the above troubles. It is well, therefore, not to be misled by the terms "wilt resistant" and "blight resistant" when applied to tomatoes, for they generally



Tomato Leaves showing Early signs of the Spotted Wilt Disease.

refer only to a variety which is resistant to the wilt disease connected with the *Fusarium* fungus, and certainly do not refer to the other diseases which are at times so destructive under local conditions.

The disease is most noticeable in the early crops, but in some years the disease may spread throughout the season. Plants in any stage of development are subject to attack. The first symptoms appear on the young terminal shoots. Small, brownish discoloured areas develop on the upper surface of the young leaves, and the discolourations spread until the whole leaf is involved. On the slightly older leaflets the disease usually first appears in the form of smooth, greenish-brown spots between the veins. These spots then may extend until the discolourations amalgamate. As the disease develops, the affected tissues blacken and shrivel until the shoot appears as though it had been scorched by a flame. Brownish-black streaks may also appear on the surface of the stems and leaf stalks. The fruits on affected plants

Tomato Shoot affected with Spotted Wilt.

usually develop more or less sunken spots, and ripen unevenly. Very young fruits shrivel and fall. Vigorously growing plants seem most susceptible, and sometimes the plant may be killed within the space of several days. On the other hand, the disease may take several weeks before reaching its full development. Apparent recoveries have been observed. New shoots may develop from the diseased tissues, and these shoots may grow for long periods before showing the usual symptoms of the disease

Spotted Wilt is one of the virus type of diseases which are characterised by the fact that the sap from a diseased plant, when introduced into a healthy one, is able to reproduce the disease. The thrips insect has been shown to be able to transfer the disease from plant to plant, and it is probable that these and other insects are the principal means of spreading the disease in the field. Sap transferred mechanically on the fingers when removing laterals in pruning is also a possible factor in this connection.

All commercial varieties of tomatoes appear susceptible to the disease. *The small egg and cherry tomatoes, however, are highly resistant.*

Tests with seed from diseased tomato fruits indicate that the disease is not carried over by this means. The available evidence suggests that it is *carried over from year to year in infected plants*—tomatoes or closely related weeds belonging to the same family.

Control Measures:—

1. *Remove and destroy affected plants on the first appearance of the* disease.
2. Destroy weeds in the vicinity of the crop.
3. Stake and prune the plants.
4. Use insect repelling and destroying sprays, *e.g.*, home-made tobacco washes or commercial nicotine sulphate, and make frequent applications in the early part of the growing season.

Mosaic.

This disease also is caused by a parasitic virus, and it appears in the form of an irregular mottling or mosaic of light green and dark green areas on the leaves. The leaves do not develop uniformly and the foliage may become crinkled and curled. Sometimes the lighter coloured areas of the leaf become brown, and these portions may die before the remainder of the leaf. Brown streaks may develop on the stems. The disease may also result in the production of extremely narrow leaves.

When a young plant is attacked, subsequent growth is checked and little or no fruit of commercial value is produced. The fruit may be deformed, dwarfed, or marked with blotches or streaks.

Control Measures are similar to those described for Spotted Wilt.

Rosette.

The plants do not usually show any sign of this disease until a foot or more in height. The most striking symptoms are the bunching together of the shoot, leaf or floral parts; the flower buds are sometimes curiously malformed. The stalk is usually thickened at the tip, or may be flattened; the leaves are smaller with shortened petioles; and affected plants rarely set fruit. If fruit is produced it is hard and mottled with red and yellow. A large number of adventitious roots are sometimes produced on the stem of affected plants.

The cause of the disease is not known, but the available evidence suggests that it is also a disease of the virus type. Such diseases are transferred mainly by insects with sucking mouth parts, *e.g.*, aphides, plant bugs, &c., which feed on the juices of diseased plants and then migrate to adjacent healthy plants.

Control Measures are similar to those described for Spotted Wilt.

Tomato Top showing Rosette.

Leaf Spot.

The leaf spot or "blight" disease is caused by a fungus, *Septoria lycopersici*, which produces small circular spots on the stem, fruit and calyx, but more especially on the leaves. The spots are usually greyish in colour with a brown border, and the fruiting bodies of the fungus are to be seen on them as very small black specks. The disease starts usually on the older, lower leaves and progresses upwards, causing the leaves to yellow and die and

finally fall, so that in bad attacks the plant becomes defoliated and the stems are left bare. As a result of the loss of leaf surface the plant is checked in growth and the fruits ripen prematurely.

The disease is able to attack the plant at any stage of growth from seedling to mature plant. In some localities it is not generally considered of sufficient importance to warrant spraying since it seldom becomes plentiful till late in the season, when it is of much less importance than if the plants are attacked early.

Control Measures:—

1. Use clean seed boxes and clean soil, and reject any diseased seedlings when transplanting.
2. A rotation of crops is recommended because the dead fallen leaves are able to carry the fungus over from year to year.
3. Cultivate only when the plants are dry, especially while the plants are young.
4. Spray with Bordeaux mixture (1—1—10) plus a spreader such as red oil or resin-fish-oil-soap, and take particular care to direct the spray on to the underside of the leaves.
5. Remove and destroy the crop debris at the end of the season. Do not plough or dig in diseased plants.

Tomato Leaf affected with Septoria Leaf Spot.

Ripe Rot.

Various organisms may be responsible for production of rot in the fruit. Late Blight has already been described; another type is caused by the fungus *Gloeosporium fructigenum*, which may cause much loss after pulling, as the rot may spread rapidly through the fruit, and also affect other fruit in contact with the diseased fruit in the cases. Large, sunken, decayed spots appear which become covered with small dark pustules formed in concentric rings, and later the spots become white to pinkish, as the spores are produced and forced out over the surface of the diseased area.

The fruit should be handled carefully to prevent any injury, as spores readily infect sound fruit if the skin be damaged. On no account should a tomato showing signs of Ripe Rot be included in a case of sound fruit.

Bacterial Spot.

This disease is caused by the organism *Bacterium vesicatorium*. It develops as a spotting of the leaves and fruit, and at first sight resembles the *Septoria* spot disease, but there are essential differences. The small, black,

pinhead, fruiting bodies of the causal fungus can be picked out in leaves affected with *Septoria*, but there is no such development in the bacterial disease. The bacterial spots are surrounded by a yellowish halo, and are more irregular in outline than the *Septoria* spots.

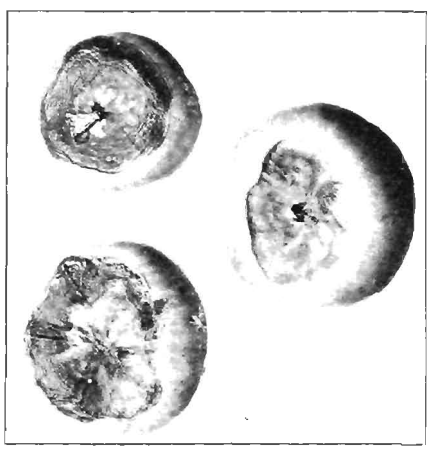
In severe attacks the leaves may fall and cankers may develop on the stems. Raised black spots may appear on the fruits, and each spot is surrounded by a water-soaked zone. These spots may later coalesce and subsequently collapse, causing a sunken blotch-like area. The disease is particularly serious during warm, moist weather.

Control Measures:—

1. Use seed from healthy plants or treat with corrosive sublimate (see treatment for Black Leg in cabbage, page 654) before planting.
2. Practise rotation of crops.

Black Spot or Blossom End Rot.

This disease first makes its appearance at the blossom-end of the fruit as a water-soaked area which later becomes brownish in colour, leathery, and sunken. A greenish-black fungus is generally found associated with the



Tomatoes affected with Black Spot

condition, giving the affected area a velvety appearance. At one time this fungus was thought to be the cause of the disease, but it is now definitely known that the trouble is associated with irregularities in the moisture requirements of the plant.

During very hot weather the roots may be unable to provide the moisture at the rate at which the plant requires it, even though there is a sufficient amount of moisture in the soil. Under these conditions the plant will withdraw moisture from the fruit, causing a collapse of the cells at the blossom-end. Where there is a deficiency of soil moisture or an irregular supply of water the same result may be expected. After the tissues have collapsed they may be invaded by fungi and bacteria.

The disease is more likely to occur in plants growing in light sandy, non-retentive soils, lacking in humus.

Control Measures.—Losses from this disease may be minimised by the observance of certain control measures:—

1. Where possible the plants should receive regular and judicious applications of water.
2. The water-holding capacity of soils of a light sandy nature may be increased by the addition of well rotted or other manure, while a mulch of any material will reduce evaporation of soil moisture. Continual stirring of the surface of the soil will aid in this direction.
3. Forcing the plants with large amounts of fertilisers is undesirable and should be avoided.
4. Young plants should be grown slowly and well hardened before planting.
5. As far as possible the plants should be sheltered from hot winds.

Sunscald.

In cases of Sunscald the injured surface of the fruit is usually shrunken, and the skin becomes dry and papery. The scorched spots may later turn brown because of invasion by rot-producing fungi, but in many cases the fruits ripen normally except for the flat, dead area on one side.

The injury is not of much consequence in itself, but frequently serves as an easy means of entry for rot fungi. Plants which have a plentiful supply of moisture and varieties with dense foliage are better able to withstand injury of this type.

Insect Pests of Tomatoes.

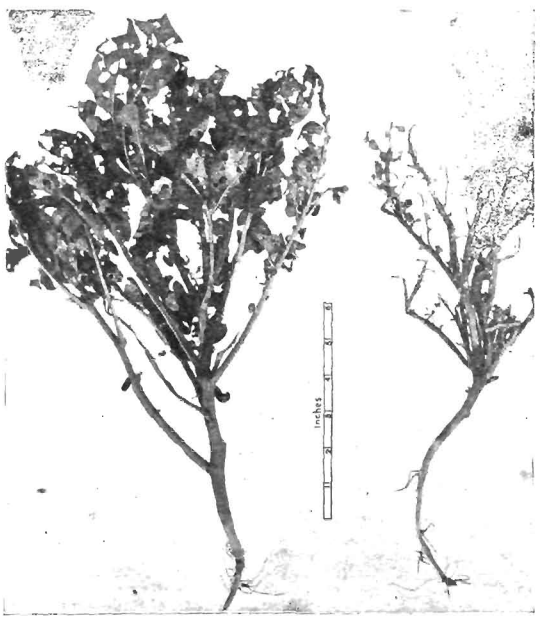
Brown Vegetable Weevil (*Listroderes obliquus.*)

This insect has become a very common pest of potatoes and tomatoes, which are at present its most favoured hosts as far as cultivated plants are concerned. In addition it has frequently been recorded on cucumbers, beans, carrots, parsnips, turnips, and lettuce, and on one occasion the larvae were found feeding on the young tobacco plants in the seed-beds. It is particularly common on Cape weed (*Cryptostemma calendulaceum*).

Injury to the plants is caused at both the larval and adult stages, although that done at the latter is much more serious. The larvae when small are usually found on the under-surface of the leaves, and at this stage do not eat entirely through the leaves, but as they increase in size they make large, irregular holes. The adults are even more destructive, and in an incredibly short time are capable of totally destroying the plant, leaving only the leaf-stalk, as is seen in the accompanying illustration. When the

weevils are present in considerable numbers even the stalks may be devoured, and a plant may be destroyed in two nights. The beetle sometimes attacks the plant underground, and large irregular holes may be eaten in such vegetables as carrots and turnips.

The adult beetle is about half an inch in length, rather elongate in shape, and in common with the rest of the weevil family has the head extended into a snout, at the extremity of which the jaws are situated. In colour it



Potato Plants partly and wholly denuded by the Weevil.

is a greyish brown, with two oblique whitish patches, which form a roughly V-shaped mark on the upper surface. The eggs are deposited in the soil, and from these the minute larvae hatch.

When full grown the larvae are pale-green legless grubs just under half an inch in length. They then construct an earthen cell in the soil, where they pupate, and later emerge as adult beetles.

Feeding in the adult stage invariably occurs at night, the beetles sheltering during the day in the soil or under rubbish near the base of the plants. The grubs feed mainly at night, but have also been observed feeding during the day.

The grubs are often present in considerable numbers during the winter, and adults begin to appear in August and September, becoming abundant in October and November, which is the period when they are most destructive.

Control Measures.—The most effective control is to dust the infested plants with calcium arsenate powder. Where the area is large the calcium arsenate powder may be diluted with ten times its weight of hydrated lime. Pure calcium arsenate powder should not be used on plants with more delicate foliage than potatoes, as some burning may result. Failing calcium arsenate powder, lead arsenate powder may be used. Spraying with lead arsenate mixed at the rate of 1 lb. of powder to 30 gallons of water will also give effective control.

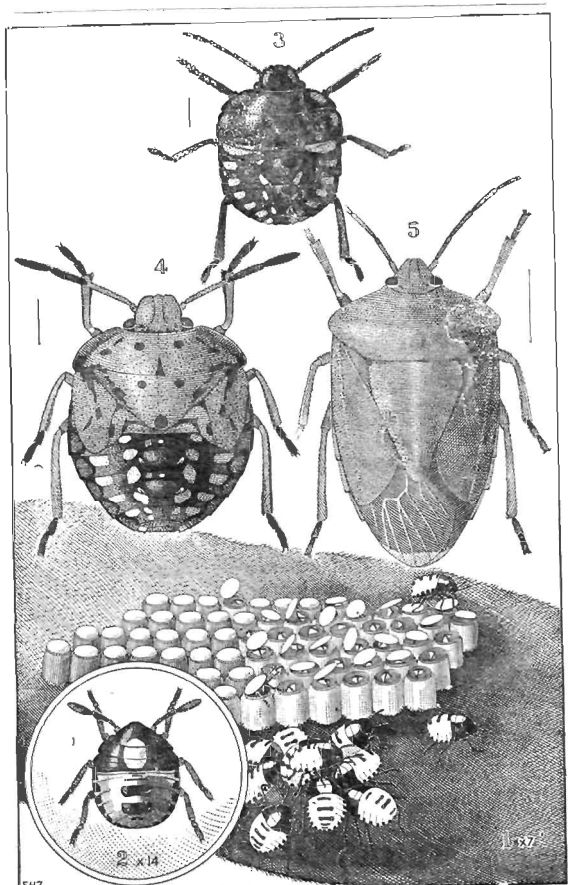
Another useful method, particularly when the plants attacked are small, is to dip the tops of Cape weed, potato, or other food plants that can be easily obtained, in a lead arsenate or calcium arsenate solution, or dust them with the diluted powder after dipping them in water, and place them between the rows of infested plants. This is best done towards evening, as the treated tops remain fresh and attractive overnight when the beetles are feeding.

Clean cultivation is also a factor in the control of this pest. On a number of occasions the infestation has been traced to a thick growth of Cape weed. The destruction of all such weeds should be carried out early in winter. If they are allowed to remain and their destruction is carried out later in the year most of the beetles will escape and migrate to the cultivated area. If such a condition occurs it might be even more advisable to allow the weeds to remain, and thus act as a trap crop.

Green Vegetable Bug.

The Green Vegetable Bug (*Nezara viridula*) is a cosmopolitan insect, which first appeared upon tomato plants in the neighbourhood of Sydney about 1911, since when it has increased in numbers, and has been noted as a pest upon the fruits and foliage of the tomato, the foliage and young pods of French beans, and on potatoes, melons, beet, citrus, maize, and garden flowers. It has been recorded from the North and Central Coast and Central Tablelands.

The adult plant bug is of a uniform, rich green tint, which fades slightly after death; the eyes are dark brown, the ocelli glassy, both marked behind with light yellow: the antennæ and feet are clouded with reddish yellow; length, $\frac{1}{2}$ inch; width, $\frac{1}{5}$ of an inch. As will be noted in the accompanying plate, this insect is of a typical shield shape, the small head projecting in front of the deflexed front margin of the prothorax, which projects slightly on the sides and is rounded behind. The dorsal surface of the thorax and wing-covers is convex, the wing-covers rounded to the apex, with the tip of the abdomen covered when viewed from above. The legs are well developed, and the insect can run and fly very well when disturbed from its food plant, but generally it drops to the ground when the plants are touched. The female lays her eggs in little patches, side by side, on the surface of the foliage of the various host plants; the young bugs, when ready to emerge, push off the flattened lids, leaving the egg shells like glass cups.



Green Vegetable Bug (*Nezara viridula*).

1. Cluster of eggs and young bugs immediately after leaving the egg shells.
2. Enlarged figure of young bug just emerged from egg.
3. Second stage after leaving egg.
4. Last stage of immature bug, showing definite wing pads.
5. Adult bug with fully developed wings; leaf green in colour.

The young bugs on emergence are black, but during their successive moults they are spotted with red, green, black and yellow, until at the final moult they appear perfect green shield bugs, with well-developed elytra and wings. These adult bugs, when resting, may be quite numerous among the foliage of a tomato plant, but unless disturbed can easily escape detection as their colour harmonises so well with that of the tomato leaves.

The bugs overwinter in the adult stage, sheltering under rubbish, grass, &c., and commence to lay their eggs in early summer. The young bugs which hatch from the eggs reach maturity in from four to seven weeks, so that several generations are produced during the summer, the bugs becoming increasingly numerous until about March.

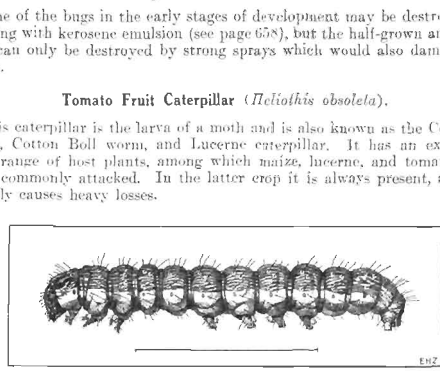
Control Measures.—Clean cultivation and the destruction of all rubbish, dead plants, &c., under which the bugs may shelter, is one of the most important factors in the control of this pest.

The clusters of rounded, flat-topped eggs are very noticeable on the foliage, and it is possible to greatly reduce an infestation of bugs by crushing the egg-clusters between the fingers.

Some of the bugs in the early stages of development may be destroyed by spraying with kerosene emulsion (see page 658), but the half-grown and adult bugs can only be destroyed by strong sprays which would also damage the plants.

Tomato Fruit Caterpillar (*Heliothis obsolela*).

This caterpillar is the larva of a moth and is also known as the Corn Ear worm, Cotton Boll worm, and Lucerne caterpillar. It has an extremely wide range of host plants, among which maize, lucerne, and tomatoes are most commonly attacked. In the latter crop it is always present, and frequently causes heavy losses.



Larva of the Tomato Fruit Worm Moth (*Heliothis obsoleta*) **(side view).**
Showing legs, dorsal markings, and the arrangement of hairs on the segments.

The adult moth is about ¾ inch long, and has a wing expanse of about 1½ inches. The colour varies considerably, but is generally buff to reddish brown, with indistinct darker markings on the fore wings and a black patch on the outer margin of each of the hind wings, which are whitish in colour. The moths are inactive during the day, but when disturbed make short, dart-like flights. The egg, which is light yellow in colour, is laid singly anywhere on the plant, and hatches in about four days. Usually the young caterpillar makes its way to the fruit, and may even attack the ovary before it has set.

The fully-grown caterpillars are about 1½ inches in length, and vary so much in colour that it is difficult to realise that they develop into the same species of moth. Some are pale-green to dark-green in general colour, with little or much black markings; others are pale-yellow with brownish markings, while others again are buff-coloured with broad brown stripes. The caterpillar attains its full size in about fourteen to twenty-one days, and then burrows into the soil and pupates at a depth of about 4 inches.

The duration of the pupal stage may be as short as fourteen days, but under cold conditions this period may be considerably prolonged. The caterpillars alone are responsible for the loss caused, and while they are capable of feeding upon the foliage, the chief damage is done to the fruit, which may be attacked in all stages of its development.

Control Measures.—The control recommended for these caterpillars is to spray with arsenate of lead powder at the rate of 1 lb. to 40 gallons of water. It should be remembered that repeated applications of the spray cannot be given after the picking of the fruit has commenced, and attention must therefore be concentrated on the destruction of the first brood. A careful watch should be kept, and should the small, whitish-yellow eggs be seen on the foliage, or damage to the young fruit noticed, the plants should be sprayed with the arsenate of lead. More than one spraying may be given, but the applications should be discontinued sufficiently early to avoid the presence of arsenate of lead on the fruit when marketed.

It has frequently been observed that the moths lay a large number of eggs on the calyx after the petals have fallen, and pinching these off and destroying them has been done with very beneficial results.

Avoid as far as possible growing tomatoes near other crops, such as maize, which are infested with this pest.

Cutworms.

Cutworms are the caterpillars of moths belonging to the family *Noctuidae*, which contain a very large number of species. Being general feeders, these caterpillars feed upon anything green and succulent, but are more especially destructive when they attack such plants as wheat, maize, cabbage, tomato, lettuce, &c., soon after they appear above ground. The caterpillars eat through the stems at the ground level, causing the plants to topple over, hence they are known as "cutworms." Later, when the plants are older and thicker-stemmed, the caterpillars may succeed in only gnawing the stems and destroying the foliage. The habits of these nocturnal caterpillars vary, and some species, like the Army Worm, which attack maize and other field crops, become so numerous as to move about in vast armies of caterpillars, capable of stripping well-grown crops bare of foliage, or of devastating large areas of pasture.

In all cases cutworms are nocturnal, hiding in the soil at the base of the plant during the day and feeding at night. Cutworms are extremely variable in colour and size, but can be said to be soft-bodied, smooth, cylindrical, robust caterpillars, varying in colour from dirty-grey to nearly black, many being more or less striped or spotted. When touched or disturbed they characteristically curl up.

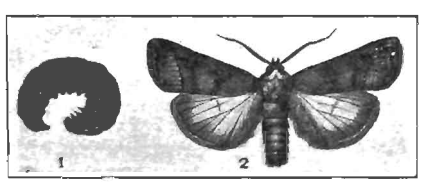
The life histories of the cutworms vary according to the species and locality inhabited. Generally speaking, the eggs are laid in masses on grasses and weeds, so that often the cutworms have already hatched and are

in the ground when it is being prepared for the new crop, and are thus ready to feed upon the young plants as soon as they appear above the surface of the ground. When fully grown the caterpillars pupate in the ground in rather compact earthen cells, in which they remain for varying periods before the adult moth emerges.

Control Measures.—The use of poisoned bait, made from the following formula, has been found invaluable in controlling cutworms:—

Paris green, 1 lb.
Bran, 24 lb.
Water, 3 gallons.
Salt, 10 oz.

White arsenic, when substituted for Paris green at the same strength, is found to be much less attractive and effective. Should difficulty, however, be found in obtaining Paris green, 9 oz. of white arsenic may be substituted. Treacle (20 oz.) can also be used in lieu of the 10 oz. salt, while the addition of some finely-chopped lemons to the water when mixing the mash renders the bait more attractive to the cutworms. It is important that the bran and Paris green *should be thoroughly mixed while dry*, and then made into a damp crumbly mash with the water. The mash can be spread along the rows of the infested plants, or placed in pellets close to the plants. It should be remembered that the bait is poisonous, and should be kept out of reach of stock.



1 (1/1 size of cell (*Agrotis ypsilon*).
1. The Caterpillar (Cutworm). 2. The Moth.

A deep furrow, with one side vertical, cut in front of the advancing caterpillars temporarily checks their progress. Holes can be dug at intervals in the furrow, and the caterpillars that fall into them destroyed. A log drawn along the furrow will crush a large number of the caterpillars, or they can be killed in the furrow by spraying with any oil emulsion.

PUMPKINS, SQUASHES, MARROWS, GRAMMAS.

Pumpkins have for a number of years been a very important crop in all the coastal and many of the more favoured districts of New South Wales, because of the large yield of palatable fodder or human food produced per acre. The crop was not well known in this State until the boom in dairying, when it was very extensively grown in our oldest districts as a stock fodder. The varieties most largely grown were of the mammoth cattle type. It was soon realised, however, that these pumpkins, although large, were usually hollow, coarse fleshed, and bad keepers, and other varieties of more solid

flesh and better keeping quality were grown. This change was largely assisted by the increase in population and the growing demand for pumpkin as human food.

The earliest table varieties grown were Turk's Cap, Button, and Ironbark. These held sway for some time, but the pure varieties were lost through cross pollination and "running out" of the types. Later the Crown became popular, and in quite recent years the three-cornered or Triangle type. The latter type is fairly well known to everyone, being triangular in shape, with three distinct folds, medium in size, exceptionally deep in the flesh, with a small seed cavity. The flesh is of good quality, and the variety is a good keeper.

The Crown variety has several distinct types which are listed under several names, but all types have a crown at the flower end of the fruit. This crown, in the perfect specimen, should be about half the diameter of the base of the pumpkin, and have three prominent divisions. The best type of this variety averages about 20 lb. in weight and is rather rectangular in cross section. The flesh is fairly thick and darker in colour than that of the Triangle. The Crown variety matures slightly earlier than the Triangle, and for this reason is very extensively grown on the Hawkesbury for the early market. The several strains of Crown pumpkin always bring top price on the Sydney market, where the dealers demand a type that is easy to cut, but in the northern markets and the coal-fields, where the consumers demand a medium size, whole pumpkin, the Triangle brings top price.

Squashes.—Of this group there are many varieties of fanciful shape and colour. Those best known for table purposes are Hubbard, Delicata, and Custard. The last two may be described as soft squashes, and the Hubbard as a hard squash, presenting more of the pumpkin characteristics.

Marrows.—There are numerous varieties of marrows, all of which are adapted for table use. The best-known types are the elongated ribbed, such as the Bush Marrows.

Grammas.—These are sometimes called Rios, and are the largest members of the family of cucurbits. In many districts they provide a large bulk of nutritious fodder for live stock. One type of gramma (of a shorter kind than the Crookneck) is largely used for culinary purposes, chiefly for pies. All types are also very good for jam-making.

Suitable Districts and Soil.

All plants of the pumpkin family are very susceptible to frost, and therefore must not be planted until the danger of frosts is past for the season. All of them have been tried throughout the State, and provided the soil selected is well-drained, friable, and abundantly supplied with organic matter in its natural state, or has been enriched by heavy dressings of well-rotted stable manure, they can be depended upon to yield satisfactorily in almost any district.

Preparation of Soil.

The land should be thoroughly worked before planting. If possible this work should be undertaken in June or early in July, especially if stable manure is to be added, so as to give the soil every chance to become mellow before the seed is sown.

In some districts pumpkins are grown between the rows in maize crops, and on rich alluvial soil this plan answers fairly well, but does not produce as good a yield of pumpkins as when the plants are grown in the open. When pumpkins are grown by themselves they are usually planted in groups of two or three plants at a distance of 8 to 10 feet apart each way. For bush varieties of marrow and squash about 6 feet apart each way will suffice.

The soil should be deeply ploughed, and care should be taken when adding liberal dressings of organic manure not to excavate in retentive subsoil pits deeper than the surrounding ploughed soil. If this be done water will lodge, and the plants will either "damp off," or refuse to run and produce a satisfactory crop. The manure should be thoroughly incorporated with the surface soil throughout a space of 3 feet or so in diameter. In many districts sandy or stony ridges prove to be highly suitable situations for this crop. Naturally in such places it is necessary to add a large amount of well-rotted stable manure, or preferably old cow manure, and to provide a few loads of fairly fine bush rakings for a mulch. The use of 3 cwt. of basic superphosphate per acre with or without organic manure will, in all cases, be found to produce an increase in yield. The great secret in obtaining heavy crops of pumpkins is to keep the plants moving from the time they show above ground, and everything that can be done to the soil to enrich and increase its powers to retain moisture will help to achieve that end.

Sowing and Cultivating.

As a rule, about 2 lb. of seed will suffice for an acre (less will be required in the case of squash and marrow, which have smaller seeds). Five or six seeds are sown a few inches apart, in groups, and when the plants are a few inches high they are thinned out to two in each "hill."

Care must be taken to keep the soil well scarified to check the growth of weeds and to conserve moisture, and these precautions cannot be discontinued until the plants are running and able to cover the ground.

It is a good plan to pinch back the runners in order to force the plants to produce a dense mass of foliage over the roots, which will resist hot, dry weather, and will also increase the production of fruit.

It is found that pumpkins, both for table and fodder purposes, keep much better if the fruit is left until the vines have died away. Table squashes and marrows may be picked as required as soon as they become firm to the touch and emit a wooden hollow sound when tapped with the knuckles.

Storage.

The keeping quality depends largely on the degree of ripeness. It will be found that if left until it is difficult to pierce the rind with the thumb nail they will keep throughout the winter, providing they have been harvested with the short stalk attached. Pumpkins from early-sown crops keep better than those from late crops, as they have longer to ripen off. Care should be exercised that the fruit is not bruised in handling. They should be stored on slatted shelves in a dry, airy shed, and looked over from time to time, any showing signs of decay being removed.

MELONS.

Water-melons, preserving melons, and rock-melons are grown in practically the same way as pumpkins. Like all plants of the cucurbitaceous family, they are susceptible to frost, and require rich, warm, and thoroughly well-drained soil. Soil and situations favourable to the production of maize will suit melons admirably

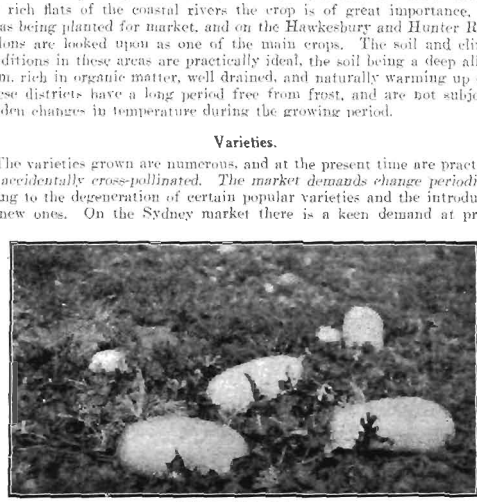
Owing to the ease with which all plants of this family are cross-fertilised at the flowering stage by the agency of bees and other insects, it is difficult to maintain purity if more than one variety is grown.

Water-melon Culture.

The popularity of this fruit can be judged by the fact that practically all farmers attempt to grow it, if not for market, at least for home use. On the rich flats of the coastal rivers the crop is of great importance, large areas being planted for market, and on the Hawkesbury and Hunter Rivers, melons are looked upon as one of the main crops. The soil and climatic conditions in these areas are practically ideal, the soil being a deep alluvial loam, rich in organic matter, well drained, and naturally warming up early. These districts have a long period free from frost, and are not subject to sudden changes in temperature during the growing period.

Varieties.

The varieties grown are numerous, and at the present time are practically all accidentally cross-pollinated. The market demands change periodically, owing to the degeneration of certain popular varieties and the introduction of new ones. On the Sydney market there is a keen demand at present



Irish Grey Water Melon.

for a melon with a light green or grey skin, the melon which created this demand being the "Sugar Stick." The Hunter River farmers nearly all grow "Florida Favourite," although other varieties receive attention.

The object of all water-melon growers is to place the melons on the market as early as possible, as prices fall rapidly once the crop begins to come forward. Providing the type is reasonably suitable for market, the earliest maturing varieties are generally grown.

The following varieties are commonly grown:—

Irish Grey.—This variety is very conspicuous by the plain, unbroken, light coloured skin. The fruit is long, oval in shape, and medium in size. The quality and colour of the flesh are good, and the seeds white. Although the rind in this melon is exceptionally thin, the skin is very hard and the variety one of the best of carriers. Owing to the hardness of the skin a good deal of difficulty is experienced in judging when the melon is ripe. This variety has many desirable qualities, and once known can be easily distinguished by the uncommon skin.

Improved Kleckley Sweet.—A long, dark-green, oval melon, medium to large in size; the flesh is sweet and high in colour; only a fair carrier.

Sugar Stick.—A light-skinned melon of exceptionally high quality, well known on the Sydney market. This melon has a reputation of being a poor carrier.

Grey Monarch.—A large, long, grey melon of fair quality. Is one of the best yielders, produces a vigorous vine growth, and is not so susceptible to disease as some of the other varieties.

Cultural Methods.

As it is so important that the plants be obtained early so that the fruit will be available at the season when it is most desirable, the height of summer, various devices are adopted for germinating the seeds early and ensuring that the young plants shall suffer no check when being set out. Indeed, the young melon plant is particularly tender, and will not survive transplanting if the root system is disturbed.

Some successful growers collect old jam and other tins, and, after melting off the tops and bottoms, arrange them, filled with fine mould, in shallow boxes or trays; on limited areas around Sydney it is now a recognised practice to use 4-inch clay pipes for this purpose. A couple of melon seeds are sown in each tin very early in the season, and the boxes are placed in some warm and sheltered place. By the time the season is sufficiently advanced to permit of safe planting in the open the plants are a fair size, and can be readily set out. With a little care the tins can be slipped off without interfering with the roots. Unfortunately for this method, only tins that are soldered at the joints are suitable, and the bulk of the tins now manufactured are not fit for the purpose.

A variation of this system is the use of "dirt bands." Thin strips of wood veneer, 3 inches wide and 18 inches long, are scored at intervals of 4 inches, so that they can be bent without breaking, and are folded into squares so as to resemble small strawberry boxes without the bottom. These squares are placed close together in a hot-bed, and filled level full with fine, rich soil. With a block of wood shaped for the purpose, the soil within the squares or bands is pressed until it is ½ to ¾ inch below the top. If only part of the soil is put in first and pressed down firmly, and the balance is then added and similarly treated, a more compact square of soil is obtained, which will hold together better during transplanting. The bed is then thoroughly wetted, unless the soil was very moist in the first instance. Next, three seeds are placed in each square, and covered with enough fine, loose soil to bring all level again with the tops of the bands. This last layer is not firmed.

The hot-bed for melon plants should have full exposure to light, and be maintained at a high temperature—about 85 deg. Fah. during the day, and 65 to 70 deg. at night. As much ventilation should be given as the weather will permit, and care exercised to avoid over-watering.

As soon as the plants are started, they are thinned to two in each square by cutting off the weakest with a sharp knife. When they are about four weeks old from planting, they are deemed large enough to transplant to the field. The bed is thoroughly watered, and the bands, enclosing their masses of earth and plant roots, are lifted by means of a spade, placed on a flat surface, and carried to the field, where they are set out with the aid of a flat trowel, care being taken that the bottom of each square is in close contact with the soil. The band is then removed and fine, moist soil is drawn in and firmed against the little square.

In field cultivation, the usual practice is to strike out furrows with the plough, say 10 feet to 15 feet apart, according to the soil conditions. Hills are worked up in the furrows, with ordinary or pronged hoes, and the seed pushed under the surface, or the plants set after having been raised as described above. When seed is planted direct in the field, about six to ten are set in each hill. This allows for poor germination and other losses, and for the grower to thin out later, leaving only the healthiest plants. The usual practice is to thin out the plants to three or less in each hill. Hawkesbury growers use fertiliser mixtures with some success, but on the Hunter the growers get good results from the use of basic superphosphate. Some farmers throw a few handfuls of dry farmyard manure on the top of the hill, so that the soil will not cake.

The land is cultivated between the rows as long as the vines will permit.

The melons are usually marketed in open trucks, without either bags or crates.

Large numbers of melons grown on the banks of North Coast rivers are also marketed without any packing, the growers simply taking the precaution of scratching a brand on the rind.

Preserving Melons.

There are a number of varieties of preserving or pie melons which are in considerable demand for jam-making, and also for juicy stand-by fodder. The Citron is a well-known and generally approved variety, and other well-known sorts are Snow, Kafir, and Trianble.

Rock Melon Culture.

During the past few years both consumers and growers have given this crop special attention, chiefly because of the degeneration of the water melon and the increased demand for high-quality melons by fruit and sundae shops. A few years ago the city markets depended almost entirely upon large growers from the rich alluvial coastal flats, and though to-day a good number of melons are still supplied from these areas during the main crop season, the small growers in the metropolitan area and in the Erina Shire have made a study of the early crop, and place the fruit at the correct stage of maturity on the early market. Growers on the river flats on the western slopes and the Irrigation Areas, which districts are comparatively free from disease, specialise in the late crops, growing the winter keeping melons.

Soil and Climate.

Rich sandy or loamy soil, well regulated moisture content, abundance of heat and sunshine with a dry atmosphere, are perfect conditions under which to grow rock melons. In late districts heavier land can be used, provided attention is given to drainage.

The plants are readily killed by frost; the most suitable climatic conditions are found in districts with a long frost-free growing period, comparatively dry atmosphere, with hot days and warm nights.

Varieties.

Rocky Ford or Netted Gem.—This is perhaps the most popular and widely-grown variety of rock melon. The fruit is of medium size, slightly oval in shape, finely netted, and indistinctly ribbed. The flesh is very thick,

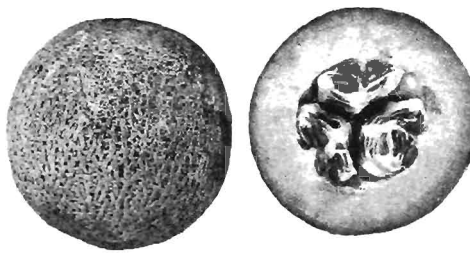
Rocky Ford.

green in colour, with a very sweet flavour and aroma. This variety is a particularly good carrier and keeper; the fruit being very uniform in size is easily packed. Rocky Ford produces a heavy yield, and ripens early. These two features are most desirable qualities, and make the variety the first to be recommended to growers.

Honey Dew.—This variety is perhaps the best known of the new introductions. It has been grown commercially for the past few seasons, and is now firmly established as the most popular winter melon on the market. The shape is oval, and the skin is smooth without ribs. The colour of the

skin is greenish-white, changing to creamy-yellow when ripe. The flesh is pale green in colour, exceptionally thick, fine grained, and has a characteristic sweet fresh flavour when ripe. This variety does not crack between the stalk and the stem like other types. The main features which denote the maturity of this melon are that the skin begins to lose its shiny appearance, and changes in colour to creamy white, and the blossom-end begins to soften. This variety keeps exceptionally well and carries splendidly.

Pollock 10-25.—*This variety has become very popular owing to its high* quality and aroma. It is much sought after by the best sundae shops owing to its convenient size and shape. The fruit is small to medium in size, *heavily netted, slightly oval, and is not ribbed. The flesh is salmon-tinted,* deep, of high aroma and flavour, and devoid of fibre. This melon belongs to the Rocky Ford group.

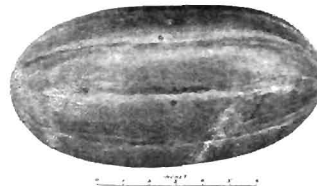


Pollock 10-25.

Early Hackensack.—This variety is the most popular with the growers around Sydney or within a few miles of the best markets, and growers along *the coast in the earliest localities have been growing it as a main crop for* a number of years. Little attention has been given to the selection of seed, and at present the variety is very mixed. The true Early Hackensack fruit is fairly large, oblate, and distinctly ribbed, although the ribs are irregular in width. The netting is coarse and offers fair protection to the fruit. The skin is green in colour in the immature fruit, turning gradually to a yellow when mature. The flesh is green in colour, only medium in depth, *medium coarse in texture, and juicy. The quality of the flesh is only fair,* being rather sweet in flavour, with a desirable odour. Early Hackensack matures very early, and is a good yielder.

Sugar.—This variety is also known as Banana rock melon. It does not in any respect appear to be suited to our trade, but it may find a place in home gardens. The fruit is long, *perfectly smooth, straw-coloured when* ripe except along the sutures, which are dark green. The flesh is very light in colour, deep, and mealy in texture. The flavour is mellow and mild, not oversweet, distinctive, and would not suit the average palate. The seed

cavity is comparatively small. The outstanding features of this variety are the large size of the fruit and its heavy yielding qualities. However, the shape and lack of netting would prevent it being carried any distance in safety.



Sugar.

Seed Selection.

At present the majority of growers depend on seedsmen for their supply of seed, but now that the market demands fruit having certain characteristics, growers should pay more attention to the home production and selection of seed. When selecting, more attention should be given to the plant than to the individual fruit. Select seed from plants bearing an average number of fruit, uniform in quality and size. Avoid plants that are light bearers, having only one outstanding fruit, or having fruit of undesirable size or quality.

To separate the seed from the pulp, &c., allow the melon to ripen thoroughly on the vine, then cut it in halves and pour the juice, pulp, and seeds into a container. The liquid is allowed to ferment for three or four days, to remove the gelatinous coating on the seed, and facilitate washing and cleaning. Any seed that floats should be poured off with the liquid. The seed is then washed with clean water several times, drained, and spread out in a thin layer to dry.

Cultural Methods.

The early ploughing should be carried out in late autumn or winter, and the land then allowed to lie in the rough; when the seed-bed is prepared particular attention should be given to soil drainage. If the crop is to be irrigated the furrows should be ploughed before the seed is planted.

In the earliest localities on the coast the seed can be planted as early as August, while on the tablelands planting cannot be carried out before late October. The actual number of seeds to be planted in each hill depends on the moisture content of the soil, time of planting, and quality of seed; fewer seeds are planted as the season advances. It is a good practice to seed heavily, as the plants can always be thinned out, the proper time for that operation being when the plants begin to put out their true leaves. A good method to follow is to thin out to five plants in each hill in one operation, and later thin out to two or three plants. The object of having the final thinning out as late as possible is in case insects or disease destroy certain plants, leaving too few in each hill. Generally about 1½ to 2 lb. of seed are required to plant an acre.

In field practice the seed is planted in hills 6 feet x 6 feet. Some farmers practise throwing a few furrows together at intervals of 6 feet; this allows the hills to be readily made, ensures thorough drainage, and facilitates after cultivation. The disadvantage of this system lies in the rapid drying out of the soil. The hills in which the seed is to to be planted are made by either working well-rotted organic manure into the soil or working up the soil with a hoe. If poultry manure is used it should be placed in the hills about *ten days before planting to allow it to ferment. At planting time this* manure is mixed with the soil after a little superphosphate has been added and the seed planted. This mixture of poultry manure and superphosphate *is the ideal fertiliser* for rock melons.

The best method of planting the seed is roughly in a circle 1 foot in diameter; about ½ inch of soil should be slightly compressed around the seed and the top mulched with loose soil or rotted manure. Seed can be *planted deeper if sown in the spring or summer,* or if sown on soil of a very light nature.

Transplanting as a means of obtaining an early crop in early districts where the area of rock melons planted is small has a lot to commend it. The methods to be adopted are similar to those described for water melons.

The after-cultivation of rock melons should be carried out very carefully, especially when the vines are beginning to run. The plants are comparatively shallow-rooted, and extend their roots over a large area, and there is danger of these roots being severed by careless cultivation. The vines eventually completely cover the ground, making further cultivation impossible.

Pollination.

The cropping capacity of the rock melon depends on the successful pollination of the flowers. This, to a large extent, depends on the work of the bees, hence growers encourage the presence of these insects. The flowers of the *rock melon can be divided into two groups—(1) male, and (2) hermaph*roditic flowers. The latter type contain both male and female organs, and can be self-pollinated. However, all hermaphroditic flowers do not set fruit, and much better results are obtained when bees are working in the crop. Rock melon varieties readily cross-pollinate; the resultant fruit of these crosses may not show variation, but the seeds from them will produce hybrid plants.

Marketing.

Very little attention has been given to correct methods of marketing rock melons, due largely to the system of marketing, and also to the type of melons grown. However, as the varieties and types become better known, the public will demand more uniformity in the product. Growers who *supply local shops, or who transport their produce right into the market,* can dispose of the crop by number. More distant growers, however, must pack and forward to market in containers. Usually a bushel, or benzine case, is used, the fruit not being packed according to any recognised system.

Apart from size (and in the majority of cases size is no guide to ripeness), growers have no fixed method of judging the maturity of their crops. The result is that the majority of material arrives on the market either too green or over-mature. With a little experience a grower should soon

be able to judge the right stage at which to harvest the crop. In some varieties the colour of the skin changes to various shades of yellow on approaching maturity, but in well-netted varieties this cannot be observed. The mature fruit can be readily slipped from the stem by pressing with the thumb. In a well-netted variety the netting becomes hard, and well developed, and with certain types the netting cracks. By picking fruit too green a good deal of the flavour, aroma, and general quality are sacrificed. The sugar content of the fruit does not increase after picking, although in some varieties the texture improves.

CUCUMBERS.

The cucumber, although not recognised as a main crop in any portion of New South Wales, is, in certain districts, looked upon as a very important sideline. Farmers in the earliest districts of the State depend upon this crop as a reliable source of income.

No vegetable is so subject to price fluctuation, or in midsummer is so over-supplied to the market as cucumbers. All growers aim to place their produce on the early market during November and December, but it is only in districts such as the far North Coast and favoured localities on the Central Coast between Sydney and Newcastle that the climate and soil conditions are suitable for the early development of the crop.

The Sydney market is supplied during the winter and early spring by Queensland, and later by North Coast growers. The cost of placing cucumbers from these districts on the Sydney market is very high, but as good prices are always obtained during the early months a handsome profit is made by the growers. Although these cucumbers are consigned long distances, they usually reach market in fairly good condition, due largely to the mild weather experienced at that particular time of the year. With the advent of warm weather the prices weaken, until the demand almost ceases when the "locals" begin to come forward.

Suitable Varieties.

The cultivation of this crop during the summer is rather a simple matter, as the plants under good conditions are very vigorous growers and heavy yielders, but the production of a very early crop is a very difficult matter, and requires a deal of experience to obtain good results. Physically the soil must be of an open nature, warm, aerated, and well drained, and to afford these conditions it must necessarily be sandy or a very light loam. Heavy soils or badly drained soils take too long to warm up during the spring, and are totally unsuitable. It will be found that in the very early districts of the State the soil is very light in texture. It has been found from practice that virgin soil, being rich in organic matter, is the most suited to the early cucumber.

Preparation of the Land.

Early ploughing of the land is essential to enable any organic matter to decay, and allow the weather and other factors to sweeten and aerate the soil. Due consideration must also be given at ploughing time to drainage, as soil erosion readily occurs in these soils. The "early" land is usually elevated, and unless numerous drains are made as soon as the land is broken up soil erosion will occur with the first rain. The rainfall in these districts is the heaviest in the State.

Varieties.

The common long green type is in general cultivation, the most extensively grown varieties of which are Commercial, White Spine, and Long Green Prickly. Commercial is the variety most commonly grown by commercial growers, and it is reported to retain its dark-green colour longer than other varieties. A cucumber that changes its colour rapidly to yellow when fully grown is undesirable.

The Apple-Shape variety, a very excellent type for the home garden, has been grown in this State for some time. Though a prolific cropper, it is only recently that commercial growers have taken it up, and the demand is already very keen. Its chief disadvantage lies in the fact that the colour is light straw, which rapidly deepens to yellow when maturing.

Boston Pickling, a variety of gherkin, has proved the most suitable for pickling purposes.

Cultural Methods.

Cucumbers are undoubtedly heavy feeders, and require a liberal application of organic manure. This can be used in conjunction with a complete manure or a mixture of five parts of superphosphate to one part of sulphate of ammonia. These manures should be worked into the soil around the hills before the seed is planted.

Seeding time takes place on the far North Coast during April, May, and June, but on the lower coast extra early planting is not practised, owing to the difficulty of obtaining a good germination. Cucumber seedlings are very easily drowned with excessive rain, and make very poor growth with cold weather. As the winter rain makes the soil cold and lifeless, sowing in the Erina Shire is not generally commenced until July. The hills are prepared where fertiliser has been worked into the soil with a fork hoe. The hills are spaced 6 feet by 4 feet apart, and at least a dozen seeds are planted in each one so as to allow for defective germination. With warm, dry weather during July, a good germination is obtained, but if heavy rain with cold weather occurs, a bad and very slow germination is usually experienced.

If a good germination is obtained, the plants are allowed to grow about 3 inches high before the weaker ones are thinned out, leaving only three or four in each hill. The after-cultivation is carried out with a forked hoe, and consists of destroying all weeds and keeping the soil in good open condition to encourage aeration and increase the soil temperature.

Marketing.

The local crop begins to come on to the market during late October. The cucumbers are cut from the vines with a knife, graded, and packed in half-bushel "grape" cases.

High returns are very commonly obtained by these growers.

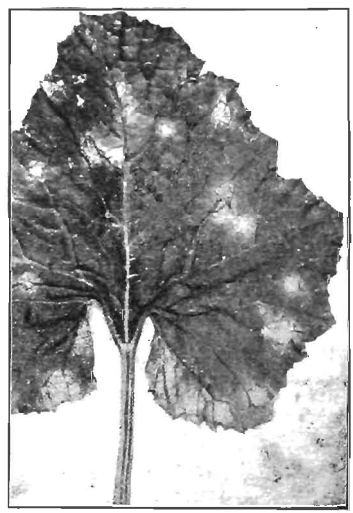
Diseases of Cucurbitaceae.

Anthracnose or Ripe Rot.

This disease is caused by a parasitic fungus, *Colletotrichum lagenarium*, and attacks pumpkin, marrow, squash, water melon, and rock melon. It may attain serious proportions during hot, moist weather. All parts of the plant except the root are subject to attack.

Dark, more or less circular spots are produced on the leaves. They may be so numerous that they run together and involve the whole of the leaf. Later, the leaves crinkle, turn black, and have the appearance of having been scorched by fire. Spots may develop on the stems. These are at first water-soaked in appearance, but later become brown, sunken and cracked. Circular to oval, sunken brown to black depressions occur on the fruit. The surface of these spots often has a pinkish appearance due to the profuse development of the spores of the fungus.

Melon affected with Ripe Rot or Anthracnose.



Rock Melon Leaf, showing diseased areas caused by the Anthracnose Fungus.

Apparently sound fruit from diseased plants may be infected although the signs of infection are not evident. Such fruit, however, may develop Anthracnose during transit if conditions favour the growth of the fungus.

If seed is saved from diseased fruits, the process involved in seed extraction may furnish means by which the seed is contaminated. Under field conditions the disease may spread extensively from the original centres of infection during periods of heavy rainfall.

Control Measures:—

1. Practise a rotation of crop—melons, cucumber, marrows, squash, and related plants should not be grown on the same land two years in succession.

2. Secure seed, if possible, from a clean crop. If the seed is from a doubtful source it should be treated with corrosive sublimate. (See page 654, Black Leg of cabbage.)

3. Avoid working among the vines when they are wet, as this helps to spread the disease if it is already present.

4. Spray the vines with Bordeaux mixture (4-4-40), making the first application when the vines begin to run, the second application a week after the first melons have set, and the third application two weeks after the second spraying. Spraying to be effective must be thoroughly carried out; the spray must be well directed on to both the upper and lower surface of the leaves and other parts of the vine. For the preparation of Bordeaux mixture, see page 500.

5. As far as is practicable, collect and burn all diseased material—never plough it under.

Powdery Mildew.

Powdery mildew is to be found almost universally during periods of moist weather on cucumber, squash, pumpkin, rock melon, and other cucurbits. The disease is caused by a fungus, *Oidium* sp., which is probably the conidial stage of *Erysiphe cichoracearum*.

The mildew is conspicuous on the foliage and young stems as a white, superficial, powder-like growth. The affected tissues at first appear normal, but finally become brown and dry. In severe attacks the leaves are killed and the plant is weakened.

Control Measures:—

1. Spraying or dusting. Though these crops are often not sufficiently valuable to warrant the expense of these methods, the disease can be checked by either of them. Bordeaux mixture (4-4-40) should be used as a spray, or flowers of sulphur dusted on to the plants while covered with dew in the early morning. The Bordeaux may be combined with the lead arsenate spray recommended for the control of pumpkin beetles, &c. It is necessary to reach the under-surface of the leaves with the spray or dust, and during periods of wet or humid weather it is necessary to repeat the application at least once a week. In dry periods no treatment is necessary, but the plants should have a protective coating of spray or dust before the disease has spread to any extent.

2. A rotation of crops is of value.

Wilt.

Several members of *Cucurbitaceae* are subject to a wilt disease due to different species of the fungus *Fusarium*. Water melon, squash, cucumber, and rock melon are commonly attacked, but the fungus causing the wilt of water melons is not known to attack any of the other related plants, and the same applies to the fungi attacking squash and cucumber, with the exception that the cucumber fungus is able to attack rock melons.

Affected plants usually wilt suddenly during the heat of the day, losing their turgidity and showing signs of under-nourishment. This is due to the invasion of the sap-conducting vessels of the root and stem by the fungus, and the resulting reduction of sap flow. After the death of the plant a fungus weft may grow about the base of the stem, and the fungus may fruit there.

Control Measures.—Since the fungus is confined to the root system of the plant, spraying will not control it. The only practical method of control is the use of a rotation of crops for as long a period as possible. Plants attacked by wilt should not be ploughed under, but should be pulled out and burned.

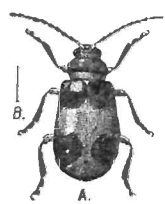
Insect Pests of Cucurbits.

Cucurbitaceous plants, such as pumpkins, melons, squashes, and cucumbers, are attacked by comparatively few insects, the chief of which are the Banded Pumpkin Beetle, the Leaf-eating Ladybird, and the Melon aphis.

Banded Pumpkin Beetle (*Aulacophora olivieri*).

This well-known foliage-eating beetle has a very wide range over Australia both in the coastal districts and far out into the interior. It is particularly fond of all kinds of cucurbitaceous plants, infesting pumpkins, melons, cucumbers and squashes, and causes a heavy annual loss in these crops.

The damage to pumpkins commences as soon as the two seedling leaves appear; though older vines may be severely damaged or destroyed, it is generally considered that once the plants commence to put out "runners" they are better able to keep pace with further attack. The beetles swarm on the foliage and stems, eating the upper surface of the leaves, and soon destroying the plant. They are extremely fond of the flowers and the very young pumpkins, and by continually destroying these, cause a heavy loss of crop.



A.—The Banded Pumpkin Beetl (*Aulacophora olivieri*).
B.—Indicating the natural size o f the Beetle.

The beetle measures a quarter of an inch in length and is of a rich orange-yellow colour. The wing covers bear four large black spots—two that almost converge across the shoulders, and two on the posterior half of the body, which in addition is tipped with black. The basal joints of the antennæ are yellow and the upper black, while the eyes, jaws, feet, outer edges of the thorax and the under surface of the last two abdominal segments are black also.

The larvæ are dull, whitish-coloured, elongate grubs, with the hind portion yellow, and measure about two-fifths of an inch. They are active little creatures, and feed on the stem and roots of the vines, and sometimes gnaw their way into the base of the stem. When full grown they pupate at a distance varying from 1 to 6 inches below the surface of the soil, and later emerge as the perfect beetle, ready to make a fresh attack on the surrounding vegetation.

Control Measures.—Arsenate of lead, 1 lb. of powder to 20 gallons of water, gives excellent results in controlling the beetle. It is, however, essential to spray thoroughly, paying particular attention to the upper surfaces of the leaves. Plants that are already damaged should receive a good covering of spray, as the arsenate of lead, in addition to giving an excellent kill, will protect the leaves and stems from further attack to a considerable extent. After the whole area has received its second or third spraying, it should then only be necessary to treat individual plants upon which the beetles are concentrating. The flowers and young pumpkins as well as the foliage need to be sprayed.

The very young plants, having a small amount of leaf surface, are, however, not protected so well by spraying, as the beetle may destroy them before the poison begins to act. It is therefore recommended that these

tender plants be dusted with a mixture of arsenate of lead and slaked lime, relying later upon spraying. For this dust, one part by weight of arsenate of lead powder is mixed with nine parts of slaked lime. These can be mixed with a shovel, but it may be done more thoroughly by shaking the mixture through a sieve. Dusting should be continued until the plants have at least two well grown leaves over 3 inches across.

Wood ashes is very commonly used against the pumpkin beetle, but slaked lime alone or mixed with soot will give a much more satisfactory covering of dust.

Another dust suggested where the plants are attacked as soon as they appear above the ground is a 5 per cent. mixture of nicotine sulphate (liquid) with slaked lime. This is a *contact poison, but also acts to some extent* as a repellent, keeping the beetles away from the plants. The nicotine-lime dust, as it is called, is made by mixing 5 parts by weight of nicotine sulphate with 95 parts by weight of slaked lime. Thus, to make 10 lb. of dust, ½lb. (approximately one-third of a pint) of nicotine sulphate is mixed with 9½ lb. of slaked lime. The lime should be entirely free from lumps, and it is essential that the nicotine and lime should be thoroughly mixed. This can be effected by *sprinkling the nicotine into the lime, a few drops at a time, and stirring* constantly. The mixture should then be sifted two or three times through a fine wire sieve (with a mesh of at least twenty to the lineal inch) with the aid of a brush. The dust should be kept in a tightly stoppered vessel if it is not used as soon as prepared, as it quickly loses its efficiency when exposed to the air.

Dusting is best done with a rotary hand dusting machine, but a sulphur bellows gives a good cover. If neither is available, the dust should be placed *in a cheese cloth bag and the plants treated by shaking the bag over them.* It is best to dust early in the morning when there is little wind and while the dew is still on the leaves.

As the larvæ of this beetle infest the roots of pumpkins, all dead pumpkin *and melon plants should* be cleaned up and burnt.

Melon Aphis (*Aphis gossypii*).

Pumpkins, melons, squashes, cucumbers, and other plants are often infested with this aphis, which injures the plant by sucking up its juices. It is a comparatively small aphid, and varies from light to dark green in colour. The insect feeds first on the underside of the leaves, causing them to curl, wither, and die, and later spreads to the terminals, where its injury is manifested by the stunting and distortion of the shoots.

Control Measures.—As with most other aphids, control may be effected by the use of nicotine extracts, either as a spray or a dust. The effectiveness of the treatment will depend upon the thoroughness of its application; as the aphids mass together on the underside of the leaves, care should be taken to ensure that the spray or dust reaches them.

For spraying the most effective work can be done if the outfit is provided with an extension rod 3 or 4 feet long, with an angle nozzle, so that the liquid can be directed upwards on the under-surface of the leaf.

Nicotine sulphate (40 per cent. nicotine) is the most effective spray, and should be used at the rate of 1 pint to 100 gallons of water. The addition of 5 lb. of soap to the solution makes it spread and stick better and

increases the efficiency of the spray. This treatment is somewhat expensive when used extensively, and for this reason a home-made tobacco wash, made by steeping 12 lb. of waste tobacco leaves or stalks in 30 gallons of water for thirty-six hours, can be used if desired. The liquid is strained off and soap added at the rate of 1 lb. to 20 gallons.

Nicotine-lime dust made and applied as described for Banded Pumpkin Beetle is also a satisfactory control for this pest.

Leaf-eating Ladybird (*Epilachna 28-punctata*).

Similar but less frequent damage to that caused by the Banded Pumpkin Beetle is also caused by this injurious ladybird. In this case, however, injury is also caused by the spiny larvae. The insect is discussed as an insect pest of potatoes on page 521.

SECTION X.

Grasses and Pastures.

MANY farmers and pasturalists have during recent years taken much more interest than previously in the improvement of the carrying capacity of their pastures, and have adopted such practices as establishing areas of drought-resistant grasses, top-dressing pastures with superphosphate, and the sowing of lucerne as a grazing proposition, with considerable benefit to themselves. As the result of many trials carried out in co-operation with farmers and pastoralists the Department is now in a position to make definite recommendations as to the best varieties of grasses and clovers to sow in the various parts of the State, the most satisfactory quantity and kind of fertilisers to apply as top-dressings, and the most desirable methods of handling the pastures to obtain the maximum return from them.

Apart from the increased value of the land itself that results from the improvement of the pasture it carries, good pasture has many advantages over poor quality grass. A good grass should be characterised by the following features:—(1) Permanence (particularly under stocking); (2) succulence, palatability, and high nutritive qualities; (3) vigour of growth and good carrying capacity; (4) good seeding habits (generally); (5) resistance to adverse climatic conditions (drought, frost, &c.). An ideal pasture should contain as great variety of good grasses as possible, combined with leguminous plants like clovers, trefoils, &c. Only by such a combination (that is, the supplement of the carbohydrate content of the grass by the protein content of the legume) can the ideal balanced ration be provided. Paspalum pastures would lose a great deal of their present value were it not for the fact that White clover grows abundantly with it in most situations.

A good pasture should provide succulent feed all the year round, though this is impracticable in many localities, as the summer grasses prove too vigorous and crowd out the winter grasses. In such circumstances there should be distinct paddocks of summer and winter grasses. Good pastures should be free of weed and fungous growth; allow weeds to obtain a hold on a pasture and it will be practically impossible to convert it again into good condition without resowing.

There is no doubt that, when possible, mixtures of grasses are to be preferred. Under natural conditions may different species of plants intermingle, and again different plants require different plant-foods in different proportions, so that plant-food not utilised by one species may be absorbed by another. A combination of grasses not only provides a more varied ration for stock, but the varying habits of the different species ensure a more satisfactory pasture in other ways. To lay down pastures of individual grasses is often unwise. For example, if a pasture of cocksfoot alone is laid down, the tufts produced are not only unsightly, but coarse, whereas when cocksfoot is mixed with clover and rye grass a more uniform sole is produced, and the pasture is improved in quality.

To the sheep man, the quality of the pastures is of prime importance. If the ewes are in good condition and on good pastures at lambing time, the lambs are strong and do not suffer any check in growth. Good succulent feed will ensure a bigger percentage of lambs than is the case where pasturage is dry and scanty. The most critical period in a sheep's life is during the first twelve months of its existence, for it is then that the animal largely builds up its framework on which is dependent its wool and mutton-producing powers. A strong, virile constitution, together with good pastures, enables the animal to withstand disease and produce a good class of wool free from "break" and other detrimental features. The market for fat sheep of any kind, and especially lambs for the export trade, demands that the flesh be free of grass seeds. In Spear grass country, if good, clean pastures are available, such as those obtained in Riverina and parts of the Western Slopes by the use of Wimmera rye, lucerne, Subterranean clover, &c., fat stock can be marketed free of this deleterious "seedy" material. Improved pastures, therefore, are valuable in that they provide more and better class of wool and meat, and lessen the danger of disease occurring.

Fig. 1.—An Improved Pasture at Crookwell.

Part of an area of 200 acres of Cocksfoot, Perennial rye, Cow grass clover and Sheep's Burnet, showing a large body of feed though heavily stocked.

To the dairy-farmer also good pastures are a profitable investment. If stock have access to succulent pastures they are less liable to become affected with such troubles as rickets, bone-chewing, &c., which are generally associated with poor pasturage. Much poor land will produce infinitely better feed, if it can be broken up and sown with suitable grasses and clovers. On some of the country on which implements cannot be worked, winter-growing plants such as Wimmera rye, Italian rye, Perennial rye, Cocksfoot, Sheep's Burnet, and Subterranean clover can be scattered in suitable places

By having numerous small paddocks, rather than a few large ones, a system of rotational grazing can be adopted, and by establishing some paddocks of winter grasses and others of summer pastures, each can be

grazed at the time when it contains the maximum amount of nutritive material. The grasses and clovers can thus be handled in such a way as to enable them to rest, recuperate, and seed at the correct time, thus maintaining the maximum degree of efficiency in each.

If the property is well subdivided, the pastures can be utilised when the feed is most nutritious. Milking cows require palatable feed rich in protein, and the grasses should be *fed off* when the growth is young, for as the plants *mature* the fibre increases and the percentage of protein diminishes.

THE PASTURES RECOMMENDED.

Attention should be given to sowing mixtures of grasses and clovers most suitable for the district, and particularly those which provide feed at those times of the year when the natural pastures are at their worst. The Department's recommendations for various districts are as follows:—

North Coast.

The following pastures are recommended:—

Paddock No. 1—*Paspalum dilatatum* and White clover.

Paddock No. 2—Rhodes grass and lucerne.

Paddock No. 3—Para grass.

Paddock No. 4—Kikuyu grass.

Paddock No. 5—Tall fescue, Meadow fescue, Italian rye, Perennial rye, Wimmera rye, Cocksfoot and *Phalaris bulbosa* grasses: White, Subterranean, and Perennial red clovers, lucerne and Sheep's Burnet.

Paspalum dilatatum and White clover (Paddock No. 1).—Sow in early autumn (February or March) or in spring (September), at the rate of 12 lb. of hand-shaken paspalum seed and 4 lb. of White Dutch clover per acre. Where it is possible to do so, the paddock should be ploughed after a period of five years, and sown to a winter fodder crop, such as oats and Berseem clover, or a grass and clover mixture (as given for Paddock No. 5), and then allowed to revert to paspalum. By this means the maintenance of a good paspalum pasture is assured.

Rhodes grass and lucerne (Paddock No. 2).—Sow in early spring at the rate of 4 lb. to 5lb. of Rhodes grass and 2 lb. of lucerne per acre. These two plants grow well together, and a balanced ration is afforded. Rhodes grass should be allowed to become fairly well established before being stocked. Under judicious treatment this pasture should last for many years.

Para grass (Paddock No. 3).—Plant cuttings in furrows about 6 feet apart in early spring. Para grass spreads over the ground at a very rapid rate, forming a dense mass of succulent feed, which provides a very welcome change to paspalum. It will carry in a good season nearly as heavily as paspalum.

Kikuyu grass (Paddock No. 4).—Plant roots or runners of this grass 3-4 feet apart in early spring. This is a perennial, very drought-resistant grass, and produces green feed well into the winter.

Tall fescue, Italian rye, Perennial rye, Wimmera rye, Cocksfoot, and *Phalaris bulbosa* grasses; White, Subterranean and Perennial red clovers, lucerne and Sheep's Burnet (Paddock No. 5).—Sow in autumn at the rate

of: Tall fescue, 2 lb.; Meadow fescue, 2 lb.; Italian rye, 2 lb.; Perennial rye, 2 lb.; Wimmera rye, 2 lb.; Cocksfoot, 2 lb.; *Phalaris bulbosa*, 1 lb.; White clover, 1 lb.; Subterranean clover, 1 lb.; Perennial red clover, 1 lb.; lucerne, 1 lb.; and Sheep's Burnet, 1 lb. per acre. The mixture will provide *succulent feed all the year round.*

In swampy land in localities where the winters are not too severe, Para, Floating Water grass (*Glyceria fluitans*), *Lotus major*, and Strawberry clover give good results.

On heath country and also on elevated sandy land in coastal districts, Carpet grass (*Paspalum compressum*) is useful for grassing such areas. The value of this grass for reclaiming heath country and eradicating bracken fern was recently illustrated at Woodburn, on the North Coast. Country there has been converted from practically useless sandy wastes into useful grazing areas. Carpet grass, however, has neither the carrying capacity nor the palatability of either paspalum or Kikuyu, and is not recommended where these two grasses thrive.

Central Coast.

The same suggestions are made for this district as for the North Coast with additional paddocks planted during the autumn months with a mixture of *Phalaris bulbosa* 3 lb., Perennial rye 6 lb., Wimmera rye 2 lb., Prairie 3 lb., Perennial red clover 2 lb., and Subterranean clover 2 lb. per acre.

The recommendations given for the North Coast dealing with swamp areas and heath country are also applicable to the Central Coast.

South Coast.

Paddocks planted to the following mixtures are recommended:—

Paddock No. 1—*Paspalum dilatatum* and White clover.

Paddock No. 2—Cocksfoot, Tall fescue, and Perennial rye grasses; Perennial red, Subterranean, and White clovers.

Paddock No. 3—*Phalaris bulbosa*, Wimmera rye and Tall Oat grasses; Perennial red, Subterranean and White clovers.

Paddock No. 4—Kikuyu grass.

Paddock No. 1 should be given the same treatment as on the North Coast.

Cocksfoot, Tall fescue, Perennial rye grasses, Perennial red, Subterranean and White clovers (Paddock No. 2).—Sow in the autumn (March or April) at the rate of 4 lb. Cocksfoot, 4 lb. Tall fescue, 8 lb. Perennial rye, 2 lb. Perennial red clover, 1 lb. Subterranean clover, and 1 lb. White clover per acre. This pasture provides good feed all the year round.

Phalaris bulbosa, Wimmera rye, Prairie, Tall Oat grasses, Perennial red, Subterranean and White clover (Paddock No. 3).—Sow in early autumn at the rate of 3 lb. *Phalaris bulbosa*, 4 lb. Wimmera rye, 3 lb. Prairie, 4 lb. Tall Oat, 2 lb. Perennial red, 1 lb. Subterranean, and 1 lb. White clover per acre. *Phalaris bulbosa* is one of the best winter grasses yet introduced into New South Wales, and it is extremely succulent and nutritious.

Kikuyu grass (Paddock No. 4)—Plant as directed for Paddock No. 4, North Coast.

New England and Northern Tableland.

The rough native grasses, such as Kangaroo grass (*Themeda Forskalii*), Wild Sorghum (*Sorghum plumosum*), and Tussocky Poa (*Poa caespitosa*) provide inferior grazing. Much better results are obtained from the finer native grasses, *Danthonia* (Wallaby or White Top), and the *Chloris* (Windmill) grasses. The *Danthonia* grasses are probably the best native winter grasses of New England, and are very palatable; they should, therefore, be encouraged in every possible way. This may be done by allowing them to seed at periodical intervals, and by collecting and scattering seed over denuded areas.

Introduced Grasses.—There are several introduced grasses which have proved successful on the Northern Tableland, the most important of which are Cocksfoot, Perennial rye, *Phalaris bulbosa*, Tall fescue, Tall Oat, and Wimmera rye. Perennial red clover, White clover, Subterranean clover, English Trefoil or Black Medic (*Medicago lupulina*), and Sheep's Burnet are also useful pasture plants.

The following mixtures, which could be sown in the early autumn, will be found particularly suitable:—

(1) *Phalaris bulbosa* 4 lb., English Trefoil 1 lb., White clover 1 lb., and Perennial red clover 1 lb. per acre (for black soil country).

(2) If *Phalaris bulbosa* is scarce, the quantity of seed of that grass may be reduced to 2 lb. per acre, and the mixture completed with Perennial rye 10 lb., English Trefoil 1 lb., White clover 1 lb., and Perennial red clover 1 lb., (for black soil country).

(3) Cocksfoot 6 lb., Tall fescue 2 lb., Tall Oat 2 lb., English Trefoil 1 lb., Perennial red clover 1 lb. per acre (for red soil country).

(4) Tall fescue 2 lb. Meadow fescue 1 lb., Kentucky Blue 1 lb., Wimmera rye 3 lb., Cocksfoot 3 lb., Sheep's Burnet 2 lb., English Trefoil 1 lb. and Subterranean clover 1 lb. per acre (for poor quality land on ridges).

(5) Perennial rye 10 lb. and Perennial red clover 2 lb. per acre (for potato land to be used for pasture purposes for three or four years).

Central Tableland.

Owing to the lower rainfall and warmer climate, some of the introduced grasses, such as Perennial and Italian rye, are unsuited for these localities.

Phalaris bulbosa and lucerne (Paddock No. 1).—Sow in autumn at the rate of 4 lb. *Phalaris bulbosa* and 2 lb. lucerne per acre.

Tall fescue, Cocksfoot, and lucerne (Paddock No. 2).—Sow in autumn at the rate of 4 lb. fescue, 6 lb. Cocksfoot, and 2 lb. lucerne per acre.

Tall Oat Wimmera rye, lucerne, and Subterranean clover (Paddock No. 3).—Sow in autumn at the rate of 2 lb. Tall Oat, 4 lb. Wimmera rye, 1 lb. lucerne, and 1 lb. Subterranean clover per acre.

Native grasses (Paddock No. 4).—A mixture of Coolah grass (*Panicum prolutum*), 2 lb.; Warrego Summer grass (*Panicum flavidum*), 2 lb.; Giant Panic (*Panicum antidotale*), 1 lb.; and lucerne, 2 lb. per acre is recommended. These grasses are very drought-resistant, and provide excellent

summer feed. Sow at the end of July. The lucerne will provide good feed right throughout the year.

Sudan grass (Paddock No. 4).—Sow in October at the rate of 8 lb. seed per acre. A paddock of this grass can be used for pasture, hay, or silage.

Southern Tableland.

The most important native grasses for these localities are the *Danthonia* (Wallaby or White Top) and *Agropyrum* (wheat) grasses.

The mixtures given for paddocks 1, 2, and 3, under the heading of Central Tableland, are suitable for this locality, sowing to be carried out in early autumn.

Perennial rye, Cocksfoot, Perennial Red clover, Sheep's Burnet (Paddock No. 4).—Sow in the early autumn at the rate of 6 lb. Perennial rye, 4 lb. Cocksfoot, 3 lb. Perennial red clover, and 2 lb. Sheep's Burnet per acre.

Slopes and Riverina.

On the Slopes and in Riverina, Wimmera rye, Rhodes grass, and lucerne have proved very successful, and the following mixture is recommended for autumn sowing:—Lucerne, 2 lb., Wallaby grass 1 lb., Rhodes grass 2 lb., and Wimmera rye 2 lb. per acre. On soils too shallow for lucerne, sow Subterranean clover 2 lb., Wallaby grass 1 lb., Rhodes grass 2 lb., and Wimmera rye 2 lb. per acre in the autumn.

The Western Division.

In parts of the North-western and Central-western Plains, lucerne 2 lb., Rhodes grass 2 lb., and Wimmera rye grass 2 lb. per acre are giving good results, especially on old cultivation paddocks. Where lucerne will not thrive sow Rhodes grass 2 lb, and Wimmera rye grass 2 lb. per acre. Certain native grasses, like Coolah (*Panicum prolutum*), Giant Panic (*Panicum antidotale*), Warrego Summer (*Panicum flavidum*), Native Millet (*Panicum decompositum*), Diffused Panic (*Panicum effusum*), and Wallaby or White Top (*Danthonia semiannularis*), have also proved promising under cultivation.

Generally speaking, however, the success of our native pastures in the west depends on (1) an intelligent conception of the good and useless varieties, (2) the subdivision of paddocks and judicious stocking of same, and (3) prevention of overstocking, particularly after a drought period. Good grasses should be encouraged in every way possible, such as by allowing them to seed and by collecting and scattering the seed over denuded areas.

GRASS SEED.

Strictly speaking, a grass seed is the grain with all the husks (or glumes) removed. It is only in the case of a few genera, however, that the seed of grasses as bought from the seedsman consists of pure grain without husk; usually some part of the husk remains attached to the grain and is only removed with difficulty. Sometimes one side of the grain is exposed, as in the brome grasses, and at other times the grain is completely concealed, as in the paspalum grasses. In the latter case it is extremely difficult to determine from its appearance whether the so-called "seed" contains grain or not.

Weed seeds are more common in some grasses than others. In the case of tall-growing grasses, like paspalum and Prairie, the seed is often fairly pure and the quantity of weed seeds is very small. In shorter grasses, however, such as Kentucky Blue, the bent grasses and clovers, weed seeds are sometimes plentiful.

The germination or vitality of seeds refers to the capacity of the grain to develop under certain favourable conditions into a living plant. The power of grass seed to germinate may be affected by

(*a*) age (it may be too old);

(*b*) injury done to grain through exposure to certain harmful conditions such as moisture, heat, &c.;

(*c*) immature state of grain through being harvested before fully developed.

As a rule the grain of grass is capable of developing into healthy plants for a considerable period after being harvested, and very little deterioration results in most grass seeds for at least a couple of years. Some introduced grasses like rye, Cocksfoot, and fescue then appear to deteriorate.

Owing to the fact that some of the seed of imported Cocksfoot, Perennial rye grass, and Red and White clovers is being harvested from fields which have not been established for many years, the longevity of plants from this class of seed is considerably reduced. It is advisable, therefore, that farmers who have old-established fields of any of these plants should harvest and plant home-grown seed, and dispose of any surplus to seedsmen and others. When ordering seed of these plants, farmers should insist of being supplied with material the perenniality of which is guaranteed. Even though an extra charge of a few pence per pound has to be paid, the additional expenditure will be worth while, as seed produced from old established pastures tends to produce plants of satisfactory longevity.

Methods of Sowing.

In coastal districts grass seed mixtures are generally sown on old cultivation land, or on virgin country that has been broken up with the plough and a seed-bed prepared. The amount of cultivation, harrowing, &c., required to be carried out on such land will depend on its physical condition, but, generally speaking, a shallow ploughing of 4 to 5 inches, and one or two harrowings are all that is necessary.

On light land a working with a disc or springtooth cultivator is the only preparation required, the seed being broadcasted and harrowed in. On small areas the seed can be broadcasted by hand, and the seed covered by following with a tine or chain harrow.

In the case of large areas the seed is generally sown with a wheat drill or top-dressing machine, mixing the seed with superphosphate (½ to 1 cwt. per acre) just before sowing. The hoes or discs of the wheat drill should be set to run on the surface of the ground, as the seed only requires to be lightly covered; run a harrow at right angles to the direction of the drilling if the seed has not been well covered by the drill. On friable soil seed can be effectively covered by driving a mob of sheep over the area on which the seed has been broadcasted.

Where it is impossible to use implements for sowing and covering, the seed should be broadcasted in and around stump holes, dug-out rabbit burrows, among fallen timber, or any other suitable cover in which it will be held, and later germinate.

BETTER PASTURES FOR DAIRYING DISTRICTS.

In most of our dairying districts the need is apparent for a change of food from the ubiquitous paspalum, which has taken possession of the best of the country in our coastal areas. While providing good food during the warmer months of the year, it suffers considerably from frosts and droughts, and at such periods is of little value for producing and maintaining a good flow of milk. Fortunately we have in White clover a very nutritious legume, and one of the very few useful plants which will thrive in association with a rampant grower such as paspalum. The clover does not last right through the year, however, and it is necessary to incorporate other plants, and especially legumes, in the pastures, and so endeavour to provide a change of feed for the animals during the four seasons of the year.

Winter Grasses and Clovers *versus* Paspalum.

The price of butter is generally high when the milk flow is decreasing, and this usually occurs during winter months. In districts where frosts are experienced, paspalum pastures are then producing little or no nourishing material, and unless succulent winter feed is available the milk flow further diminishes as the winter advances. Where succulent winter grasses and clovers are available, a good flow of milk is assured, not only during the colder months, but during the greater part of the year, because the majority of the plants recommended for coastal districts are perennials.

The most outstanding plant for sowing in coastal districts, and especially amongst paspalum, is White clover (*Trifolium repens*). In many localities White clover is so plentiful that in a good season dairy stock have to be judiciously grazed on it, otherwise losses may occur through hoven or bloat. There are centres, however, where this species of clover is becoming thinned out of pastures through overstocking, and re-seeding of the area is necessary.

Until recently, the idea that the various perennial forms of Red clover (*Trifolium pratense* var. *perenne*) formed little or no seed was generally accepted, but their spread into areas which have not been planted with seed has proved that a fairly liberal amount of seed is formed, especially when the crops are grown under cultivation. During the past few years, the growing of Perennial Red clover on cultivation land and grazing stock on it has been fairly extensively practised in Central Coast districts and in dairying centres on the Southern Tableland, and it is now quite a common sight to see patches of this clover springing up in paspalum and native grass paddocks. This result is obtained through the cows grazing on clover areas which are in seed. The seed is evidently not affected by the animals' digestive processes, as it germinates freely in the droppings, which form an excellent medium for rapid growth. This is also a most satisfactory method of spreading Subterranean clover in pastures. By turning the stock into a profuse growth of Subterranean clover that is carrying large quantities of seed this valuable legume is soon established among the other pasturage.

The Value of Top-dressing.

The use of fertilisers, such as superphosphate, stimulates the growth of grasses and legumes, and the amount of mineral matter in the plants is increased, particularly the elements lime and phosphorus, which are essential for the animal's development. Stock grazed on pastures deficient in these

substances invariably become "bone chewers," but by feeding the pasture plants with fertilisers, the composition of the feed is considerably improved. Where a marked increase in the lime content of the soil takes place, the percentage of nitrogen in the pasturage also increases.

Stock prefer top-dressed portions of a paddock to unmanured sections, because (1) they obtain more lime and phosphorus (two substances essential to the building up and maintenance of the animals' framework), and (2) the top-dressed pasture is more palatable and nutritious, and contains a greater amount of protein, due, mainly (*a*) to the increased growth of clovers, and (*b*) to the increased percentage of nitrogen present in the pasture as a whole.

Therefore, by nourishing the pastures, not only is a greater quantity of feed obtained, but also a considerable increase in the nutritive value of the plants. It has been demonstrated for many years past that by top-dressing pastures the growth of the better class grasses is encouraged, and the development and seed production of clovers are increased. Clovers are the most economical form in which to supply protein to animals, and it is expedient that young growing stock, animals producing and rearing young, and cows in milk, should receive large quantities of this nitrogenous material, which is so essential to their well-being.

Stock grazing on pastures remove from the soil an amount of fertility that corresponds to the quantity of meat or milk produced from the pasturage consumed. To counteract this loss the fertility of the soil must be reimbursed, chiefly through the application of fertilisers.

Most of our winter grasses, and especially the clovers, respond to fertiliser, and applications of 1 cwt. to 1½ cwt. of superphosphate per acre should be made during the autumn months. Subterranean clover, however, should be top-dressed later in the year—in June or July.

Paspalum and its Renovation.

Ploughing the paspalum in March or April every fourth or fifth year with a mouldboard plough, turning furrows about 6 inches wide, and working the furrows down with disc harrows or cultivators, or grass or tine harrows, and broadcasting the following mixture of seed gives very beneficial results:—Wimmera rye 2 lb., Italian rye 2 lb., Perennial rye 2 lb., *Phalaris bulbosa* 1 lb., Cocksfoot 2 lb., Tall fescue 2 lb., Subterranean clover 1 lb., Perennial red clover 1 lb., White clover 1 lb., and Sheep's Burnet 1 lb. per acre. If the soil is friable and deep, include 1 lb. of lucerne in the mixture. Ploughing induces a new root system to develop, and the plant is then better able to assimilate any fertiliser applied and to make full use of the rainfall.

Where it is impossible to plough, broadcast the following mixture amongst the paspalum during the late autumn:—Wimmera rye 3 lb., Italian rye 2 lb., Perennial rye 2 lb., Subterranean clover 2 lb., White clover 1 lb., and Sheep's Burnet 2 lb. per acre. Use the disk harrow or grass harrow where possible to work the seed in and round the crowns of the paspalum plants.

If it is not desired to sow grasses on ploughed land, by broadcasting 1½ to 2 bushels of oats per acre on the area little or no loss of feed is sustained through the paddock being ploughed.

If it is desired to renovate paspalum in localities such as the Dorrigo, where long, cold winter periods are experienced, the grass should be ploughed during spring months; heavy frosts will kill out a big percentage of the grass if it is ploughed during the autumn. As useful grasses such

as Cocksfoot, Wimmera, Italian and Perennial rye grasses, fescues, *Phalaris bulbosa*, and various species of clovers, provide good feed all the year round, and particularly during the winter months, larger areas should be sown than is the practice at the present time. It is readily admitted by farmers on the Dorrigo plateau, that originally their pastures of Cocksfoot, rye grass, and clover carried more stock than is the case to-day, when paspalum predominates.

Wherever it is possible to do so, it is sound practice to plough up paspalum areas in the autumn, and sow the mixture of grasses and clovers given above for ploughed paspalum areas. This will result in an increased capacity on land which, under paspalum, can only be looked upon as summer pasture. A considerable quantity of the paspalum will be killed off, and a good mixed pasture with a sprinkling of paspalum, will result.

Fig. 2.—A Paspalum Paddock that was Ploughed April, 1925.

The manner in which this part of the paddock has been eaten down, compared with the part illustrated in *Fig. 3*, indicates how palatable the new growth was to the cattle. The photograph was taken on 17th August, 1926.

Manurial Trials with Paspalum.—On red volcanic soils, superphosphate, 2 cwt. per acre, is giving good results, especially where the paspalum has been ploughed. At *Wollongbar Experiment Farm* the residual effects of ploughing carried out in 1925, and an application of 2 cwt. superphosphate per acre made in the same year, are shown in the following weighings, which were obtained from a cutting made in February, 1927:—

	tons.	cwt.	qr.	lb.
Check plot, unploughed and unmanured	3	7	3	7
Plot, ploughed and unmanured	6	13	1	13
Plot, ploughed and manured with superphosphate 2 cwt. per acre (1925 application)	6	9	0	24

The area from which these results were obtained was thrown open to continuous grazing for eight months prior to being closed up to allow growth to mature for harvesting purposes.

Back to Cultivation.—When it is intended to bring a paspalum paddock back to cultivation it should be ploughed with a mouldboard plough in the

autumn, thoroughly worked with a disc harrow or disc cultivator, and a winter fodder crop, such as oats or barley, plus vetches, field peas, or Berseem clover, sown broadcast over the area in June or July.

After the fodder crop has been removed, keep the land worked during the summer months to destroy any paspalum seedlings, and make an early sowing of the winter fodder crop in February or March.

Areas which cannot be Ploughed.—At a number of centres in North Coast districts, on very hilly country, where it is impossible to plough, good results

Fig. 3.—Portion of the same Paddock that was not Ploughed.

The cows have practically neglected the unploughed portion of the paddock. This photograph was also taken on 17th August, 1926. Compare with Fig. 2.

are obtained from top-dressing paspalum every second year in August or September with a mixture of superphosphate 2 cwt., and sulphate of ammonia ½ cwt. per acre.

Burning Paspalum.—Some farmers burn off the dry growth on paspalum pastures. This is not a sound practice, as the crown and surface roots of many of the plants are destroyed, as well as much seed that is lying on the ground; bare patches result, and weeds and other useless plants become established in the pasture.

Cutting Paspalum for Hay.—Where a mowing machine can be operated, much of the rank growth of this grass can be cut and converted into hay, which is a useful standby during winter months or droughty periods. This work is generally carried out towards the end of the summer season. The grass then makes fresh succulent growth, and, where frosts are not too severe, is in a better condition to go through the winter than if carrying rank, dry, unpalatable feed.

Kikuyu Grass.

Kikuyu is a useful plant to work in amongst paspalum, or to plant in ploughed paspalum areas, as it will not only hold its own, but in most cases will choke out the other grass. Kikuyu is more drought resistant, and produces more feed during winter months than paspalum, although it must be remembered that it is primarily a summer grower. It does not form seed, and consequently roots have to be planted. The best time to plant is during the spring. Where it is impossible to plough the roots in, such as on

hillsides or in stony land, use a mattock or hoe, completely burying the roots 1 to 2 inches deep, so as to prevent stock from pulling them out of the ground during the early stages of growth.

Lucerne.

Although lucerne is fairly extensively grown in coastal districts, dairy farmers should endeavour to grow larger areas, as this crop is undoubtedly the most satisfactory hay, green fodder, and grazing proposition available. Once established it lasts for a number of years; although the initial expenditure for seed and preparation of the land is somewhat high, the value of the feed produced during the first two years of the crop's growth more than covers these costs. Lucerne as green feed or hay is excellent fodder for dairy stock. Being a legume, it is rich in protein, an ingredient that is required in large quantities by milking cows in high production. On most dairy farms there is often a shortage of succulent green feed during winter months, and cows respond well if judiciously grazed for a brief period each day on the winter growth of lucerne. Two or three times during the year, and especially at the end of the winter, the fields should be worked with a *springtooth cultivator fitted with special lucerne points, or a heavy tine* harrow if a cultivator is not available, to break up any crust formed on the surface soil; a top-dressing of 2 cwt. of superphosphate per acre should also be applied at this period.

Harrowing the Pastures.

Implements of the chain tripod or similar grass harrow types, that will scarify the ground and break down and distribute animal droppings, are recommended for use on pasture land. By disturbing the surface of the pasture a seed-bed is formed in which grass and clover seed will readily germinate. A mulch is also produced around the established plants, and soil moisture is better conserved and fertiliser retained than would be the case if the surface soil was in an extremely consolidated condition.

IMPROVED PASTURES FOR SHEEP.

That greatly increased carrying capacity is possible by laying down pastures and top-dressing with superphosphate has been proved beyond doubt at a number of centres on the tablelands and slopes and parts of Riverina. In periods of drought, when the natural pastures have been

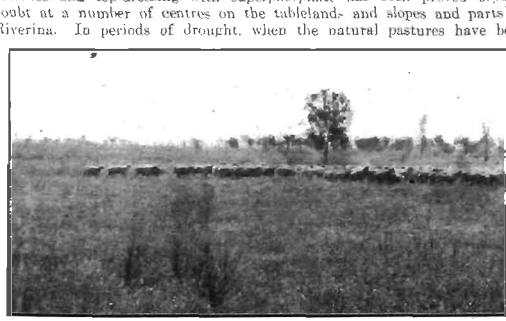


Fig. 4.—Unmanured Pasture on the property of Mr. W. P. Heffernan, Milvale.

practically useless, large areas of lucerne on typical wheat land have carried up to two sheep per acre. In parts of the Tablelands and the Slopes, where the country is too rough for lucerne, Subterranean clover has given good results. Maximum results can only be secured from this clover by top-dressing it with superphosphate.

Not only is the actual quantity of feed produced greater than in the case of native pastures, but the quality is better. In despasturing experiments conducted at Glen Innes Experiment Farm, it has been demonstrated that not only do the sheep attain greater weight and fatten more rapidly on such grasses as *Phalaris bulbosa*, Cocksfoot, and Perennial rye, and White and Perennial red clovers, but that in addition they return an average increase *of 1 lb. of wool per sheep, per annum, over those grazing on native pastures.*

Superphosphate Increases Carrying Capacity.

Quite apart from the improvement in the quality of the pasture effected by the application of superphosphate, which is just as great in sheep as in dairy pastures, and its utility in causing vigorous growth that chokes out weeds, the actual sheep-carrying capacity of a pasture is considerably increased by top-dressing with small quantities of this fertiliser.

In large top dressing experiments conducted by the Department over the period May, 1926–April, 1928, in the Milvale, Parkes, and Milbrulong districts, the following beneficial results were obtained:—

	Sheep per acre.		
	1926-27.	1927-28.	Average for two years.
Milvale.			
140 acres top-dressed with ¾ cwt. superphosphate in 1926	2·9	2·8	2·85
100 acres—no manure	1·4	1·0	1·2
Parkes.			
120 acres top dressed with ½ cwt. superphosphate in 1926	3·5	1·6	2·55
120 acres—no manure	2·2	1·1	1·65
Milbrulong.			
80 acres top dressed with ¾ cwt. superphosphate in 1926	3·6	4·4	4·0
80 acres—no manure	1·3	2·2	1·75

The *average increase in carrying capacity of the top-dressed pasture* over the unmanured area covering a period of two years was—Milvale, 137·5 per cent.; Milbrulong, 128·8 per cent.; Parkes, 54·5 per cent. The cost of fertiliser and its application for the two years at Milvale and Milbrulong was only 5s. 9d. per acre, and at Parkes 4s. 3d.

Light dressings of superphosphate—¼ to 1 cwt. per acre—are sufficient in the drier parts of the State.

Clovers and Superphosphate.—The residual value of superphosphate is seen in the profuse growth of clovers which occurs in many of our wheat districts on fallowed and old cultivation land. Not only is this growth of *value in providing valuable feed rich in protein*, but also results in the formation of humus, an essential requirement of our wheat soils.

To obtain the best results from Subterranean clover, it is essential to top-dress the growth about July of each year with 1 cwt. of superphosphate per acre. *Not only is a larger bulk of feed obtained by adopting this practice, but the plants form large quantities of seed, an essential factor with any annual plant if it is to be retained and encouraged to spread in a pasture.*

Fig. 5.—Pasture treated with 84 lb. Superphosphate per acre; Mr. W. P. Heffernan's property, Milvale.

Fig. 6. Pasturage cut from 1 square yard each of Top-dressed and Unmanured Pasture.

Weight cut from top-dressed area (left) was 9 lb. 2 oz.; from unmanured (right) 1 lb. 14 oz. The latter was practically all Saffron thistle and barley grass with a little Ball clover (*Trifolium glomeratum*). The cut from the top-dressed area was mainly succulent Ball clover, which had crowded out weeds and inferior grasses. The experiment was conducted on Mr. W. P. Heffernan's property, "Glen Oak," Milvale.

The residual effect of the superphosphate is seen in the increased growth of the clover in the early part of the following year, top-dressed pastures providing early feed, whereas unmanured pastures carry little or no growth.

Converting Old Cultivation into Improved Pasture.

The use to which old wheat cultivation paddocks can be put is being demonstrated very effectively in many parts of the State by progressive farmers and graziers.

The practice adopted is to sow Wimmera rye and lucerne with the last crop of wheat to be grown; the land is then turned over to grazing for five or six years. The mixture generally used is 2 lb. Wimmera rye and 2 lb. of lucerne. In the Henty district it is estimated that this class of pasture will carry two sheep per acre, whereas the carrying capacity of unimproved pasture is slightly less than one sheep per acre. In order not to crowd out the rye grass and lucerne, reduce the quantity of wheat to half that usually sown.

The country is sweetened up by the cultivation, and the better-class grasses, such as Wallaby or White Top, reappear in the pasture.

The policy of planting Wimmera rye and lucerne is more effective than allowing the old cultivation simply to revert to barley grass, herbage, and weeds. Such growth does not provide the quantity or quality of feed obtained from sowing a few pounds of seeds of the plants, which will supply good grazing practically all the year round.

Ploughing Up Poor Pasture and Planting Seed.

In many instances where originally the pasture was of very poor quality, and growing inferior herbage plants, very considerable improvement has been effected by turning it over with ploughs or disc cultivators, and sowing a mixture of grasses and clovers.

This work has been adopted with advantage on ploughable Spear grass country on the Slopes and Eastern Riverina, the country having been converted into valuable grazing paddocks, free of "seedy" grasses, through cultivation and planting of grasses and lucerne on the deeper classes of soil, and Wimmera rye grass and Subterranean clover on the shallower types of land.

Broadcasting Seed Amongst Native Grasses.

In many districts considerable improvement is being effected by simply broadcasting seed of grasses and clovers amongst the native grasses.

Where top-dressing machines are used, the opportunity should be taken to distribute grass and clover seed by mixing it with the fertiliser. As most of the top-dressing work is carried out in the autumn, this time synchronises with the correct period to sow winter grasses and clovers.

LUCERNE FOR GRAZING PURPOSES.

Lucerne has been established in many parts of New South Wales in recent years with very satisfactory results, notwithstanding that the conditions in certain districts were not previously regarded as suitable for this valuable crop. At one time it was considered that lucerne would only give profitable results on rich alluvial flats, and undoubtedly these are the ideal conditions for a stand. But to-day it has been found that even in districts formerly regarded as too cold or as too dry for lucerne, good stands can be obtained which will yield one to two cuts of hay in a fair season before being turned over to grazing for the rest of the year.

In average wheat country, provided the land is not too clayey and is of sufficient depth to permit the plant to form a deep-rooting system, lucerne is one of the best and most drought-resistant fodder crops that can be grown. In districts with cold winters and short summers it is giving very satisfactory results as a combined hay and grazing proposition, especially on better class country, while on the poorer class land under similar conditions lucerne is excellent for grazing purposes.

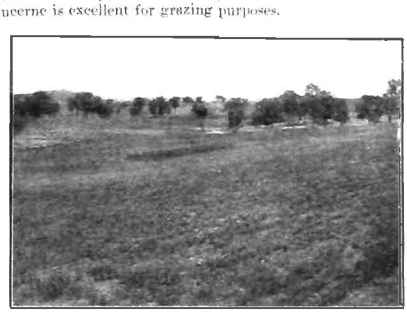


Fig. 7.—A 5-year-old Stand of Grazing Lucerne at Cowra.

There are two conditions which limit a stand of lucerne and the growth to be obtained from it. They are as follows:—

(1) Soil that is shallow, with an impervious subsoil close to the surface.

(2) Wet land in cold districts, where the plants get "wet feet." Plenty of moisture is present under these conditions, but the soil does not warm up, and the plants cannot thrive. Stunted growth results, and although the plants may struggle along for twelve to eighteen months, the root systems become "drowned," and the lucerne usually dies.

As farmers and graziers have learned how well lucerne will do in districts previously thought unsuitable for it, the areas sown in such localities have become very extensive.

Lucerne on Second-class Land.

On second-class pasture land, lucerne is taking the place of clovers in mixtures on account of its drought resistance, deep-rooting habits, and all-round permanence. In sowing lucerne for pasture purposes in districts having a limited rainfall, 2 to 3 lb. of seed is ample to plant per acre. In most localities autumn sowing is recommended. Only where irrigation is available, and spring and summer weeds are not plentiful, or in very cold localities, should spring sowing be carried out. On large areas the wheat drill is extensively used for planting the seed.

The seed only requires a very light covering, and the scheme generally adopted when planting with the drill is to sow the seed through the grass-seed box, allowing the seed to fall in front of the hoes or discs. If no grass-seed box is on the drill, mix the seed with superphosphate, using ½ cwt. of

the manure per acre, and pull the tubes out of the hoes or discs so that the manure and seed will be broadcasted in front of them. Ideally the seed should be covered with about a quarter of an inch of soil.

Top-dressing should be carried out after late winter cultivations have been given. Top-dressing with 1 cwt. of superphosphate per acre gives excellent results. Cultivations with tine cultivators give better results than disc, as the latter damage the crowns of the plants more than the former.

On Average Wheat Country.

The areas being sown on average wheat country that is reasonably deep and has produced fair crops of wheat are increasing every year, and the next ten years should find many thousands of acres of lucerne planted for grazing purposes in the drier parts of the State. In good seasons large quantities of lucerne hay could be harvested from the better areas in this type of country, and what better stand-by could there be for drought periods than this product? It stacks and keeps well, and there is no grain present to attract rats and mice, as is the case with most other types of hay.

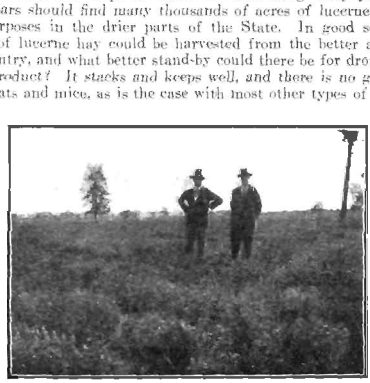


Fig. 8.—A 3-year-old Stand of Grazing Lucerne at Trangie Experiment Farm.

The Department has demonstrated for some years past the value of lucerne for grazing purposes and its drought-resistant qualities. This work has been conducted at Trangie Experiment Farm, where the average annual rainfall for twenty-nine years is 17.62 inches. Here lucerne has been established for eight years and still provides excellent grazing. The soil is a red sandy loam and typical of many thousands of acres of western wheat country. Light seedings of from 2 to 3 lb. per acre are made with the object of encouraging the plants to produce large spreading crowns; such growth is hardier and produces better results for grazing purposes than heavy seedings, as the latter result in small crowns being formed.

In average years at the Trangie Experiment Farm the carrying capacity of lucerne is approximately 2.5 sheep per acre.

In trials conducted at the Cowra Experiment Farm on 45 acres of grazing lucerne for the twelve months ended February, 1928, the area carried at the rate of 3.6 sheep per acre. The rainfall for the period was 19.71 inches.

GRASSES, FODDER PLANTS, AND FODDER TREES OF THE WEST.

Some of the best of our native grasses found in the drier parts of the State are Flinders, Curly Mitchell, Bull Mitchell, Hoop Mitchell, Queensland Blue, Brown Top or Sugar, Warrego Summer, Coolah, Native Millet, Wallaby, Native Oat, Kangaroo, Early Spring, Rare Blue, Satin Top, and Star or Windmill.

Flinders grass is one of the most nutritive of our native grasses, and is relished by all classes of stock. It spreads freely from seed which germinates well.

Of Mitchell grasses, three are found in New South Wales, and of these Curly and Hoop are the most palatable and nutritious.

Queensland Blue is one of the best known and easily recognised of all grasses, its fluffy head being very characteristic. This is an exceptionally good grass, and it should be allowed to seed periodically, as, unfortunately, through overstocking, it is becoming very scarce in western pastures.

Warrego Summer, Coolah, and Native Millet are three very hardy and very drought-resistant members of the Panic group. They seed freely, and are generally to be found in many pasture areas.

There are a large number of species of Wallaby grasses, which are generally referred to as White or Silver Top grasses. Their short, white fluffy heads are very characteristic. These species provide feed mainly during winter months, and although not attaining any great size, they are excellent feed for all classes of stock, especially sheep. They are very nutritious and exceptionally drought resistant.

Star or Windmill grasses are well known to all pastoralists. They do not grow to any great height, but are very plentiful in all sheep districts. They are nutritious, and, not growing coarse, are readily eaten by sheep and large stock.

The majority of the grasses indicated above are spring and summer growers, but the dry plants provide a useful standby during the winter months. They are all good fattening grasses, and should be encouraged to seed occasionally in order that they may be maintained in pastures for all time. If some provision is not made in this respect, the plants will be eaten out and worthless weeds will take their places.

The best plants in a pasture are naturally eaten back continuously, and it becomes only a matter of time when they disappear altogether. This undesirable state has been reached in many of our western pastures, the harsh, wiry grasses, such as numerous species of Spear (*Stipa* spp.), Three-awned Spear (*Aristida* spp.), and many others predominating at the present time.

A most striking object lesson in the matter of overstocking and its effect on grasses is shown in areas such as the Coonamble Commons. Here country totalling several thousand acres that has been grazed heavily and continuously year in and year out for many years, is practically devoid of grasses. Odd plants of Spear grass (*Stipa scabra*) and Lindley's Sporobolus are to be found. The area is covered with useless weeds such as Russian thistle or Roly Poly, Caltrops or Yellow Vine, and Goat's Head. A good deal of Pigweed is also present, though this plant is eaten by most classes of stock when feed is scarce.

Indiscriminate clearing and picking up of all small timber is a mistake, as the area soon becomes windswept and bare of cover in which seeds could be retained and the resultant plants become established.

The more nutritious and drought-resistant species of our native grasses and saltbushes have been isolated and grown in seed reserves at our western experiment farms and on graziers' holdings, in order to raise supplies of seed of these useful plants.

Herbage.

Many plants are classified as herbage, but those of most value to the pastoralist are trefoil or Burr clover, Introduced crowfoot or Cranesbill, Native crowfoot, Musky crowfoot, Spotted-leaved medic, Ball clover, Hare's Foot trefoil, and Woolly clover. The most useful in providing large quantities of feed rapidly is trefoil or Burr clover. Although the burrs are detrimental to wool, they are often the means of keeping sheep alive in seasons when other feed is lacking. The animals, in picking up the burrs from the ground, not only maintain their condition, but, when the material is plentiful, even fatten on it.

One of the main advantages of herbage is that it comes in at a time when the majority of grasses are dormant, and when ewes require large quantities of green feed to maintain condition and a good flow of milk for their lambs. Although the large growth of herbage has, to some extent, contributed towards the crowding out of the more permanent pasture grasses, many pastoralists maintain that stock will fatten more rapidly on herbage than on any other class of feed. The species of crowfoot are becoming widely distributed throughout the State, and being very bulky, provide large quantities of feed.

Herbage and Weeds as Silage.—In a good year considerable quantities of valuable silage could be made from the profuse growth of clover burr, crowfoot, Barley grass, Mallow, Variegated thistle, and other plants which are available in large quantities in many of our grazing districts. There are thousands of acres of pasture land, which are very free of fallen timber, stones, &c., on which mowing machines could be operated to cut this valuable feed. It can be stored in pits as a stand-by for dry times, instead of allowing it to dry off as in the majority of cases it does now, and simply provide fuel for bush fires. Some of our pastoralists are conserving this valuable green feed as silage, but the practice should become more general.

Clover burr hay is a very nutritious fodder, because the material contains large quantities of seed. The value of harvesting and stacking this hay as a stand-by for dry periods is now recognised by a few pastoralists.

Saltbushes.

There are a number of saltbushes which provide feed in many districts of the State, but their greatest use is found in the far west. Those of most value to stock-owners are:—

Old Man saltbush, which grows to 6 feet high in places, and provides large quantities of feed. Its large succulent leaves are greatly relished by stock. Propagation is effected by seeds or cuttings.

Bladder saltbush is a useful fodder plant that has become greatly diminished in pasture areas by overstocking. It forms a large quantity of seed, each seed having a bladder-like covering. Seed of this species should be collected and sown.

Slender-fruited saltbush is very plentiful in most of the drier districts of the State, and although not attaining much size, provides good drought feed for stock, especially sheep. Although it forms large quantities of fruits, very few of them contain mature seed.

Creeping saltbush is a more robust plant than Slender-fruited saltbush, and is fairly palatable to stock. Propagation is effected by means of seed.

Hastate-leaved saltbush, Nodding saltbush, and *Rhagodia linifolia* are characterised by their succulent fruits. They are all palatable and grow readily from seed. *Rhagodia spinescens* is also likely to prove a most useful species for the drier parts of the State. It forms a plentiful supply of seed which germinates very readily.

Fodder Trees.

In the far west, stock invariably show preference for the better known native fodder trees, such as Kurrajong, Supple Jack, Rosewood, Myall, Mulga, Ironwood, Whitewood, Wilga, Leopard-wood, Colane and Warrior or Currant Bush. Through rough usage at lopping time many of our fodder trees are dying out. Care should be taken to preserve established trees and wherever possible to plant the species which do best in the district.

SECTION XI.

Silos and Silage.

DURING recent years considerable attention has been given to the problem of conserving fodder with the object of preventing, or at least mitigating, the losses which occur during droughts. A method that has been adopted with success by many farmers and graziers is that of converting greenstuff into silage. It is recognised by those who have preserved fodder in this way that it is not only one of the cheapest and safest of all means, but that the fodder itself is one of the best substitutes for green grass. The advantages of the method are so great that it deserves the attention of all stockowners who are in a position to raise crops suitable for the purpose.

In the days when land was cheap and there were no rabbits, stockowners could perhaps afford to take risks, but with the present high interest charges and working costs, the margin of profit is not so very great, and if the landowner's stock are destroyed by drought he has little hope of recovering his position, and must give place to men who have more capital.

Enormous losses have occured as the result of drought in the past, but the figures compiled by the Government Statistician indicate only the decrease in numbers of sheep, cattle, and other farm animals. They do not show the losses which occur through a lighter and less marketable wool clip, the reduced flow of milk from dairy cows, and the reduced returns from beef and mutton which form so substantial a part of the stockowner's income. Neither do they indicate the loss which the stockowner experiences, after the breaking of the drought, owing to his holding being understocked.

The disastrous drought of 1902 was repeated in 1919 with more or less severity throughout the whole of New South Wales. As a matter of fact, almost every year some portion of the State feels the effects of a prolonged absence of rain, or of a cold winter, when little or no feed is available for stock. During these droughts and times of shortage of feed, farmers and graziers alike talk of the need of fodder conservation, resignedly taking the consequences of not being prepared, and swear that they will not be caught again—only to forget their good resolutions when better seasons and times of plenty come again.

For the Department to preach conservation of fodder in the midst of times of distress is useless, but when times are normal and the harvest a bumper one, the wisdom of a careful consideration of the advantages of silage as a means of averting, or at least minimising, the disastrous effects of drought, is urged upon farmers, dairymen, and pastoralists.

By converting into succulent and nutritious fodder, material (such as surplus grasses, herbage, and crops) that would not otherwise be used, silage effects a saving, which, if the practice was universal throughout the State, would be of almost incalculable value, the more so, as silage can be made anywhere in New South Wales, and is adaptable to the particular conditions obtaining in every part.

It is inexpensive, even though the cost of installing the silo, in the event of one being necessary, may seem to some to be large. A brief survey of the losses of stock and of the money paid for fodder at famine prices will soon bring conviction as to the wisdom and economy of the practice of silage making. And there is no possibility of waste even though the silo remain full and unused by reason of good seasons for a number of years.

The feeding value of silage is high; it enables dairy cows to produce milk and butter-fat more abundantly; it produces fat beef more quickly than pasture, and more economically than dry feed; and it is of inestimable value as succulent feed for lambing ewes and for fattening young lambs and calves.

A silo will also enable feed to be utilised that by reason of a rainy season cannot be converted into hay. Altogether it is estimated that the use of silage will increase the carrying capacity of an ordinary farm by 25 per cent.

Considering all its merits, it is rather inexplicable that more silage is not made by farmers. Apparently the chief reason is because it is thought that the making is a complicated process, in which special skill and knowledge are required. As a matter of fact, it is simpler and easier to make than hay. In haymaking a considerable amount of judgment is required, as it is easy to make a mistake in putting it in before it is properly dry. The difficulty seems to be that farmers, being used to making hay, cannot realise that good feed can be made from green, sappy material. The processes of silage-making and hay-making are somewhat analogous to fruit canning and fruit drying. If the farmer, knowing that his wife cooks the fruit and then puts it in a bottle and makes that bottle air-tight, would just realise that when he puts green material into a silo it naturally cooks itself, so to speak, he could go ahead with greater confidence.

If certain simple instructions are followed boldly there is practically no danger of failure.

What is Silage?

Silage is the product obtained by cutting and placing the crop in the silo or stack while still in a green, fresh condition. For hay, on the other hand, the material is not stacked until the moisture has been removed by drying in the field. Practically no chemical and bacterial action can take place in such dry hay. If, however, the hay is not sufficiently dried out it will ferment, and if it becomes wet with rain it will mould. In some cases, hay that is brought in before it is sufficiently dry will blacken, and where the amount of moisture is fairly considerable it will cure in the stack to a brown colour and will, in fact, be converted into a kind of silage. Brown lucerne hay is stacked before it is thoroughly dried out, and is practically a form of silage.

In the case of hay, the aim is to dry the material sufficiently to prevent any fermentation or other change after it is placed in the stack. In making silage, the idea is to encourage fermentation for a time at least.

Vinegar, wine, beer, cheese, &c., are all produced by different processes of fermentation, substances being produced during the process of fermentation which act as preservatives so long as the air is excluded. In the case of silage, the changes which occur in the green material after it is stacked are partly caused by fermentation and partly by a continuance of the living

processes of the plant. When it is growing a plant absorbs carbon dioxide from the air, and water, nitrogen, phosphoric acid, and other substances from the soil, and, bringing all these substances together and forcing them to act upon one another, converts them into leaves, stems, and roots. Other substances, such as sugar and starch, which are not so apparent, are also produced.

When the green crop is cut, it does not die immediately, but the living processes of the plant continue for some time. Respiration is one of the processes that go on until certain changes have been effected in the plant material, but when the crop is put into the silo the exclusion of the air prevents the continuance of respiration for long, and hence also some of the changes. As a consequence certain intermediate products, such as acids, are formed. These various changes develop a considerable amount of heat, and raise the temperature of the silage. After a time the chemical changes cease, partly because all the plant material upon which the chemical forces can operate has been used up, and partly because all the air that is mixed up with silage has been exhausted. No further change can then take place so long as the air is kept out.

To make silage satisfactorily, therefore, it is necessary that the crop shall be green when it is put in the silo, and that the air be excluded as much as possible. There is no difficulty in keeping the air out of pits or properly-constructed overhead silos, but it is practically impossible to keep it out of stacks, and therefore while there is rarely any loss of silage when made in pits, there is generally a good deal of loss when it is made in stacks.

Value of Silage as Food.

Silage is eaten eagerly by sheep and cattle; mares also, with foal at foot, take to it, but, speaking generally, it is not suitable for horses. There is often considerable loss in ewes near lambing from constipation, and in lambs after lambing from the ewes going dry—in both cases owing to the dryness of the natural feed. These losses can be avoided by giving the ewes a small daily ration of silage, the laxative effect of silage being greater, if anything, than that of green feed, and the milk-producing quality being equal to that of green feed.

While there is any dry feed about, a ration of 1 lb. a day will be quite sufficient for sheep; but as the dry feed disappears, it will be advisable to gradually increase the ration to 3 lb. a day. At these rates, 1 ton of silage will give a daily ration of 1 lb. to 2,000 sheep, allowing a fair margin for possible, but not probable, waste, while 3 tons will give a full daily ration. When it is remembered that, in drought times, if chaff or hay can be obtained at £8 per ton it is considered very reasonable, and also that dry feed is not nearly so suitable for either breeding ewes or milch cows as silage, the value of silage is much greater than its moderate cost. In fact, once green feed has disappeared, there is nothing within the reach of the sheep-farmer which approaches silage as a cheap and satisfactory food for sheep.

Silage is ready for use in two to three months. It is practically indestructible, and does not deteriorate by length of time; so that, if not wanted for a number of years, it is as good when opened up as when first ready for use. Further, there is no danger of loss from fire, flood, rabbits, mice, &c., the silage (when not chaffed) being a solid mass that must be cut out with a strong hay-knife or a broad axe.

PIT SILOS.

In the wheat-growing districts, especially where the silage is intended for sheep, the pit method is undoubtedly the best, for by it silage can be made with the minimum amount of labour, and with a minimum loss of material. The pit is not rivalled even by the most up-to-date silo, as with the latter the material must be chaffed, which means greater expense both in making the silage and also in feeding it to stock. In the case of the pit the crop is put in whole, and when taken out it needs only to be spread over clean ground for the stock, whereas the chaffed material that goes into an overhead silo must be put out in feeding troughs of some kind.

A Pit Silo.

The making of silage can be fitted into the operations on a wheat farm without interfering unduly with the production of hay or grain. When it is intended to produce either hay or grain, seed must be sown at such a time as will ensure that the crop will be ready to harvest when the weather is suitable for the purpose; it would be disastrous to sow too early. Silage, however, may be made equally as well in June as in October or in any other month, and thus crops intended for silage may be sown before the hay or grain crop, and cut and pitted before hay-making is commenced.

Silage Means More Sheep.—A farmer to be successful in these days must carry a flock of sheep as well as grow wheat, and a good reserve of silage will not only prevent loss during drought, but will enable him to increase the number of his flock because of the reserve of feed on which he can draw should the necessity arise.

Under present conditions, it is hardly possible for many wheat-farmers to carry more than a few sheep profitably, as the natural grasses of their holdings are not sufficient, even when helped by the wheat stubble, to provide feed for any length of time. There is no great inducement for a farmer to grow crops specially for feed when he knows that he will have to wait until the crops are ready before he can buy, and that he will then have to pay such a high price because of the number of other farmers in the same position, that he will not be recompensed for the cost of growing the crop.

It is undeniable that a better system of rotation is required in the wheat areas of this State than the almost universal wheat-and-bare-fallow. Sound as the practice of fallowing is, the adoption of it as the sole rotation with wheat will, within a very few years, so reduce the supply of humus in the soil that the yields of wheat will no longer be profitable. Such a condition is already arising in many soils, and will become more pronounced as time passes. In this country, where the rainfall is so uncertain, one of the most important constituents of the soil is humus, because it is one of the prime factors in helping the soil to retain moisture for a long period, and even the best fallowing will not yield good results in its absence.

The only practical means of restoring or maintaining a good supply of this invaluable constituent, other than allowing the land to lie out in grass for a long period, is to grow upon it, in rotation with wheat, a crop which can be fed down by sheep. The remains of the plants left by the sheep, and their excrement, become humus, and thus give to the soil the desirable moisture-retaining character.

The conservation of silage will enable the farmer to adopt such a rotation with greater certainty that he will make a good direct profit from his green crops, and also a larger indirect one, because he will be in the position of being able to stock his land to its full capacity. Unless a reserve of fodder is held it is unsafe to increase his flock, as the green crops may fail to grow at the expected time, owing to the absence of rain.

Moreover, a full silage pit enables him to lamb his ewes with certainty. Should a dry season threaten at the mating time, he need not be afraid to join the rams in the usual way.

Silage Means Less Worry.—Another consideration which should weigh heavily with anyone who has to deal with stock is the enormous load of anxiety which is lifted from the mind of the fortunate possessor of a store of silage. The man who has a good reserve can carry his sheep along on the grass up to the last moment, and when, in the ordinary course of events, some of the weaker ones would be dying through lack of food, he can turn to his silage with the satisfactory feeling that although things have got pretty bad he is still right for a further few months, and that it is very unlikely that it will not rain before his feed supply runs out.

Farmers May Assist Graziers.—Even if a farmer does not require silage for his own use, its conservation may be made very profitable because of the prices which can be obtained for it during drought periods from owners of starving stock. During the last drought many thousands of sheep were brought into one western district where lucerne hay was available. To enable silage to be utilised in this way it is necessary that ample water shall be available. On very many farms in the western and north-western districts unlimited water is provided by the sub-artesian bores, and the owners have an opportunity of helping graziers, with profit to themselves, by making silage.

Crops Suitable for Pit Silage.

To make good silage, it is essential that the material used should contain the right amount of sap. If it is too dry, it is likely to mould or char—that is, the heat generated, although not causing actual burning, will produce a charred condition of the material and render it useless. If, on the other hand, it contains too much sap, a mushy, evil-smelling product will be produced, which in some cases will be quite valueless.

Crops of wheat, barley, or oats which have made good growth and have not been withered by drought are in the best condition just after the ears appear. Even when they have made rank growth, these crops do not contain too much moisture. At Coonamble Experiment Farm, silage of extra good quality has been made from barley grown on black soil, which had lodged so badly through rank growth that it was extremely difficult to cut. This crop was cut before it had all eared in August, and was put straight into pits. At Condobolin Experiment Farm barley was also used, and at Trangie and Nyngan Farms silage has been made from wheat. In every case the silage was excellent.

Wheat, oats, and barley are the most generally useful crops for silage in the western districts. They are easy to grow and to handle, and the silage is easily removed from the pit, and is readily eaten by sheep. Practically no loss is made when these cereals are conserved in pits. As just stated, they should be cut just after the ears are well out, or even before that stage if necessary, though by waiting till the ears are well out more weight is obtained. Many farmers, when cutting wheat and oats for hay, wait until the grain is well formed, but as there must be plenty of sap in the straw to make good silage, crops intended for this purpose must not be allowed to form grain, as the straw may then be too dry to make good silage. Cutting with the reaper and binder is the most economical method, as sheaves are easier to handle than loose stuff. Furthermore, the sheaves can be laid down in the pit in an orderly way, and when the pit is opened the silage can be removed without the slightest difficulty. Silage made from crops cut with a mower gets into a very tangled condition, and is difficult to remove from the pit.

Black oats cut before the seed is formed makes splendid silage, so that the farmer can clean his land and conserve useful feed at the same time.

Lucerne makes good silage, and the early and late cuts may be reserved for this purpose. The sale value of lucerne in the form of hay, however, makes the ensiling of other cuts inadvisable.

Maize and sorghum make good silage if cut when the cobs are well formed in the case of the former and when the heads are well out in the latter. Both crops, especially maize, are affected by frost, and they dry out rapidly after a frost. They should therefore, if at all possible, be cut before they are frosted. In dry times, particularly in western districts, these crops may dry off prematurely, but if cut in time they will make good silage. Rape cannot be converted into silage, owing to its excessive sappiness. Even stray plants of rape mixed with barley put into the silage pit at Coonamble came out mushy and useless.

Among natural herbage, trefoil and variegated thistles make good silage, but it is as well to let the material wilt a few days before putting it into the pits. It is doubtful whether very succulent herbage, such as crowfoot, will make good silage. It contains so much sap that it would be risky, though if it were allowed to dry somewhat and could be mixed with drier material, it might turn out satisfactory.

As plenty of moisture in the crop is essential to the making of good silage, it is obvious that dry material, such as many western grasses when in flower, cannot be used for this purpose. Neither is it possible to utilise such weeds as Star thistle, Black thistle, &c.

Selecting a Site.

Pit silage cannot be made where there is water seepage. For this reason the method is not always successful on the coast. Even on many coastal farms, however, particularly on the South Coast, where granite or sandstone formations occur, suitable sites for pits could be found. In inland districts suitable sites can be found on practically every farm.

A high spot should be selected, and the pit, if possible, made on the crest of a rise, though this not essential. What is necessary is good drainage, so that water will not run into the pit. Care should also be exercised to ensure that the site will not be subject to floods. On Coonamble Experiment Farm the land is practically level, and is subject to flooding in very wet weather, but there has been no difficulty in securing sites on low rises. Any red soil is suitable, and sites should be selected on such soil in preference to black soil, which is generally low-lying and likely to crack in dry weather and to admit water after heavy rain.

It is, of course, an advantage to have the pits as near as possible to the crop that is to be made into silage. Consideration should be given to the question of convenience in feeding, but as a rule the nearer the pit is to the crop the better, as it saves expense in filling.

Making the Pit.

A handy size is a pit capable of holding about 100 tons. Such a pit is easy to fill, the silage can be got out without difficulty, and generally it will be found that when opened it is all used. If the pit is larger it is quite possible that before the silage is all used, the drought will have broken and grass have become available in the paddocks, which means that feeding will be discontinued before the pit has been emptied. The pit will then have to remain open for perhaps months, until crops have been grown to refill it.

If only a few hundred sheep, say, 300 to 500, are kept, then the pits may be made smaller. A pit about 65 feet long, 21 feet wide, and 6 feet deep will hold 100 tons. The pit should be made with batters of about 3 to 1 at the ends, but with the sides almost perpendicular. There is not much difficulty in making such pits. If necessary the pick could be used to clean up the sides, but by adjusting the plough with an extension to the bridle, or by using the horses tandem when ploughing, the sides can be kept practically perpendicular. Batters are required at the ends, as the drays are drawn right into the pit in the process of filling, and also when the silage is being taken out.

There is no advantage in making the pits deeper than 6 feet. In fact greater depth is a disadvantage, as the pit is more difficult to make and it is harder to remove the silage.

Two men with about three good horses, a strong but light single-furrow plough, and a light half-cubic-yard scoop, will put down a pit comfortably [illegible] weeks. The cost per yard will be slightly greater than the usual

charge for tank sinking, but will not exceed 2s. per yard, which is equivalent to a cost of 4s. per ton of silage. There should be no difficulty in getting contractors to excavate the pit at 2s., or even less, per yard. Once made it will last for years, and may be filled time after time.

Each cubic yard of such a pit will hold about a half a ton of silage. A handy way to reckon is 2 yards to the ton.

Filling the Pit.

The special considerations that have to be given to each crop have already been discussed, but a few points connected with their handling remain to be mentioned. Only as much crop as can be put into the pits should be cut each day. As the crop is in a sappy condition when being cut for silage and the mornings are usually damp, cutting should be done each afternoon.

A team of about six men is required—one to drive the binder and to help with the waggons when he has cut enough crop for the day, four men with two waggons, lorries, or drays, and one man in the pit.

If only 80 to 100 tons are to be made the work can be done quite easily by three men.

When making silage, everything should be done to pack it as closely and tightly as possible. The sheaves must be placed in the pit lengthways, the *bands being cut, though it is not necessary to remove them.*

The waggons may, of course, be drawn into the pits from the commencement, but it is not altogether necessary to do this at first. Later when the pit has been filled to about the ground level, or nearly so, the waggons are drawn right into the pits for unloading. This compresses the silage.

When the pit has been filled to slightly above the ground level, work on it should cease for a couple of days to give the silage a chance to settle. It is a great advantage to have two pits, so that one may be settling while the other is being filled. If only one pit is in use work should be stopped for two or three days, or at any rate delayed, to allow the settling to take place. Filling may then be resumed and the material stacked until it is about 4 feet above the surface at the centre. The stack should slope away gradu*ally towards the ends. It is a good plan, when filling above the ground* surface level, to overlap the sheaves about 6 inches over the sides of the pit. Then the main mass of the material on settling down by its own weight drags this overlapping material in and down the sides, and thereby prevents any undue shrinkage away from the walls. A further period should be allowed for settling, and when this has taken place the filling should be continued.

Careful note should be taken of how the pit settles, as this gives a good indication as to when it will be safe to stop. When it is considered that the material has settled thoroughly, the stack should be again built to a height of about 4 feet. Working this way to allow periods of settling, and spreading the work over a fortnight, the pit is generally so compact that when covered it will not settle below the land surface level. Even when allowing for plenty of settling, and leaving a stack of about 4 feet, the material will, after a few months, sink down until only a slight mound is left. It is very important to get the pit well filled, otherwise after a few weeks the site of the pit will be marked by a deep depression, which means that not only is some of the storage capacity not utilised, but water can run into the pit and damage the contents. A well-filled pit a few weeks after filling will

show just as a small mound. It must be remembered that, even when pressed in as tightly as possible, the material is, comparatively speaking, *loosely packed. The heat generated softens the stems, and the enormous* pressure of the greenstuff above, together with the covering of earth, presses it together, until finally it becomes almost as solid as a plug of tobacco.

Rain on the silage while it is being made does not in any way damage it. If the material is rather too dry, rain actually improves it. Indeed, many farmers add water to such material to insure that good silage shall be made.

Covering the Pit.

After the final filling it is advisable to allow the material to settle for two or three days. This reduces the height and renders covering easier. If the rate of settling is very slow, it may be taken for granted that the pit has been well filled.

The work of covering is done with a scoop, the earth being scooped straight on to the top of the greenstuff. Practically no loss of material occurs. Some pits when emptied have only shown about 2 inches of loss at the surface. It is quite unnecessary to give a deeper covering than 9 or 12 inches of soil, as it does not protect the silage any better, and only involves greater expense in covering and in removing the soil later.

It will be noted that nothing has been said in regard to noting the temperature of the material as the pit is being filled. This is not an oversight. It has not been mentioned because it is not necessary. It can be taken as a *certainty that if the crop is cut at the stage indicated and put straight into* the pit, the result will be satisfactory, and there is no more need to take the temperature than there is when building a haystack.

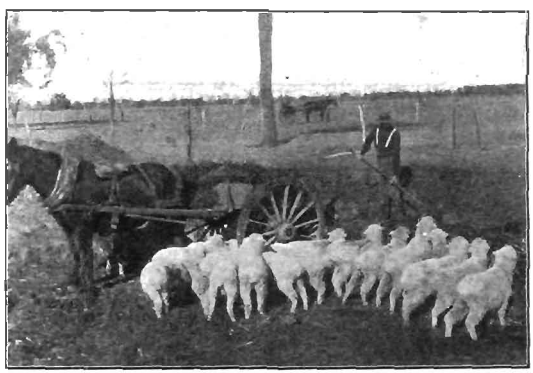
Feeding the Silage to Sheep.

The pits are uncovered by simply removing the earth with a scoop. If any earth happens to get mixed with the silage, it is shaken out when the fodder is being thrown to the stock. It is preferable to open up a section at a time —say, 16 feet of the length of the pit. The silage will be found to have a coating of perhaps 2 or 3 inches of rotten material, and this should be kept out of the way of stock, which are liable to eat it if starving, with harmful results. The silage becomes densely packed and almost as solid as wood, and is cut out in "benches" of about 4 feet the full length of the pit with an axe or an adze. When a clear face is obtained and a block is cut, the material can be lifted out quite easily.

*One man can feed 800 to 1,000 sheep daily, giving them a liberal allow*ance. The silage need only be thrown over a clean piece of ground, but it should be well spread out. It is better to get a good deal out every day before the sheep are allowed to feed, as they not only surround the waggon and get in the way of operations, even to the danger of being injured, but the strong ones run ahead, picking the choice bits and trampling over the remainder. Sheep should be drafted into lots according to their strength for feeding. If this is not done, the strong ones take all the best of the silage, and leave only the coarse stuff for the weaker ones.

Feeding should be commenced while the sheep are still in good, strong condition, and while there is some rough grass about. They do better under such circumstances and make better use of what rough feed there is than if the silage it withheld until they have become low in condition and all the grass is gone.

Sheep do fairly well on silage alone if feeding has not to be continued too long, but after they have been fed on silage exclusively for a couple of months they commence to go off in condition. This is due to the fact that silage is of a succulent nature, and is lacking in protein. It is not such a properly-balanced food as that which sheep pick up in paddocks where there is a mixed growth of grasses and clovers or trefoils, the latter of which are especially rich in protein. It is therefore advisable not to feed silage alone, but to combine with it a small quantity of wheaten, oaten, or lucerne hay—preferably the last-mentioned, because of its high protein content. Notwithstanding all this, it is, of course, true that during the last drought many sheep were satisfactorily fed on silage solely.



Feeding Silage to Sheep at Coonamble Experiment Farm.

The silage ration will vary according to the amount of feed to be picked up in the paddocks. At Trangie Experiment Farm during a recent drought period 2 lb. of silage, with ½ lb. of lucerne hay, was allowed per day. This was varied occasionally by feeding 2 to 4 oz. of maize per day with the silage instead of the lucerne. A plentiful supply of salt should be provided for sheep when feeding on silage, even in districts such as saltbush country, where it is ordinarily not used to any extent. The lick is improved by adding about 6 oz. of Epsom salts to about 100 lb. of coarse salt.

Loss of Silage in Making and Feeding.

In the pit method practically no waste occurs. After feeding out one pit of about 90 tons, only a few straws could be seen lying about the pit and paddock. The total waste in the pit and while feeding did not amount to more than 1 per cent. of the material originally put in.

The Cost of Making Silage.

Silage is the cheapest form in which fodder can be conserved. This is owing to the small amount of handling required after the crop is cut. When hay is made it has to be stooked and stacked, and then protected from the weather, mice, &c., and to protect hay satisfactorily an expensive shed is required. In the case of silage the amount of handling is reduced to the minimum. Immediately the crop is cut it is carted to the pits, and when these have been filled and a little earth has been scooped over as a covering the job is finished. The cost, therefore, consists only of growing the crop, cutting it, and filling the pits.

The cost is necessarily influenced by the yield. A good crop suitable for silage will yield about 8 tons per acre. To produce such a crop will not cost more than £2 per acre (a liberal estimate), or 5s. per ton. Cutting and carting will cost about 4s. per ton, while 1s. per ton represents a very fair charge for the pit. The total cost will therefore not exceed 10s. per ton for the production of the crop and the making of the silage.

How the Sheep appreciated Silage at Coonamble.

The Value of Silage.

The market value of silage is not fixed, as is the case with hay. In nearly every case the fortunate farmer who possesses it regards it as of so much value to himself that he will not sell it. It has, however, a very definite market value. During a recent drought the manager of Wagga Experiment Farm was offered £8 per ton for pit silage. Considered from the point of view of its actual food constituents it may not be so valuable as hay, but its succulence is an important feature, and renders it of considerable value, particularly in time of drought, when succulent feed is the very class of which there is a special scarcity.

Farmers are beginning to appreciate to real monetary value of a reserve of silage—not merely its value as fodder, but the profits accruing from the enterprise made possible by the reserve of feed.

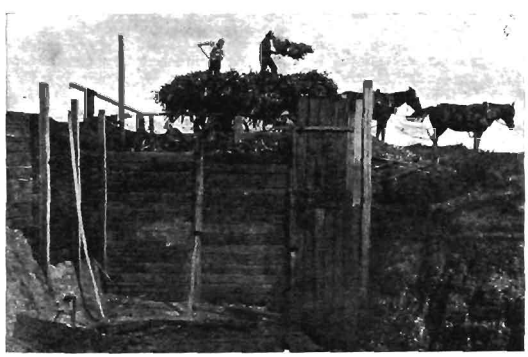
Pit Silage for Dairy Cows.

Pit silage has been considered in the foregoing principally in relation to its value to the sheepowner. This is because it can be most largely made in those districts where sheep are of greatest importance. Its use, however, is by no means restricted to sheep or sheep country. Pit silage is of equal value to the dairyman, whether in the interior or (where its preparation is practicable) on the coast. At Wagga Experiment Farm it is used regularly to feed the dairy herd, and so cheap has the pitting method been found, and so satisfactory the product, that the pit is now regarded as quite superior to the overhead silo.

The pitting method is found satisfactory on the coast, provided a suitable site is obtainable. There is no doubt, however, that in the case of the coastal dairy-farmer the general convenience of making and feeding warrants the erection of overhead silos.

HILLSIDE SILOS.

When the conformation of the land allows it, the hillside silo possesses many advantages. Amongst these are the ease with which it can be filled, the silage being thrown downwards from the carts, and the less labour



Filling a Hillside Silo, Bathurst Experiment Farm.

required in the removal of the silage than from the ordinary pit, it being removed from the lower side. As the silage is below or level with the surface, weighting materials, such as earth, stones, &c., are economically applied, and the silage is protected from the sun and winds.

To take the place of the tub silo at Bathurst Experiment Farm a hillside one was excavated. Most of the excavating was done with plough and scoops, as in tank-sinking. The sides were trimmed with the pick, and the bottom also squared where the plough could not work. After sinking several feet,

the decomposed granite became very hard, but exposure to the air and rains for a month or so softened it and allowed of its being ploughed, and intermittent work thus assisted in reducing the cost.

The excavation was carried 12 feet below the surface, and the earth taken out was placed 4 feet above, leaving the silo 16 feet deep. Upon this earth the teams were drawn when filling the silo.

Old railway sleepers were used to timber the sides, to keep the soil and loose earth in position. The slope of the hillside is such as to allow of any water running off by means of a drain from the lowest portion.

The dimensions of the silo are 36 by 20 feet by 16 feet deep, but a temporary end made of sleepers can be placed so as to enclose but half this capacity, or moved back according to the amount of fodder available. A fall of 1 foot in the 36 was allowed for drainage.

No arrangements have been made for any roofing, as in dry climates 1 foot or 18 inches of earth would be sufficient to absorb all excepting the very heavy rainfalls.

Over 80 tons of maize silage have been placed in a section of this silo with very satisfactory results as regards costs and waste.

OVERHEAD SILOS.

To the late Mr. J. L. Thompson, the first Principal of Hawkesbury Agricultural College, belongs the credit of first bringing under the notice of the dairy-farmers of New South Wales the many advantages of silage as a means of increasing their profits. At that time cost was as great a stumbling block as it is to-day, although both materials and labour were much cheaper, and it was possible to build overhead silos at 15s. to 20s. per ton capacity, as against 40s. to 70s. to-day. Among those who have built silos there are very few, if any, who have regretted the expenditure; in fact, some very hard-headed dairy-farmers say they have easily doubled the carrying capacity of their farms by feeding silage.

The idea prevailed until recent years that, owing to the strong fermented flavour of the silage itself, a taint would be conveyed to the milk and cream. It has been conclusively shown, however, that good, properly prepared silage does not impart any harmful flavour to the milk. The cows soon acquire a taste for silage and become very fond of it.

The Limitations of Pasturing.

Pasturing is no doubt the easiest method of feeding a herd, but it is within the mark to say there is hardly a single district in the State where that can be done all the year round. It is just here that the silo comes in, for it is an undoubted insurance of a continuity of good food, and consequently of a regular milk supply, and it also makes it possible to carry on operations on a smaller area, and therefore at lower rental charges.

The productive capacity of most dairy farms is limited principally by the pasturage available during the coldest months—indeed, in the main dairying districts there is invariably a shortage at that time. On the North Coast, paspalum has taken possession of the best dairying lands, and being a summer grass it makes no growth in the late autumn and winter months, while its aggressive habit in the summer prevents other plants that might provide feed in the winter from living in association with it. On the South Coast the cold is sufficient in the winter to prevent pastures from making much growth.

Notwithstanding these limiting factors of the cooler months, the number of cows on many farms is as many as the pastures will support during the summer, and the stock consequently have a hard time during the winter and losses frequently occur, while even where the animals do not actually die they become so reduced in condition that when spring returns they do not readily respond to the growth of grass, and it may be six to eight weeks before they come to their full flow of milk. Production is thus seriously reduced during some of the best months of the year.

More careful farmers help their stock through the winter to some extent by keeping the number below the maximum summer capacity of the farm, and thus allow the grass to make a growth which will carry the cattle through the winter. This is not economical, however, as it prevents the best use being made of the grass during the summer, and the rough pasturage that is obtained for the winter is not after all of much value.

Many farmers take advantage of the fact that cultivation forces the land to yield a great deal more greenstuff per acre than can be obtained from pasture, but even these crops do not yield at a time when feed is otherwise short. With a silo, crops can be grown at the time of the year when they yield their heaviest, and the material can be conserved in its best and most succulent condition until it is needed. The carrying capacity of the farm may therefore be increased in the summer with the confidence that the stock will be kept in good condition during the winter ready to respond at once to the improvement of the grass in the spring.

The Recommendations of Silage.

A consideration that must weigh heavily in favour of silage is the insurance it offers against the loss of valuable cows during a hard winter or a drought. Dairy herds that have taken years to build up are worth a great deal, and the numbers and the standard of a herd cannot be easily recovered when a drought ends. If losses occur periodically, the rate of improvement in the herd is very slow indeed, as the ground lost during one drought has probably hardly been regained when another period of scarcity comes along. It is the best cows that generally go off first if feed is scarce, as, owing to their high-producing disposition, they keep low in condition; while the poor yielders keep themselves in condition by using the feed to build up flesh and strength instead of making milk.

A silage crop is preserved in its green state, and it is therefore an excellent substitute for green grass. The succulence of the green crop is preserved and stimulates the milk flow, whereas dry feed tends to reduce it. Moreover, it is a convenient means of conserving fodder in the dairying districts.

Crops Suitable for Silage.

While many crops can be used for filling the silo, the most suitable in regard to feeding value and ease of handling are maize, sorghum, Sudan grass, wheat, oats, and barley. In the coastal districts maize and sorghum are undoubtedly the best, as they give a big yield per acre and are very easily converted into silage. Maize is the better of the two, being less subject to disease and producing fodder of higher quality. As a rule, the best crops for inland districts are wheat, oats, and barley, although in some localities, particularly in the north-west, maize is quite satisfactory. On the whole, however, for western districts preference may be given to the

winter cereals, as the yield is more certain. There is not the slightest difficulty about making silage from any of these crops, provided the silo is of the right type and the crop is cut at the right stage, and also that it is put into the silo immediately and is well packed down during the process.

When and How to Cut Crops.

To produce good silage for dairy cows the crop should be cut when it contains the maximum food nutrients in a condition that will make good silage.

Maize should be cut when the grain is glazed or well dented, the lower leaves on the stalk yellowing, but the stalk itself full of sap. At this stage it will contain maximum food value, and at the same time sufficient moisture to pack well in the silo.

Sorghum should be cut when the heads are reaching maturity and the seeds so hard that they are crushed between the finger and thumb with difficulty. Sudan grass should be cut when the seed is formed but is still in the milk stage.

Maize and sorghum can be cut with the least labour with the maize-harvester, but where that implement is not available, cane knives, short hoes, reaping hooks, or scrub scythes may be used. A slide fitted with scrub scythe blade and drawn by a horse is used by some farmers.

Wheat, oats, and barley should be cut just after the ears are well out. Many farmers, before cutting these crops for hay, wait until the grain is well formed and the straw has become somewhat dry. Crops intended for silage should not be allowed to reach this stage, as plenty of sap is required in the plant to ensure a good product when the silo is opened up.

Wheat, oats, and barley are cut with the reaper and binder.

Unlike hay, silage may be made at any time, irrespective of the weather. Rain causes inconvenience, but it need not delay the work.

Cart in Without Loss of Time.

An essential point in making good silage is that the material should be put in the silo in a succulent condition—no drying out should be allowed. Cut the material and put it into the silo the same day; teams should be carting from the harvester to the silo.

Slides are very useful for hauling the crop to the silo, especially as the material has not to be lifted to any height.

All crops must be chaffed before being put into the silo, to ensure close packing and to prevent fermentation. The pieces should be cut to about a ½ inch in length. The chaffing can be done either with a silage cutter fitted with a blower for filling the silo, or with an ordinary chaff-cutter with a chain elevator. The former equipment is useful when large quantities are being handled, but for the ordinary sized farm a chaff-cutter with an elevator is, on the whole, more satisfactory, as it requires less power and fewer men to operate it, and the knives are easier to sharpen. These chaff-cutters are generally made with 9-inch, 10-inch, or 12-inch mouths. Any one of these is satisfactory, but the smaller ones, of course, will not handle the crops so quickly as the 12-inch machine. Chain elevators can be easily fitted to almost any chaff-cutter.

When silage cutters are used a fairly high-powered engine is required, but a 4 or 5 h.p. engine will drive a chaff-cutter.

Filling the Silo.

The proper packing of the material in the silo is most important. If not properly packed or sufficiently tramped to exclude air, spoiled silage results. It is a well-known fact that the more the material is tramped during filling the less it settles afterwards.

When the material settles in the silo, it tends to draw away from the walls, leaving an air space; which results in spoiled silage. The best method is to build the material up about 2 feet around the walls and sloping to the centre, and to trample this down well; then fill the centre up and tramp it around the walls equally; then again build up around the walls, and so on. By this means silage will settle without pulling away from the walls. At the top the silage is rounded off by being made higher in the centre, and within a few days it will settle till nearly level. Tramping is more important in the upper half and top of the silo, because this silage has less weight bearing on it to force it down.

Feeding Silage to Dairy Cows.

The system of feeding to be adopted must be decided by the farmer, but once the reserve is opened up a little should be taken off the whole of the surface daily, or the top material will turn sour. Feeding with silage can, if necessary, start quite shortly after the material has been put in the silo.

Maize or sorghum silage is best fed with lucerne hay at the daily rate of 3 lb. silage and 1 lb. lucerne hay for each 100lb. body weight of the cow.

Concentrates may be added to the ration, a mixture being preferable to a single concentrate. Cracked or crushed grain, bran, pollard, linseed meal, and copra cake are suitable for this purpose. A concentrate mixture may be fed according to the yield of the cow and the amount of pasture available. Under bad winter conditions a full daily ration would be completed by adding to the silage and hay 1 lb. of a concentrate for each—

3 lb. of Jersey milk produced per day.
3½ lb. of Shorthorn milk produced per day.
4 lb. of Holstein milk produced per day.
1 lb. of butter-fat produced per week.

Thus a full ration for a Shorthorn cow weighing 1,100 lb. and producing 21 lb. of milk per day would be—

33 lb. silage.
11 lb. lucerne hay.
6 lb. concentrates.

At Hawkesbury Agricultural College it is found that the following make good mixtures:—

For Winter—

	lb.
Maize silage	25
Green barley	25
Lucerne chaff	6
Cocoanut oil cake	2
Linseed meal	1
Bran	3

If green barley is not available, 30 lb. of maize silage and 10 lb. of lucerne hay may be given.

For Summer—

	lb.
Maize silage	25
Green maize	25
Lucerne hay	25
Bran	2
Linseed meal	2

Oaten and wheaten chaff can also be fed in conjunction with silage, but more concentrates should be used.

The only care to be taken in feeding silage is not to overfeed bulls. Excess feeding of silage to bulls tends to develop a "pot" belly, and thus affects their potency. The maximum amount that a bull should receive is 15 lb. a day.

The average quantity of silage consumed per cow at the College during the winter months is 30 lb. per day.

Farmers frequently ask if silage is equal in feeding value to green grass, and it must be said at once that it is not equal to an ordinary mixed pasturage, though it is a very good substitute. Mixed pasture, on a fairly good soil, is almost ideal feed, as it is made up of many kinds of true grasses, legumes, and other herbs. It is therefore fairly well balanced in regard to protein and carbohydrates, and is also extremely palatable; which is an important feature. Pastures made up entirely of one kind of grass, such as those of the coast, where paspalum has possession, are not entirely satisfactory owing to the lack of variety.

As a rule, silage is made from one crop only—generally either maize, sorghum, or winter cereals, and as these are weak in protein the silage is somewhat deficient in that very important food constituent. For this reason it has been found economical to add the concentrates mentioned in the mixtures fed at Hawkesbury Agricultural College.

Silage will maintain stock in good condition without the admixture of other feeds, but much better results are obtained by using with it such foods as bran, pollard, oilcake, or lucerne hay.

THE CONSTRUCTION OF OVERHEAD SILOS.

In view of the necessity for the exclusion of air in making silage, it is essential that the walls of the overhead, or rub, silo shall be as air-tight and as high as possible consistent with general convenience. In a high silo the silage becomes very compact by reason of its own weight, and thus excludes air. In the early days of silo construction in this State, some so-called silos were built from 8 feet to 15 feet high, the latter being considered a deep silo, but unless considerable weight was placed on top of the material there was much loss in such structures. In the silo that is built to-day no weighting is necessary owing to the height of the silo, and the only waste that should occur is a little on the top, and even that may be saved if the material is covered over when filling is finished. Another advantage of the high silo is that the fodder packs more closely together, and more weight per cubic foot of silage is obtained, while the storage capacity of the silo is made better use of.

Practical considerations, however, limit the height of a silo to from 25 feet to 35 feet. Above the latter height the cost of construction increases rapidly, and the link belt elevator which is recommended by the Department

for filling the silo must be replaced by a blower, which is not so satisfactory. With the object of reducing the height above ground it has been the practice in the past to sink the silo 4 feet 3 inches into the ground. This reduced the length of elevator and was convenient for shovelling up the silage on to the mixing floor. Instead, however, of putting a concrete floor on the ground at the head of the feed stalls, the Department now favours a wood floor set level with the top of the feed trough; this is not only cheaper but is more convenient. In this case the silo should be sunk 4 feet 3 inches below this floor (see Fig. 3).

The cylinder of a silo must be perpendicular, and as smooth internally as possible, to permit the silage to settle without cavities or air pockets. It must be strong enough to resist the bursting pressure set up by the silage when fermenting, which varies from a minimum at the top to a maximum at the bottom. The pressure is not nearly as great as that

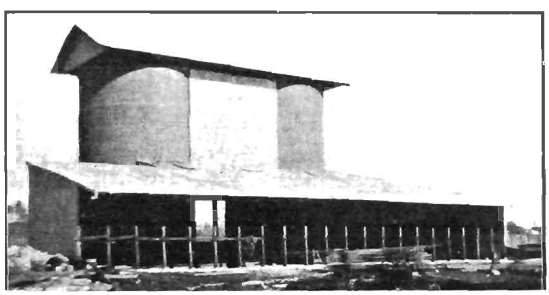


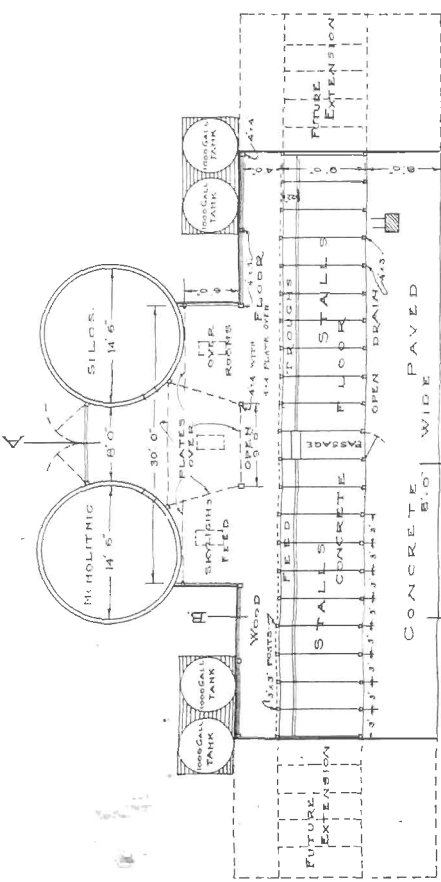
Fig. 1.—A General View of the Twin Monolithic Concrete Silos and the Feeding Stalls at Glen Innes Experiment Farm, when nearly completed.

exerted by an equal volume of water; it is considerable, however, in silos of the dimensions recommended by the Department, and is greater than concrete, brick or wood stave silos will withstand unless reinforced by steel hoops. Concrete and brickwork offer comparatively small resistance to forces which tend to tear or pull them apart.

A cylindrical silo is recommended because it makes better silage. It was the Department's experience that the quality of silage from an octagonal silo on one of its farms was always inferior, but after relining the silo to a true circle the silage produced was of uniformly high quality. A circular silo requires less material in its construction than one of any other shape.

The Capacities of Silos.

As silage should be fed each day at the rate of not less than a depth of 2 inches over the whole surface of the fodder (and, if possible, 3 inches) so that the surface shall not mould before it is fed to the stock, the rate at which the silage is likely to be consumed has a close relation to the capacity of the silo. For a herd of thirty cows a suitable silo would be one 14 feet 6 inches diameter and 28 feet high, such a structure holding feed


SILOS.
14'6"
8'0"
30'0"
MOLITNIC
14'6"
PLATES OVER PIT
SHORTHORNS FEED
OVER ROOMS
OPEN PIT 10'0"
4:4 WITH 4:4 PLANK OVER
FLOOR
TROUGHS
STALLS
FLOOR
CONCRETE
PASSAGE
OPEN DRAIN
CONCRETE PAVED
8'0" WIDE
FUTURE EXTENSION
FUTURE EXTENSION
FEED
Wood
3x3" POSTS
A
B
A
B
10'0"
10'0"
10'0"
10'0"
4:4
4:4
4:3
4:3
4:3

for 160 days calculated at the rate of 40 lb. per cow per day. If greater capacity than this is required, it is recommended that twin silos be erected as indicated in Figs. 1 and 2.

The following table of capacities will be useful in determining the size of silo to build:—

Height.	*Diameter.*	*Capacity.*
feet.	ft. in.	tons.
25	12 0	50
25	14 0	70
25	16 0	90
28	14 6	85
30	16 0	107
35	16 0	125
35	18 0	160

The silo favoured by the Department is one 28 feet high with a diameter of 14 feet 6 inches, having a capacity of 85 tons. Moulds of a comparatively cheap kind have been designed for this structure, and their use in the construction of this silo is fully described in the following pages.

The Location.

As feeding is an every-day job, it is important that the silo shall be located close to the feed stalls. It may be at one end of the feed passage or placed centrally as shown in Fig. 2. Here the silos are placed a short distance back from the stalls, and space is provided for storage of the concentrates in a convenient position. When mixed, the fodder is quite close to the feed trough, and may be fed into it with a bucket, trolley, or any other means desired.

Choice of Building Materials.

First-class silage may be made in silos constructed of wood, brick, or concrete, provided the structure is circular, smooth internally, air-tight, and waterproof.

Wood silos are short-lived, unless substantially built, kept well painted externally and oil-coated internally, and free from white ants. They require much more attention than a concrete silo. Oregon is a splendid timber for this class of work, but unfortunately it is particularly subject to white ant attack.

As previously mentioned, a brick silo, like a concrete one, lacks sufficient strength in itself to withstand the pressure exerted by the silage. For this reason hoops of fence wire are built into the bed joints to make up the deficiency. This reinforcement is effective only when the bricks are laid wet with cement mortar; it is not effective with lime mortar. It is necessary always to render a brick silo, *i.e.*, plaster the interior with cement mortar; otherwise the silage hangs to the brickwork and retards settlement, and the walls absorb water readily. Perhaps the greatest factor operating against a more general use of this material is the difficulty of obtaining bricks and skilled labour at a suitable price.

A good silo can be made with concrete blocks. For this a block machine is necessary, and may be purchased in Sydney for something like £16. This is not a big outlay considering that, with the machine, blocks may be made for numerous other purposes ranging from water troughs and sheds

to an elaborate residence. The blocks, for which sand or a very fine gravel only can be satisfactorily used, can be made in slack periods, and do not deteriorate with age. A mixture of one part cement to five parts sand will make a block that is quite strong enough, but it will be porous, and therefore internal rendering is just as necessary as in the case of a brick silo. Concrete block silos also require reinforcing in the bed joints in a similar manner to brick silos.

Unquestionably, the monolithic concrete silo has distinct advantages over those constructed of all other materials and by other systems of construction. Properly constructed it is practically everlasting. It is a permanent asset, and for this reason is most favoured by the Department. By monolithic is meant concrete cast in moulds in such a way that the whole structure ultimately becomes one piece of concrete. The term is therefore used to distinguish this form of construction from the concrete block or other unit system of concrete work.

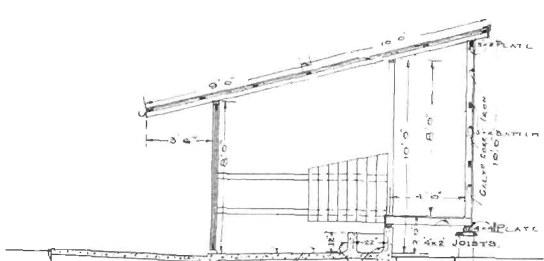


Fig. 8.—Section B.B. of the plan shown in Fig. 2.

Note the height of the floor of the feed passage and its relation to the feed trough.

It is not possible to make a definite statement as regards comparative costs, as so much depends upon local conditions. Generally, however, it might be said that there is little difference between brick, monolithic, or concrete block, and that the wood stave silo costs about 25 per cent. *less than any of the others. It frequently happens that sand and metal or* river shingle are available at small cost, in which case the cost of the concrete silo will be considerably reduced.

Building a Concrete Silo.

Apart from cost, probably the greatest influence operating against a more universal adoption of the monolithic silo is the reluctance of the farmer to use a material with which he is not very familiar. It is hoped, therefore, that the detailed instructions given in the following pages will enable the average man to comprehend fully what is, after all, a fairly simple construction.

The Moulds.

Moulds are required for casting the cylinder of the monolithic silo. They should be strong, of such construction that they may be taken down and set up again in the shortest time possible, and also, of course, as cheaply as possible. The mould herein described has been fully tried by the Department on its own works, and also by farmers. It is the cheapest yet devised (£12 f.o.r. Sydney, with battens and bolts) and has the advantage that, if set up perfectly level for the first stage, no great difficulty will be experienced in building the silo vertical and to a true circle.

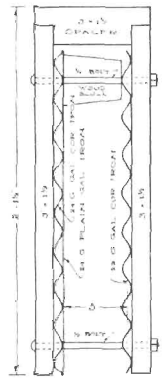


Fig. 4.—Detail of Mould.

By referring to Fig. 4 it will be seen to consist of *an inner and an outer ring of galvanised corrugated* iron curved to the requisite diameter. The inner ring is lined with plain galvanised iron to produce the necessary smooth surface. The outer ring is *simply of 22-gauge galvanised corrugated iron*, which moulds the silo with a corrugated effect externally, which is rather pleasing. These corrugations help to keep the mould level right throughout the work, provided, of course, they are level to start with. The Department has working drawings and specifications of these moulds, which it will supply, or as an alternative will arrange to have the moulds made and despatched ready for immediate use if requested to do so.

The Materials Required.

The following materials will be required for a monolithic concrete silo of 85 tons capacity; the dimensions being, internal diameter, 14 feet 6 inches, height 28 feet, walls 5 inches thick, without concrete floor. The prices quoted are current rates (1929).

Material and Quantity.	Rate.	Cost.					
		£	s.	d.	£	s.	d.
Sand, Stone, Cement, Wire, &c.							
1-in. gauge stone, 22 cub. yds.	15/- per yd. ...	16	5	0			
Clean, sharp sand, 13 cub. yds.	10/- per yd. ...	6	10	0			
Portland cement, 5 tons ... ... (Total concrete, mixed 1 : 3 : 5, equals 25 cub. yds.)	108/- per ton ...	27	0	0			
½-in. dia. steel rods, 32 lb. (verticals in reveals at doors).	20/- per cwt. ...	0	5	9			
⅝-in. dia. deformed steel rods, 1¾ cwt. (verticals to walls, also foundation reinforcement).	20/- per cwt. ...	1	15	0			
No. 4 gauge wire, 1½ cwt.	18/3 per cwt. ...	1	7	6			
No. 8 gauge wire, ¾ cwt.	18/3 per cwt. ...	0	13	9			
No. 16 gauge wire (tie wire), 4 lb.	6d. per lb. ...	0	2	0			
					53	19	0

The Materials Required—*continued.*

Material and Quantity.	Rate.	Cost.					
Timber for Roof, &c.							
6 in. x 3 in. H.W.—two 15 feet and two 18 ft. top plates; 99 sup. ft.	35/- per 100 sup. feet.	1	14	8			
4 in. x 4 in. H.W.—two 16 ft. lengths to cut *four* 8 ft. *diagonal plates*; 43 sup. ft.	39/6 per 100 sup. ft.	0	17	0			
6 in. x 1 in. H.W.—one 18 ft. ridge; 9 sup. ft....	30/- per 100 sup. ft.	0	2	9			
3 in. x 2 in. H.W.—sixteen 11 ft. rafters; 80 sup. ft.	28/- per 100 sup. ft.	1	4	8			
3 *in. x* 2 *in. H.W.—two* 23 ft. *ladder sides*; 24 sup. ft.	28/- per 100 sup. ft.	0	6	9			
3 in. x 1 in. (3 in. x 1½ in. if cypress) battens; 250 ft. lin.	32/- per 100 sup. ft.	1	0	2			
2 in. x ¾ in. H.W.—one 18 ft. to cut ladder rungs; 3 sup. ft.	30/- per 100 sup. ft.	0	1	0			
3 in. x 2 in.—one 12 ft. to cut trimmers for elevator opening in gable; 6 sup. ft.	30/- per 100 sup. ft.	0	1	10			
12 in. x 1½ in. *Oregon*.—three 8 ft. to cut door planks; 36 sup. ft.	36/- per 100 sup. ft.	0	13	0	6	1	10
Timber for Elevator.							
3 in. x 2 in. H.W.—12 ft. lin. for frames; 6 sup. ft.	36/6 per 100 sup. ft.	0	2	2			
9 in. x 1 in. pine—70 ft. lin. for sides; 53 sup. ft.	62/- per 100 sup. ft.	1	13	5			
6 in. x 1 in. pine—120 ft. lin. for bottom; 60 sup. ft.	57/- per 100 sup. ft.	1	14	3			
3 in. x ¾ in. H.W.—100 ft. lin. for carriers; 25 ft. superface.	40/6 per 100 ft. superface.	0	10	2	4	0	0
Galvanised Iron, &c.							
26 gauge corrugated iron—twenty 10 ft. sheets for roof.	5/4 per sheet ...	5	6	8			
26 gauge corrugated iron—nine 6 ft. sheets for gables.	3/2 per sheet ...	1	8	6			
Ridge capping—four lengths	1/9 per length ...	0	7	0	7	2	2
Bolts, Nuts, &c.							
36 in. x ⅝ in. C.H. bolts and nuts—8 only ...	.....	0	8	0			
7 in. x ½ in. C.H. bolts and nuts to gusses—16 only.	... .	0	2	6			
10½ in. x ½ in. C.H. bolts and nuts to plates—8 only.	.....	0	1	6			
8½ in. x ½ in. C.H. bolts and nuts to cleat to mast—2 only.	.....	0	0	6			
19 in. x ⅝ in. C.H. bolts and nuts, frames of elevator—14 only.	....	0	14	0			
9 in. x 8 in. x ¼ in. steel gusset, to plate—8 only	3/6 each.	1	8	0			
1½ in. x ½ in. hooks for top of hanging ladder—2 only.	.....	0	7	6			
3½ in. x ⅜ in. C.H. bolts and nuts to same—2 only.	.....	0	0	3			
1 in. x 18 gauge hoop iron to ladder—50 ft. ...	.....	0	3	9	3	6	0

The Materials Required—*continued.*

Material and Quantity.	Rate.	Cost.	
Nails, Screws, &c.			
3 in. x 10 gauge wire nails—7 lb.	.....	0 1 11	
2 in. x 11 gauge wire nails—4 lb.	4½d. per lb. ...	0 1 6	
1½ in. x 12 gauge galvanised roof screws—5 lb....	1/- per lb. ...	0 5 0	
Lead roofing washers—5 lb.	6½d. per lb. ...	0 2 9	
			0 11 2
Elevators.			
Elevator, 34 ft. centres	.....	12 15 0	12 15 0
Extra Timber for Scaffolding.			
12 in. x 1½ in. Oregon—five 8 ft. lengths, 60 sup. ft.; 9 in. x 1½ in. Oregon—sixteen 6 ft. lengths, 108 sup. ft.; total, 168 sup. ft.	36/- per 100 sup. ft.	3 0 6	3 0 6
Timber for Door Frames.			
5 in. x 2 in. H.W. or Oregon—one 22 ft. length... 2 in. x 1½ in. H.W. or Oregon—one 10 ft. length	.....	0 5 0	0 5 0
Moulds.			
*Silo moulds, battens and bolts...	.....	12 0 0	12 0 0
Total	.....	.....	£103 0 8

* As previously stated the moulds can be obtained with battens and bolts ready for assembling on the job.

Scaffolding.

An important item in the construction of a silo is cheap but suitable scaffolding. For the silo herein described, most of the scaffolding is done with the roof timbers. A plan is shown at Fig. 5, and a photograph at Fig. 6. The system is simple and perfectly safe. It consists of a central mast of two 16 feet lengths of 4 inch x 4 inch hardwood; shown on the list of quantities as diagonal plates. The first 16 feet length is set up quite plumb in the centre of the silo and made fast. To this mast a clamp, Fig. 7 is fastened, with bolts screwed up tight and lightly nailed cleats underneath as a safety measure. On this clamp the putlogs, or radiating bars, shown in the list of quantities as sixteen 3 inch x 2 inch hardwood rafters 11 feet long, take their bearing. The other ends of these timbers project through the silo wall to form an outer scaffold, the holes in the wall being formed by wood blocks (Fig. 8) tapered so as to be easily driven out when the moulds are taken down for the next lift. Fig. 6 shows these blocks in position—note that the thinnest end points outwards. These blocks also save the "green" concrete from much damage when the moulds are being taken down and set up for the next filling. The holes made in the silo wall are later filled with a concrete block which is dipped in a slurry of cement.

To complete the scaffold it is necessary to have five 8-feet lengths and sixteen 6-feet lengths of Oregon planks 12 inches wide and 1½ inches thick. As previously intimated the central mast is ultimately used for roof plates, the putlogs for rafters, while some of the planks are cut into short lengths for slabs for the silo doors. There will probably be no use about the silo for the remainder of the planks: it is unlikely, however, that on the farm they will go to waste.

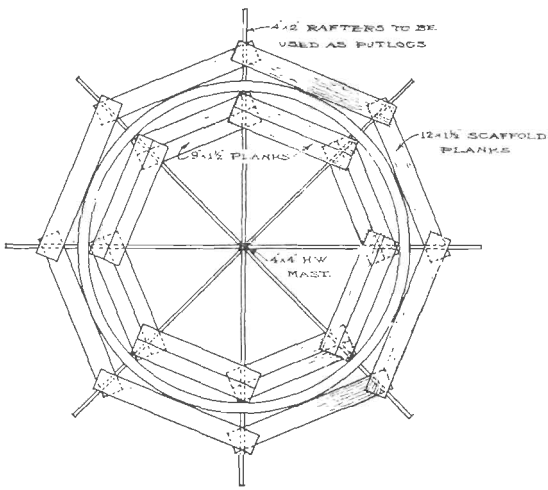


Fig. 5.—Detail of Scaffolding.

Excavating.

It is recommended that the floor of the silo be 4 feet to 5 feet below the mixing floor and feed passage. The depth of the excavation will therefore depend on whether the floor of the feed passage is raised, as at Fig. 3, or is a concrete floor laid on the ground.

Having decided where the silo is to be erected and determined where the centre is to be, the excavation can be marked out in the following manner:—Drive four pegs into the ground as indicated at A.B.C.D. in Fig. 10, so that strings drawn across from fine nails in each peg will intersect at the centre of the silo. Drive a peg at the intersection of the strings to ground level, and into this peg drive a stout nail. With this nail as a pivot and with the aid of a batten of length equal to half the overall diameter of the silo, describe the circle. A small V or notch should be made in the end of the batten to pivot on the nail.

Having marked out the silo, excavating may be commenced, and, of course, the centre peg will have to be dug out. The wall of the excavation should be cut vertical and to the circle, and the floor neatly scabbled off to an even and level surface. This done determine the centre of the silo again by

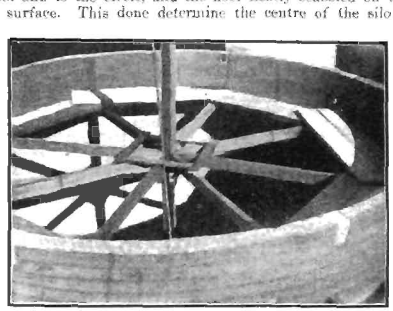


Fig. 6.—A View of the Inside of a Silo during Construction, showing the Scaffolding.

Note the wood blocks in position to form the holes for the next lift of the putlogs.

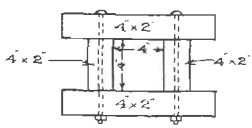


Fig. 7.—Detail of Clamp.

Used on the central mast to support the scaffolding.

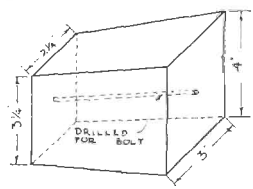


Fig. 8.—Detail of Wood Block

Used in the mould to form the holes in the walls for the putlogs.

dropping a plumb line from the intersection of lines drawn from the pegs (A. to B. and C. to D.), and immediately under this plumb line drive a peg and nail as before for the purpose of describing with a batten the inner line of the excavation for the foundation ring. By referring to Fig. 9 it will be seen that the bank has to be undercut for this ring (which is 18 inches wide and 12 inches deep), to be excavated.

The Concrete to Use.

The making and placing of concrete is fully described on page 192 in the Farm Holding section of this book. The proportions of the concrete to be used for silo construction are as follows:—

For the foundation ring; one part cement, three parts sand and six parts metal not larger than 1½-inch gauge. For the cylinder, one part

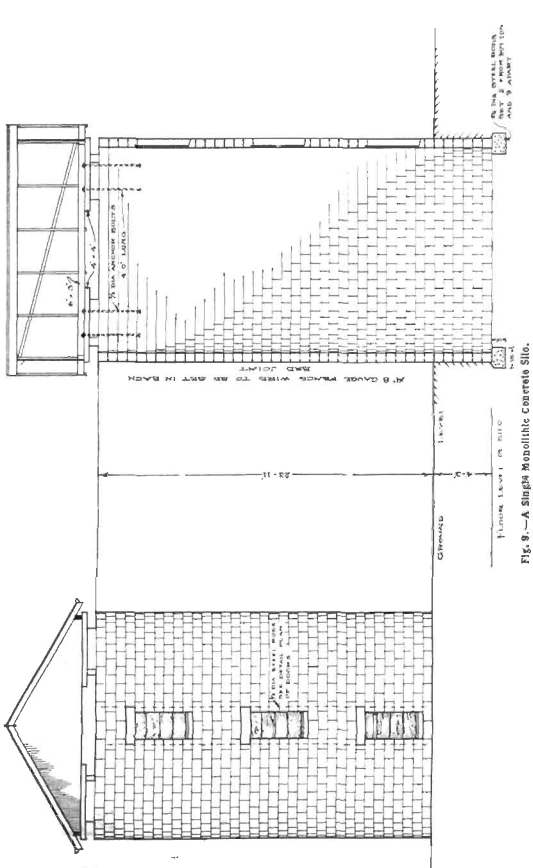


FIG. 9.—A Single Monolithic Concrete Silo.
On the Left—An Elevation. *On the Right*—A Section.

cement, two and a half parts sand and five parts metal of not larger than ¾-inch gauge. Metal of ¾-inch gauge may be used for the foundation ring also, should it be desired not to have two different gauges of metal on the job.

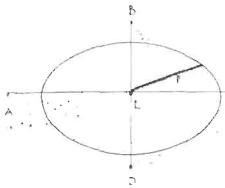


Fig. 10. – Diagram showing the Method of Marking-out the Excavation for a Silo.

Reinforcement.

As previously stated, it is necessary to reinforce the concrete with steel. Fence wire is recommended because of its cheapness, and because if there is any left over the farmer can generally find a use for it. The various drawings show how this reinforcement is distributed throughout the work, and although to the lay mind the placing in position of these wires might appear a complicated operation it is a comparatively simple matter. It is important that

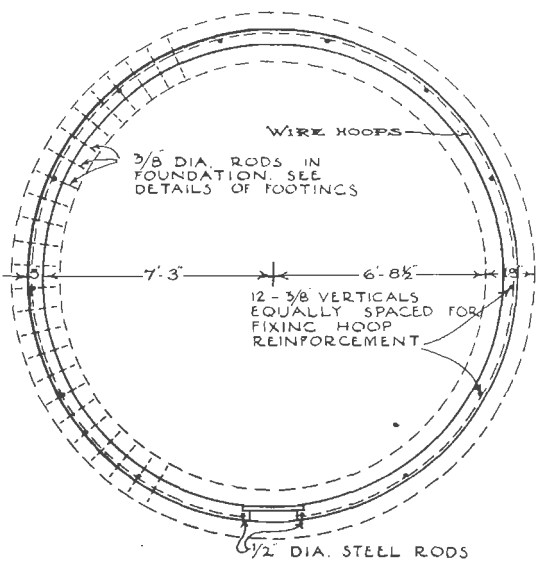


Fig. 11.—Detail of Reinforcement for Monolithic Silo.

the reinforcement be placed in the positions indicated, or the silo will lack strength where it is most needed. For this reason the following directions should be carefully read, in conjunction with the illustrations.

The foundation ring is reinforced with sixty-three ⅜-inch diameter rods 16 inches long, set 2 inches from the bottom of the concrete. The rods are laid radiating towards the centre of the silo, and spaced 9 inches apart, measured in the centre of the foundation ring (see Fig. 11).

The cylinder or wall of the silo is reinforced with No. 4 gauge black wire laid in the form of horizontal hoops every 6 inches in height till the silo has been carried up to a height of 12 feet; then No. 8 gauge or ordinary fence wire is used every 8 inches to the top of the silo (see Fig. 9). These wires or hoops are placed about 2 inches from the outside face of the wall. Obviously it is necessary to fasten these wires in position, and in such manner that they will not be displaced when the concrete is being poured into the mould, and this is done by fixing these wires with twitching or tie wire to vertical tie rods of ⅜-inch diameter. The plan shows that there are thirteen of these verticals. They are equally spaced round the cylinder, beginning and ending at the doors. For convenience these rods are set up in 8-feet lengths, and because of this short length are lapped not less than 12 inches. Fig. 12 shows rods shaped thus ⌊ embedded in the foundation ring. To these are fastened the lower ends ⌋ of the vertical rods referred to above. It will be noted that the verticals are not exactly in the centre of the wall, but about 2 inches from the outside face.

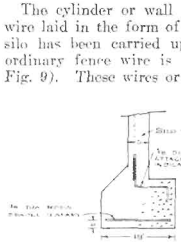


Fig. 12.—Detail of Footings.

The hoops or wires are fixed round before the mould is set for the next fill of concrete.

The Floor of the Silo.

Where the natural formation is hard and dry, a paved floor for the silo is not necessary. By hard and dry is meant, say an earth floor from which silage can be shovelled up clean. Conversely, if the formation is such that when the last of the silage is being taken out it proves to be a soft sticky mess, or if the soil is sandy and readily drains the liquid out of the silage, then a concrete floor will be necessary; and will require to be 6 inches thick, proportioned as specified for the foundation ring, and rendered ½-inch thick with cement mortar gauged one part cement to two parts sand, steel trowelled to a smooth surface.

The Roof.

The chief consideration in the construction of the roof is to so secure it that a windstorm will not blow it off, and (as tramping to consolidate the chaff when filling is very important), to raise it fairly high at the eaves, *i.e.*, where the roof takes its bearing on the wall plates. To obtain increased height the concrete is carried up 8 inches above the rest of the work where the plates are bedded (Fig. 9). The plates are the 4 inch x 4 inch hardwood that was used for scaffolding. They are each 8 feet long, and are firmly anchored to the concrete with two ½-inch diameter

bolts 36 inches long to each plate. It is important not to use shorter bolts than this, or the wind might take portion of the concrete as well as the roof.

On these plates are laid the 6 inch x 3 inch hardwood plates which carry the rafters (see Fig. 13). Before fixing, however, these plates are used in obtaining the rafter cuts as described below. They are held to the 4-inch x 4-inch plates where they cross with ½-inch diameter cuphead bolts each 10½ inches long, and are also secured to each other with two

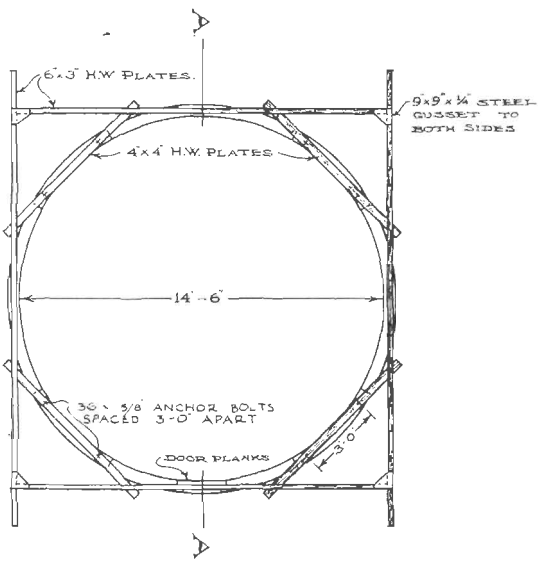


Fig. 13.—Roof plan of Monolithic Silo.

9-inch x 9-inch x ¼-inch steel gusset plates, one under and one over, at each angle. (See Fig. 13.) These steel plates are cut and drilled as at Fig. 14 and fixed with ½-inch diameter bolts; they make the roof very rigid.

The scaffold planks used for the concrete work are of considerable help in setting up the rafters for they permit of temporary fixings or supports to the ridge plate whilst the rafters are being set up in position. The rafters are birdsmouthed over the plates (Fig. 15) and splayed to ridge board.

To obtain these cuts proceed as follows:—Lay the 6-inch x 3-inch hardwood plates on the ground so that they will be quite level and arranged as they will be when fixed on top of the silo. Make certain that these plates are square by measuring, with a tape or long batten, from opposite corners (from A to C and from B to D in Fig. 15). If square both measurements will be equal. If not the plates should be so adjusted that both diagonal measurements will be the same.

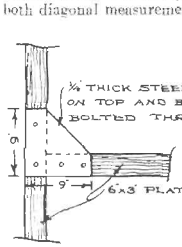


Fig. 14.—Detail of Steel Gusset.

This done, measure from B and C a distance, say, 2 feet on each plate, giving points 1 and 2; draw a line across from 1 to 2. From 1 and 2 measure back a distance of 4 feet 4 inches, giving points 3 and 4. Now take the ridge board and set it up on its edge across the plates as shown on the drawing, so as to be midway between side plates but packed up so as *to pass over the rafter.* Set the rafter so that it will touch the ridge at H where the line from 1 to 2 passes; set the other end of the rafter so that it will cross in the centre of the plate, the line drawn from 3 to 4. The splay cut at ridge can now be obtained by drawing a pencil line across rafter where the ridge crosses it, and the birdsmouth by drawing a line in line with the outer edge of the plate to intersect the line drawn from 3 to 4; the piece to be cut out is blackened thus:— ◥ in Fig. 15. This rafter is now used as a template from which all other rafters are cut.

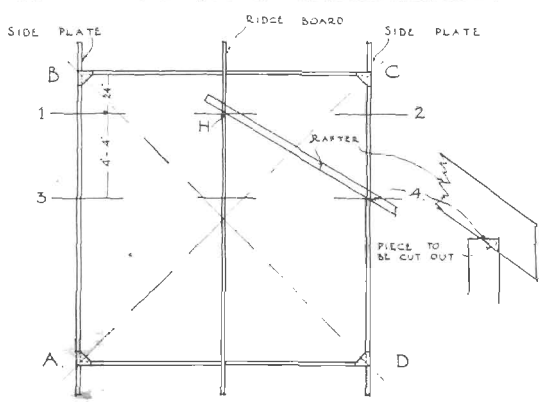


Fig. 15.—Diagram of Roof Set-out to obtain Rafter Cuts and Ridge Splay.
On the Right—Detail of Birdsmouthed Rafter.

Before dismantling the plates, cut the ridge and side plates to their correct length, mark the ridge board where it crosses the plates and mark off on the side plates and ridge board the spacing of the rafters, so that all that is necessary when constructing the roof is to set the rafters to these marks and securely nail.

It is necessary to brace the roof with a 3-inch by 1-inch diagonal batten nailed to the underside of the rafters, as indicated at Fig. 9. Before fixing this brace see that the rafters are plumb. This is done by plumbing one pair of end rafters at the ridge with the wall plate below. When these are plumb, secure the brace with a 2½-inch nail at each rafter.

The roofing iron, ridging, &c., are then fixed. The iron is secured to the battens with 1¾-inch galvanised screws and lead washers, and is lapped 6 inches at the ends and one and a half corrugations at the sides. The accompanying illustrations show guttering to the eaves of the roof, but owing to the difficulty of fixing this and the downpipes in position most farmers will probably prefer to leave it off.

The gables are covered in with corrugated iron screwed to the rafters and to the bottom plate. A sheet of iron is taken off when filling the silo to allow the elevator to go inside. It is put back again after filling and the removal of the elevator.

The Silo Doors.

The silo doors consist of 1½-inch thick boards 12 inches wide. They are held in position by the weight of the silage behind them. To make the silo air-tight at the doors, tarred paper (a commercial commodity) is placed

Fig. 19.—Detail of Door Frame

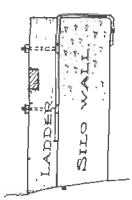


Fig. 17.—Detail of Top of Silo Ladder

between the boards and the silage so as to cover all joints. These boards fit into a rebate formed by a door frame of 3-inch by 2-inch hardwood with 3-inch by 1½-inch cleats lightly nailed on the inside to the verticals and head piece (see Fig. 16). Note that these cleats are only lightly nailed, for the reason that they are used only to form the rebate, and afterwards, together with the head piece, are removed. Note also that the head piece is supported with small cleats under it, so as to enable easy removal when the concrete above it has set. The sill piece requires no fixing to hold it temporarily in position. These door frames should be so placed in the wall that when the planks are in position there will not be a ledge internally, either at the head or the sill, to retard settlement of the silage. To throw off moisture the sills of the doors should be weathered or sloped outwards with cement mortar gauged one part cement to two parts sand.

A Silo Chute.

With a silo standing alone (as at Fig. 9), a chute would be necessary down which the silage could be thrown to the mixing floor without being scattered by the wind. It is customary, however, to build a silo as part of the feed stalls: in which case the bottom door—and often the middle door also—is below the roof of the stalls, in which case a chute is necessary from the top down to and just through the roof. This is easily constructed with a light framework of 3-inch x 2-inch verticals and cross pieces, to which corrugated sheets are fixed in such a way that the framing timbers are outside; thus providing an unobstructed passage for the silage.

The Ladder.

A ladder to reach from the ground to the top of the silo will, of course, be necessary. It must be so placed that entry to the silo can be gained over the top or through each of the doors. If a chute is built to the silo then the ladder will be constructed inside it. It may be constructed with 3-inch by 2-inch side rails, and 2-inch by ¾-inch rungs sunk flush with the rails and nailed. As a safety measure a strip of 1-inch by 18 or 20 gauge galvanised hoop-iron should be placed down each side rail and nailed through each rung. If placed on the silo wall as at Fig. 9, the ladder may be secured with 1½-inch by ½-inch steel hooks over the wall, secured to ladder rails with ½-inch bolts (Fig. 17). With this fastening it may be placed anywhere round the silo.

Cutter and Elevator.

There are several good chaffcutters on the market, with cuts ranging from ¼-inch to ¾-inch and with 9½-inch mouth. These will be found quite suitable for silage making, and given reasonable care will be fairly trouble-free.

Connected with the cutter and the silo is the elevator. It is a simple construction with little that can get out of order. Because of the woodwork in its construction, however, it should, when not in use, be covered with sheets of iron or taken down and stored, say, under the floor of a building. The elevator itself consists broadly of an inclined wood trough through which an endless link belt or chain passes. Attached to this chain are the floats, which are cut from 3-inch battens, and serve the same purpose as the buckets on a grain elevator.

The length of elevator required for a silo standing 26 feet out of the ground is 33 feet. The fittings, comprising sprockets, chain, take-ups, and bolts may be obtained from Sydney firms at a cost of from £12 to £15.

Points in Construction.

A brief resumé of the operations associated with the building of a monolithic concrete silo follows, and should prove useful in preventing the mistakes commonly made by those new to the work:—

Have the metal and sand placed conveniently to the work, and on a clean surface; have plenty of water conveniently situated and the cement stored in a dry place. Construct a temporary wood floor on which to mix the concrete. See that the requisite plant, such as the moulds, timber as listed, two square mouth shovels, a water can, kerosene-tin buckets, a small pulley wheel and rope for hoisting the concrete, a small spade for compacting the concrete in the mould, &c., are on hand. Make the tapered wood blocks for forming the scaffold putlog holes; make the clamp for the central mast; obtain spanners to fit the bolts specified, and ensure that hammer and nails, oil, and old whitewash brush for painting the inside of the moulds so that concrete will not stick to them, are readily available. A good ladder will also be required.

Having excavated for the silo and the foundation as described earlier, throwing the spoil well out of the way, drive in pegs round the floor of the excavated foundation ring, to stand 12 inches out of the ground (the depth of the foundation), and make the tops quite level right round. Scabble off the floor of this ring and generally clean up.

Mix a batch of concrete for the foundation ring, using the proportions before specified, and by the method described in the concrete section on page 194. Wet the ground and place the concrete in position to a depth of 2 inches; on top of this place the radiating steel rods, and afterwards place the remainder of concrete to the level of the tops of the pegs. Finish the top of this concrete ring fairly smooth, because the moulds have to be set up on it. While this concrete is wet, bed the cranked bars to take the vertical rods into it. While the foundation ring is "green," describe a circle equal to the internal diameter of the silo, and to this circle, place the inner ring of the moulds—this, of course, to be done after the vertical rods have been set up and the hoop wires placed and fixed in position.

Fig. 18.—The First Ring of Moulds in Position.

With the moulds set up level at the beginning (see Fig. 18) no trouble should be experienced throughout the work. The ring of moulds consists of eight sections, and on four the plain iron on the inside finishes flush at the ends with the corrugated iron (call these A). On the other four sections the plain iron is stopped back from the end of the corrugated sheets (call these B). The sections are set up A, B, A, B, A, B, A, B, all the A sections being set up first. The B sections being set up last, are the first to come down when dismantling; no trouble should be experienced if this system is adopted.

When placing the concrete in the moulds, see that it is of the right consistency, and is well consolidated, so that when the moulds are removed it presents a clean, smooth surface. The moulds will require scraping and oiling or greasing with fat each time they are taken down. Any holes or rough surfaces which show in spite of these precautions should be *immediately filled and floated over with mortar composed of one part* cement and two parts sand. Do not leave this pointing until the concrete is quite hard or much soaking with water will be necessary, and even then an inferior finish will result.

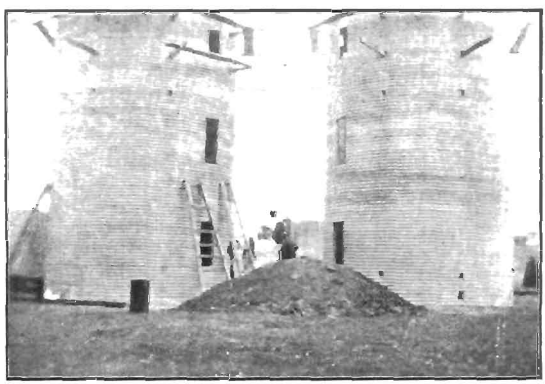


Fig. 19.—Twin Silos with the Walls Nearing Completion.

Note the outside scaffolding resting on the putlogs.

Remember when placing the concrete to set the door frames, anchor bolts for roof plates, &c., in position.

When the concrete work has been completed, proceed to frame the roof. This is first set out on the ground, and the rafter cuts obtained as explained earlier. The anchor bolts should not be touched for at least two days after they have been set in position, or the concrete might get cracked. It is unlikely, however, that the average man will get his moulds down and the roof framed ready for fixing earlier than this, and there should, therefore, be no occasion to interfere with these bolts before they are secured.

The construction and setting up of the elevator will not present any difficulties.

It is necessary to add a caution against filling the silo before the concrete has set hard. In contract work the silo will probably be erected and completed in a few weeks. In this case it should be given at least two weeks to harden. If constructed by farm labour progress will most likely be much slower, and by the time the silo is finished the concrete at the bottom of the cylinder, where the greatest pressure occurs, will be quite hard and no harm result if it is filled immediately on completion.

THE CONCRETE BLOCK SILO.

A convenient sized block for silo construction is 16 inches long by 8 inches high and 8 inches thick. Machines may be purchased which will make a block of this length and height and which can be adjusted to make blocks of thicknesses of 4, 6, 8, and 10 inches. The most suitable machines are those which mould blocks face downwards, for the reason that a richer mixture, say, one part cement and two parts sand may be first put in the mould to a thickness of 1 inch, and the remainder made up with a mixture of one part cement and five parts sand. Further, a fine sand may be used with the first mixture and a very coarse sand for the second.

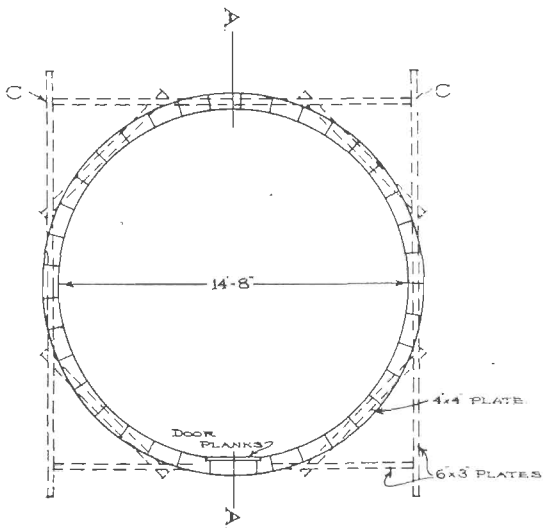


Fig. 20.—Plan of a Concrete Block Silo.

These blocks are hollow, and are quite strong enough if reinforced with No. 4 wire in the bed joints in the form of hoops. Note that the reinforcement is essential. Further reference is made to it a little later.

The directions given for excavating for a monolithic silo will apply here, except that the walls being thicker, viz., 8 inches, the outer diameter will be 1 foot 4 inches greater than the internal diameter.

The foundation ring should be constructed to the same dimensions and with the same reinforcement as for a monolothic concrete silo, except, of course, that as no vertical rods are used, the bent rods for fixing the lower ends of these are not necessary.

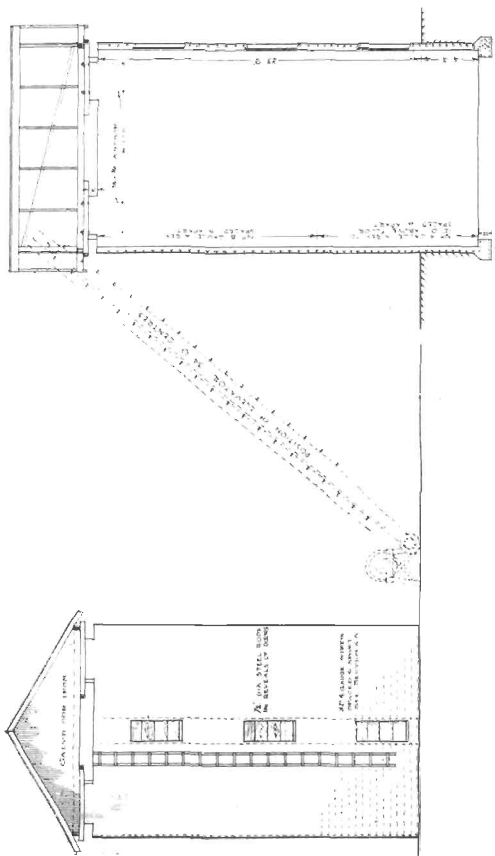


FIG. 21.—A Concrete Block Silo.
On the left—An Elevation. *On the Right*—A Section.

Making and Laying the Blocks.

The mortar or concrete should be used as soon as possible after it is mixed. The block machine must be kept clean, the mortar well packed into the machine by careful tamping, especially at the corners, and the blocks, when made, placed under cover, if possible, and under bags kept wet for three or four days.

It is very necessary, if sound workmanship is to result, to soak the blocks thoroughly with water immediately before building them into the wall. *It is equally necessary to scrape clean and thoroughly soak the top surface* of the foundation ring where the blocks are to be laid. Ascertain the centre of the excavation, as described in connection with the monolithic silo on page 764, and with a batten describe a circle on the foundation ring to set the blocks to.

The mortar for laying these blocks should be gauged one part cement to two parts sand. The sand for this should not be too coarse, as it will be difficult to work. The bed and cross joints should be $\frac{5}{8}$-inch thick.

When the first ring of blocks is laid, make marks equal distances around the ring, and from these marks plumb the walls with a bricklayer's plumb rule as the work proceeds.

The Reinforcement Necessary.

It is essential for the stability of the silo that it be suitably reinforced with steel, and the method recommended is as follows:—

In each bed joint, *i.e.*, on the top of each ring of blocks, lay No. 8 fence wire to form a complete ring, set 1½ inches in from the outside face. The ends of the reinforcement to lap 24 inches and be turned back to form a hook. Where the doors are shown, insert ½-inch diameter vertical rods, and fill around same with concrete, as shown in Fig. 22. Around these vertical rods the bed joint reinforcement must be securely bent and twisted. From about 2 feet below ground level, and for a distance of 8 feet above, build in a second ring of fence wire, set 1½ inches in from the inside face.

Anchor Bolts.

Build into the walls eight ½-inch diameter bolts spaced as indicated in Fig. 21, to secure the 4-inch by 4-inch roof plates. These bolts are to be embedded in concrete poured into the cavity of the block after the wall has been built, so that this filling will extend from the bottom to the top of the silo.

Doors.

The blocks forming the reveals to the doors should have a 2-inch by 1½-inch rebate formed in them for the door planks. The sills must be formed to slope outwards, and the bottom plank bevelled to fit.

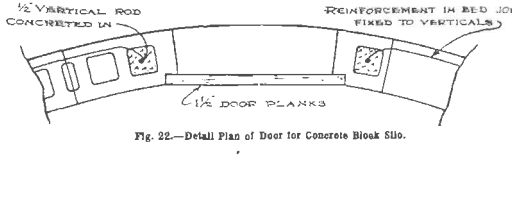


Fig. 22.—Detail Plan of Door for Concrete Block Silo.

The Roof.

The roof construction is the same as for a monolithic concrete silo, the 4-inch by 4-inch plates being set up on piers as shown in Fig. 21, and secured to the same with ½-inch bolts as already indicated.

Rendering.

The interior of the silo should be well soaked with water and rendered ½-inch thick with mortar gauged one part cement to two parts sand, and trowelled to a smooth, even surface. Keep this rendering covered with hessian to prevent too rapid drying, and occasionally sprinkle with water. Ledges that will retard settlement of the silage are to be avoided, particularly above door planks.

STACK SILAGE.

Of the three distinct methods of conserving green fodder in the form of silage, that of stacking in the open is generally regarded as the most wasteful and the least to be recommended. There are modifying influences existing in certain districts, however, that render the use of any other system almost impracticable. Farmers in some districts are naturally disinclined to invest, without some experience, the amount of money involved by the high cost of materials and equipment in the making of a tub silo. Moreover, while the pit silo is an ideal type for the drier areas of the State, it is never likely to become popular on the coast; mainly because of the heavy rainfall experienced, but partly owing to the fact that excavating machinery is only in the most rare instances included in the equipment of the farm.

None of these objections, are, however, applicable to the stack silo. As appreciation of the advantages of conserving green fodder becomes more general, it may be anticipated that silage will come into very general use; meanwhile, any cheap and reliable method that will appeal to farmers generally, gaining for silage the esteem that it deserves and paving the way to the installation of the fully equipped tub silo, is to be welcomed.

Several effective methods can be adopted to make stack silage. These can only be determined by local conditions. In all cases provision should be made to render the stack weather-proof from the top to exclude rain. If a shed be used, with a good floor and well drained, a space of 16 ft. x 14 ft. will provide for 100 tons with a stack 22 to 24 feet high. The first consideration, after having determined to select the stack as a means of conserving the crop, is to secure a site in close proximity to the milking or feeding sheds. An elevated spot is best, with natural drainage and a firm dry surface layer of soil to start on, and, if possible, sheltered from prevailing winds.

In some instances it may be expedient to build stacks in the paddocks where the crop is grown. Care should be exercised in selecting a well-drained site. Soil may be used to weight the stack, but in using this special precautions should be taken to secure a level, evenly-balanced surface.

Four stout posts at either corner of the stack would assist in keeping it plumb. The material should not be allowed to jamb at the posts to interfere with its settling. Stacks of green material very often tilt over to one

side on account of uneven drying. The wind may dry one side more than the other and prevent its settling uniformly. A stack may fall over if not watched. A tarpaulin may be hung against the side to protect it from the wind. Water also could be applied to the drying side.

It is of the utmost importance that each layer be built up evenly, to maintain a regular and unbroken contour, to ensure an equal distribution of weight, so that the stack will shrink evenly and maintain its shape. The main principle to observe in all cases is to keep out the air, and to obstruct its ingress during the curing stage.

Apart from the object of excluding and getting rid of the confined air, a danger to obviate is the opening up of the stack through uneven settlement and shrinkage during the fermentation processes later on.

It is essential to surround the stack with a fence sufficiently substantial to prevent stock of any kind reaching the fodder. Without this, calves, pigs, horses, and cattle, are always attracted; they draw out stalks all round to get at the edible portion, and by this means admit air to the stack and spoil it for fodder. The crop should be stacked immediately after cutting.

Crops Most Suitable.

The crops recommended for use in overhead silos (see page 753) are suitable also for making silage in stacks.

Elevating the Bundles.

The elevation of the bundles presents some little difficulty, but this can be easily overcome by several methods; a mast and spar can be used, or a block and tackle operated from an overhanging limb of a convenient tree; but the system most to be recommended is the "whipstick," as illustrated. (Fig. 1.) The length of the "whip" is, of course, determined by the height of the stack, but usually a pole of about 30 feet in length will fulfil all requirements. The "whip," like the block and tackle, can be worked from an adjacent tree, or, as is more usual, a stout pole can be erected for the purpose at the end of the stack framework. Fig. 2 shows a pair of clutching-dogs, which any local blacksmith could make, for gripping the bundles of greenstuff.

Building the Stack.

In completing the stack of sorghum silage at Hawkesbury Agricultural College, depicted in the accompanying illustrations, the aim was to shape the roof so as to exclude rain, to keep the stack intact, and to resist wind. No thatching was designed, and no special materials were utilised. The sheaves of sorghum were laid transversely, and when the ridge was reached the whole was kept firmly in position by passing across every four feet fencing-wire weighted on each side to heavy fencing-posts hanging loose. In this way, as shrinkage set in and the stack fell, the fencing posts hugged the stack closely, and kept the wires tight and in close position until the whole mass condensed and became solid and stationary.

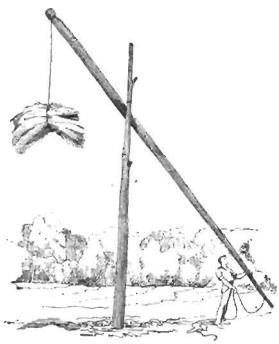


Fig. 1.—A Whipstick.

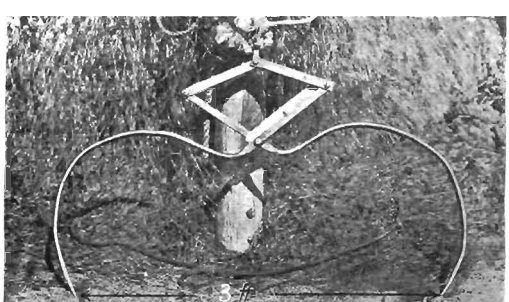


Fig. 2.—Clutching-dogs for gripping and hoisting bundles of Silage.

The following measurements were recorded six weeks after the completion of the stack:—

	ft.	in.
Average length of stack	27	6
,, width ,,	20	0
Height from ground to eaves	11	0
,, ,, ,, ridge	18	0
Length of ridge	24	0

Computed total volume .. 7,894 cubic feet.

A rough estimate of 32 lb. per cubic foot being accepted, the total weight of the stack would be 113 tons. This estimate of 32 lb. per cubic foot was arrived at by taking into consideration the shrinkage of the stack to about two-thirds of its former size, and the actual weight of the cured silage, as obtained at a later date, at 47.37 lb. per cubic foot.

Eight months later this stack was remeasured when curing was complete with following result:—

	ft.	in.
Average length	26	9
,, width	19	6
Height from ground to eaves	8	6
,, ,, ,, ridge	11	6
Length of ridge	24	0

Computed total volume ... 5,189 cubic feet.

The stack was opened shortly afterwards, and as the centre was approached measurements were again taken to ascertain approximately the waste.

It was decided to allow for waste—

18 inches all round the stack or the sides.
12 ,, over the top or roof.
6 ,, for the floor or bottom.

This reduced the measurements of available fodder, or good silage, to—

Length	23·75	feet.
Width	16·5	,,
Height from ground to eaves	7	,,
,, ,, ridge	10	,,
Length of ridge	21	,,
Total volume	3,308	cubic feet.

The exact weight per cubic foot was next determined by carefully cutting out a cube, measuring and weighing it—*i.e.*, the cavity from which the cube was removed was measured, and the cube weighed. This gave:—

Contents of cube	6,925 cubic feet.
Weight of cube	328 lb.
Weight of 1 cubic foot	47·37 lb.

Using this weight per cubic foot, the total weight of the cured silage was—

5,189 cubic feet × 47·37 = 245,803 lb. = 109¾ tons nearly.

Deduct the waste on the top, sides, and bottom, and the result is—

3,308 cubic feet × 47·37 = 156,700 lb. = 70 tons nearly.

An examination of the 6 inches of waste on the bottom showed that while the fodder was not equal in standard value to the other for milch cows, it was readily eaten by dry stock, and hence 2¾ tons was added to the total edible silage, bringing the total to 72¾ tons.

Fig. 3.—A Silage Stack just completed and weighted down with old fence posts suspended from wires across the top.

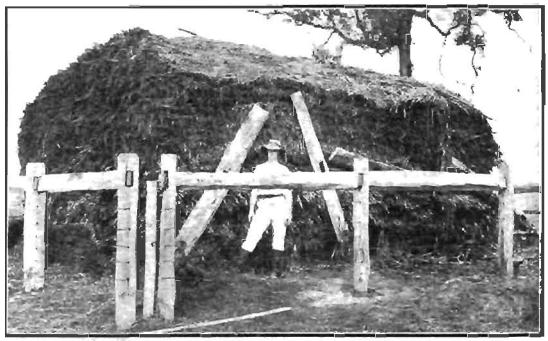


Fig. 4.—The Same Stack, nine months later.

The actual loss of food material from waste was thus found to be 37 tons.

The loss of moisture in the curing stage was the difference between 115 *tons and* 109¾ *tons, or* 5¼ *tons.*

No difficulty was experienced in cutting the silage with the ordinary hay knife, as the accompanying illustration (Fig. 5) shows.

The larger the stack the less the waste in proportion, and hence a large square stack is more economical. A stack may be made of any size, and so can be built to suit the amount or weight of the crop. Avoid making the base too big.

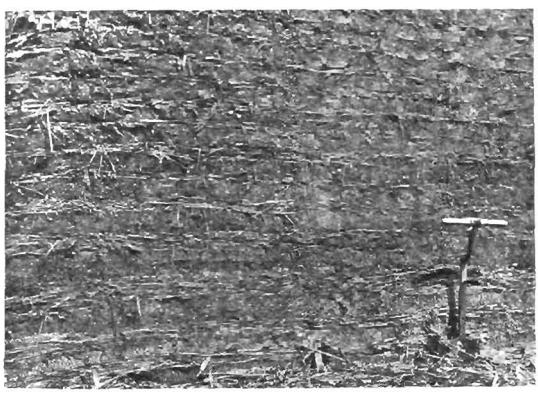


Fig. 5.—View of open cut face of same silage stack, showing benefit of placing material in position in even layers and having a uniform pressure.

Cutting and Feeding.

In opening a stack silo the point to be observed is that silage moulds very rapidly when exposed to the air, and the correct mode of procedure is to expose the smallest portion of the inside surface and to endeavour as far as possible to renew this inside surface daily. It is usual, therefore, to open the stack at one end, and at the same time to disturb the covering and weighting system over as small an area as possible. Only small benches *should be opened up, so that they can be cut right out as soon as possible.* It is absolutely essential that no more than the day's ration be cut at one time, and that the cutting be clean and free from tearing. For best results the cutting should be done with a silage knife, but in the event of this implement not being available, a sharpened spade or an old squaring axe, or even an ordinary chopping axe, may be successfully used.

It is not advisable to open the stack earlier than fourteen to sixteen weeks from the time of stacking, in order that the fermentative processes of curing may have time to complete their work.

It is unusual for any difficulty to be experienced in inducing stock to eat good silage; in fact, it has been observed that even the waste from the stack is readily devoured, especially when stock have become accustomed to silage. It is not recommended that cows in milk should receive any of the weathered portions.

A New Type of Stack.

A factor that has exerted a retarding influence upon the development of stack silage on the North Coast is the difficulty frequently experienced in securing the services of competent stack-builders. As little or no hay is produced in this district, opportunities for practising stacking are correspondingly few. Farmers are aware that bad stacking means increased waste, and realise that the collapse of the stack after completion would mean silage wholly spoilt—considerations which naturally make them somewhat cautious. In order to overcome these objections and to assist in bringing ensilage into more general use, a system of parallel stacking, as distinct from the square system of crossed bundles, has been evolved. This new method has achieved much popularity in Queensland, and has also been practised successfully on the North Coast of New South Wales.

The advantages of the new system are, briefly, as follows:—

1. Practically all risk of collapse consequent upon bad stacking is eliminated, no skilled labour being required, and the construction of the stack being such as to prevent collapse or canting.
2. Weather waste is minimised. Maize and sorghum are the crops almost invariably used for silage on the North Coast, and, as under the new system the bundle or sheaves are laid in the one direction, a much better compaction is obtained.
3. Good samples of silage can be made from amounts of material much too small for utilisation by the old method.
4. Some advantage is derived from the fact that when feeding the silage there are no great inequalities in length of stalk.

Building the Frame.

The new method is designed chiefly for handling maize or crops of similar habit of growth, such as sorghum and millet. It usually consists of an oblong stack, supported along both sides in order that the bundles may be laid in the one direction, the need for cross layers being thus entirely avoided.

The dimensions of the proposed stack must first be estimated, after which a row of bush poles is erected along each side of the selected site, as shown in Fig. 6. Great weight of timber or strength of framework is not absolutely essential, as the pressure is mainly downwards; and as the stack settles it contracts from the framework, which, if necessary, can ultimately be removed. The length of the poles is, of course, fixed by the height to which it is proposed to stack, but their diameter should be about 3 to 4 inches at their small end. The large ends should be inserted 30 to 36 inches into the ground, and the tops braced by a light pole, to which the uprights are

wire twitched. The exact distance between the posts is determined by the length of the material to be stacked, well grown maize or sorghum usually being safe with a space of 36 inches between uprights, and 24 inches being recommended if a shorter growth has to be treated. The framework should be braced across the ends and the middle at the top, and if possible, the poles carrying the centre brace should be sufficiently high to allow ample head room for the stacker to work as the stacks near completion. A pair of light poles should be erected at end of the framework, and a light cross-piece provided to carry the heads of the end rows of bundles during stacking (as explained later).

The site selected for the stack should be a dry one, and it should be so located as to be convenient to the crop that is to be ensiled, and also to the point at which the material is to be fed to the stock.

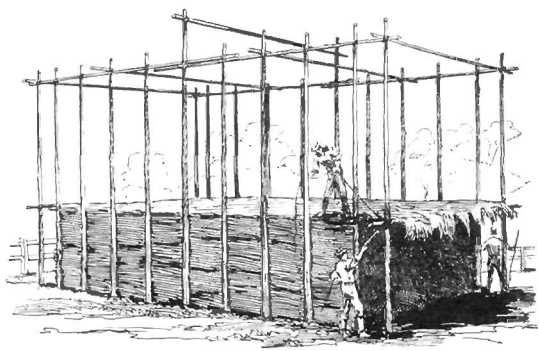


Fig. 8.—A Stack Silo suitable for Coastal Conditions.

It is always advisable to ensile as large a quantity of material as possible in one stack, as the larger the stack the smaller will be the percentage of waste. For general purposes a framework of about 25 feet long x 15 feet wide x 20 feet high is to be recommended. This space should hold enough green fodder to produce, approximately, 80 tons of silage, and at a safe estimate it should be filled by the product of from 5 to 6 acres of maize. If, however, large supplies are available, better results are likely to follow with a stack containing 100 tons or upwards.

Directions for Stacking.

A foundation of about 18 inches of grass or any coarse material should be placed to receive the first layer of bundles, and a start made by placing the first row of bundles with their butts in line with end pair of uprights in the framework. Under no circumstances, however, should a timber foundation be used, as this allows air to penetrate the bottom of the stack. Successive rows of bundles, each overlapping the last, are laid until the entire

floor of the framework is covered; the heads of the last row protruding from 30 to 36 inches beyond the last pair of uprights. In placing the second layer, the heads and butts are reversed, and the stacking continued in this manner. When a height of approximately 30 inches has been reached, a rough "straightedge" should be laid across the ends of the stack on the outside edges of the last pair of uprights, and the protruding heads of the bundles cut off and thrown back into the body of the stack. This practice may not be absolutely necessary, but is strongly advised; an unbroken and compact face being thus presented to the weather, while the heads of the alternate end rows of bundles are preserved, and make to swell the stack instead of being permitted to go to waste. After the first trimming has been made, the light cross-pieces referred to earlier are placed in position against the additional pair of uprights at the ends of the framework, so as to carry the protruding heads of the bundles of the ensuing layers. These cross-pieces carry little weight and should be easily adjustable; they can be held in place by a pair of stout forks or wire twitched to their supports. After a further 30 or 36 inches of material has been stacked the ends are again squared off with the straightedge and the cross-pieces elevated accordingly, and so on until the completion of the stack. Under ordinary conditions this operation would not be necessary more than once daily.

For satisfactory results, a depth of not less than 30 inches over the surface of the stack should be put on daily; liberties in this direction can be taken with immature material, but with more matured crops speed in handling is imperative. If a portion of the crop is drier than the rest, it is advisable to place it on, or near to, the bottom of the stack, and to have the heavier and greener portion near to the top; in order that the drier portion may be subjected to the greatest pressure, and that its deficiency of moisture may be rectified by the soakage from the upper layers of the stack. Unlike hay, silage suffers no damage from rain during stacking, and save for the inconvenience caused thereby the work may proceed under moist weather conditions without detriment to the product; it is, in fact, sound practice to apply water when stacking a crop that has attained an advanced stage of maturity. In completing the stack the aim should be to leave the centre slightly higher than the sides in order that a depression may not be formed by the more complete heating and settling of the central portion; this point must be carefully observed when two or more classes of crop are ensiled in one stack, and complete layers made of each.

If the bundles are placed with average care, the weather waste on the exposed surfaces should be comparatively slight; heaviest waste will necessarily be towards the top of the stack, and this can be materially reduced by the application of even a light pressure. Good results may be obtained by regular attention to some form of winding gear, which can be successfully operated from the ends of logs embedded beneath the foundation of the stack, the weight being applied by the usual wire ropes and distributed over the surface of the stack by means of a framework of light poles; but almost anything that can be easily and conveniently handled (such as logs, stones,

bags of sand, or even loose earth) will give results more or less satisfactory. Whatever system of weighting is adopted, it is essential that the pressure be evenly distributed over the stack surface, and that a thick layer of grass or straw be placed directly on top of the silage. The stack can be further protected by a layer of grass on top of the weighting material, and by ridging this last layer well down the centre of the stack, an unbroken surface is presented to the weather. Experience indicates that this additional covering requires no holding in position except in exposed situations, as under the usual North Coast weather conditions the grass "mats" very rapidly; where necessary, however, a few strands of fencing wire will give all the support necessary. When loose earth is used for the top-weight the need for the upper covering is avoided, but the protective layer of grass should be increased in thickness to prevent ingress of soil from above, and poles laid around the top of the stack to hold the earth in position. For obvious reasons this system of weighting is not recommended when any other is available.

SECTION XII.

The Feeding of Farm Stock.

THE study of dietetics is only in its infancy in this country, and has not yet assumed its true position of importance, but it will come more and more to the front as the country becomes more closely settled. Scientific feeding is economic feeding with all classes of animals; its neglect here is due to the fact that the vast majority of our stock has been, and still is, entirely paddock fed. This state of affairs is steadily passing away; and with the continued cutting up of large estates, the extension of mixed farming and *irrigation, and more intense working of the land, it will become more and* more necessary to hand-feed stock of all descriptions, except, of course, in those areas of the State which will for very many years, and probably for all time, remain in large holdings.

This change of conditions does not only apply to large stock but also to sheep, which, if not hand-fed, will in the future be grazed by methods very different from those at present employed. These methods will approximate more and more to those existing in Europe and will involve greater subdivision of farms, the growth of crops solely to be fed-off by sheep, and the feeding-off of several small paddocks in rotation in place of one or two large ones.

THE GENERAL PRINCIPLES.

The question of the economic feeding of farm animals depends as much on scientific principles as does the economic feeding of farm crops.

Farmers all the world over have come to realise that in order to apply manure without waste, it is necessary to apply it with some regard to the nature of the crop and the soil, and the readiness with which the various ingredients are availed of by the plant. In the same way the feeding of farm animals is quietly undergoing a revolution, and it behoves the farmer who does not wish to see himself at a disadvantage to learn something concerning the nature of the substances which comprise the food of his stock, and of the idiosyncrasies of the individual animals.

For animals, just as much as plants, require certain definite ingredients in their food, and require these to be present in definite proportions. There is, however, this difference, that with plants the supply of a large amount of unnecessary food simply means a waste of money, but in the case of animals it may have injurious effects on the health. The selection of food by the plant takes place, for the most part, by means of the roots, and before it enters the plant itself; whereas, with animals, the assimilation of the nutritive material takes place after the food has been swallowed, and the indigestible material has to be got rid of, and if this is excessive in amount, discomfort and even disease result. Indigestion, the "blowing" of cattle, the formation of fibre balls in the stomach, are all instances in point.

Nature of Food Required.

It is also quite clear that not only do different animals require different foods, but that the same animal must be fed differently according to the object in view in feeding. The simplest problem, and the one that forms *the basis of all dietaries, is what is called the maintenance diet, that is to* say, the amount of food necessary to keep the animal in good health, and to meet daily requirements and repair the waste of tissue. Without going too much into technicalities, it may be laid down that a food must contain the following ingredients:—

(1) Water;
(2) Mineral matter;
(3) Fat or oil;
(4) Carbohydrates (substances such as starch and sugar);
(5) *Flesh-forming material, or proteins (substances such as gluten)* which contain nitrogen.

Just as the crop requires all the nourishing constituents to be present for its proper growth, and fails if one be absent, so the animal will starve on *a diet composed exclusively of, say, carbohydrates (starchy and sugary foods)* if the nitrogenous materials are absent.

The amount of protein especially is of the highest importance in the feeding of stock, as it is the only source of supply of the nitrogenous material which is essential to the animal. It has been found that the amounts of protein and non-nitrogenous material in the food must bear a definite ratio to one another, and that if a food contain too large a proportion of carbohydrates or of proteins the result is equally disastrous. This ratio differs with different animals, and even with the same animal when used for different purposes. For example, a horse doing heavy draught work requires a relatively larger proportion of protein in its food than one doing light work.

How the Food is Supplied by Plants and Fodders.

Let us briefly discuss the ingredients present in plants and fodders, and see what part they play in providing food for animals. All plants and fodders contain the following ingredients:—

Water.—The presence of water makes the food more succulent and palatable, and also renders it more easy of digestion. It takes the place of drinking water to some extent, and animals fed on watery food require less to drink.

Ash or mineral matter represents the inorganic substances present in the fodder—or is that portion which remains after the organic portion is burnt. The nature and amount of mineral matter in fodder plants will vary considerably according to the quality of the soil, the locality, the conditions obtaining during the growing period, and the stage of maturity, *i.e.*, whether the growth is new or mature. Where there is reason to suspect a deficiency of mineral matters, these may be supplemented by the use of suitable stock licks.

This mineral matter (or ash) is of considerable importance to the welfare of stock, and should contain sufficient amounts of lime, potash and phosphoric acid and smaller amounts of other inorganic substances which are *also necessary, such as iron, magnesia, soda, silica and iodine compounds.*

It is from this part of its food that the animal derives the material with which to build its framework of bone, which is largely composed of phosphate and carbonate of lime. All parts of the animal body contain a certain proportion of mineral ingredients, and the amounts of these in the food depend upon the amount of ash. Some of the salts—like common salt—have a definite physiological action, and, though not properly foodstuffs, are essential to a proper digestion of foodstuffs. The amount of this mineral, or saline matter, is not taken into account in estimating the feeding value of a plant, for though small in amount it is usually present in sufficient quantity to supply the requirements of the animal.

Fibre.—The cell walls in plants are cellulose, which is a complex carbohydrate, and exists in several forms or modifications. In fodder analysis "crude fibre" is that portion of the plant which is unattacked after treatment with dilute acid and alkali of a specified strength, and consists of *cellulose and pentosanes*. *The primary function of crude fibre in a fodder is* that of a non-nutrient ballast, or a dilutent. It also exercises a mechanical effect on the digestive tract, and probably excites the function of bowel movement and the secretion of digestive fluids. The nutritional value of crude fibre is low—the digestion by the animal of 57 per cent. crude fibre results in neither gain nor loss: if more is digested there is a proportionate gain. Fodders rich in crude fibre must be used with discretion, since effort and muscular energy spent on mastication and digestion will be large, and in addition, such fodders will be deficient in nutrients. In estimating the nutritional value of a fodder, that of the crude fibre is usually disregarded. Water and fibre, it will be seen, are not direct foods, but give succulence and bulk, and exercise a physiological action.

The ingredients of direct feeding-value are the following:—

Proteins.—These are distinguished from the others by the fact that they are the substances which contain nitrogen. They are composed of carbon, hydrogen, oxygen, nitrogen, and sulphur. The flesh and blood of animals is made up of nitrogenous material, dry blood or meat containing about 16 per cent. nitrogen, as do also substances like hair, wool, horns, hoofs, &c. It will thus be seen that the amount of proteins in the food is a point of the highest importance since these are the main source of nitrogen available to the animal. The proteins are, therefore, often called "flesh formers" or "muscle formers." Their chief function is to produce the nitrogenous material of the body, but their utility is not restricted to this alone, since any surplus or excess may be utilised for the production of heat or for conversion into fat, as in the case of fats and carbohydrates. On the other hand fats and carbohydrates cannot replace proteins.

It must be understood that the term "protein" is a general term, including a large number of those complex bodies which are very similar in the percentage of constituent elements, but differing very markedly in their chemical structure or linkages, and also in the nature and kind of the decomposition products (amino-acids) they produce when digested. Recent investigations show that great importance is attachable to these decomposition products, and that several of these must be supplied before optimum nutrition can be obtained. Two of the most important in connection with growth formation are lysine and tryptophan. All proteins are, therefore, not of equal value from a nutritional point of view.

The foregoing suggests that more satisfactory results will be obtained from using mixtures of various fodders, rather than one fodder only, since the decomposition products of the protein in one class or type may, and possibly will, act as supplementary to possible deficiencies in the decomposition products of other types of protein.

Carbohydrates.—This is the name given to a large class of organic compounds most frequently and largely found in plants, the principal of *which are the starches and sugars. The carbohydrates are composed of* carbon, hydrogen, and oxygen only, without nitrogen, the hydrogen and oxygen being present relatively as in water. Their consumption, therefore, does not add to the nitrogenous substances of the body nor repair the waste. Their function is the production of heat and mechanical energy by their combustion within the body. They are often called "heat-producers," because they maintain the temperature of the animal. The process of *their combustion consists in combining with oxygen, and being split up* into carbonic acid and water, a process identical with that of the burning of fuel. There is evidence that they also partially assist in the production of fat, especially when consumed in excess of immediate requirements. In *recording the analysis of fodders the term "nitrogen free extract"* is now generally used instead of the older term "carbohydrate."

Fats and Oils.—The function of these substances is much the same as that of carbohydrates. They also are composed of carbon, hydrogen, and oxygen, but contain proportionately much less oxygen, and consequently much more carbon and hydrogen, than the carbohydrates. They are on this account a much more concentrated form of fuel, and their combustion *produces a greater amount of heat and energy than does that of starch or* sugar. The fat present in various fodders is not of equal dietetic value or equal in heat production and fat formation in animals. Taking the value of the fat or oil in seeds as 100, that of coarse fodders would approximate eighty.

The part played by each of these ingredients in the nourishment of the animal is, roughly, as follows: —

Mineral matter supplies bone-material and inorganic salts, and has also an influence on general nutrition, and the assimilation of other fodder constituents.

Proteins supply flesh and all nitrogenous material, replace waste of tissue, supply to a lesser degree heat and energy and fat.

Carbohydrates and Fat supply heat and muscular energy; also fat when taken in excess. The heat-producing power of fat is very much greater than that of carbohydrates, being about 2¼ *times that of starch.*

Cellulose, even when assimilated, is of little value as a heat-producer, as it is not split up into carbonic acid and water like starch, sugar, fat, &c.

Nutrient Value of Foods.

In calculating, for the sake of comparison, the nutrient values of different fodders, the percentages of crude protein (albuminoids), nitrogen free extract (carbohydrates) and fat are simply added together, the fat being multiplied by 2¼ to reduce it to its equivalent in starch.

Albuminoid Ratio.—This is a matter of the first importance in the compounding of a properly balanced ration, and is obtained by taking the percentage of nitrogen free extract (carbohydrates), adding to it 2¼ times

the percentage of fat, and dividing the sum by the percentage of crude protein. This ratio of albuminoid or nitrogenous substance to the non-nitrogenous constituents in the food differs considerably in different classes of food.

Thus lucerne hay contains one part of nitrogenous material to about three and a half of non-nitrogenous. This is an example of a relatively nitrogenous food, and the ratio is said to be a "narrow" one. In the case of straw on the other hand there are twelve to thirteen parts of non-nitrogenous material to every one part of nitrogenous material. This is an example of what is known as a "wide" ratio, and represents a food poor in nitrogenous constituents. Foods such as oil cakes, &c., have a still higher nitrogen content (a much narrower albuminoid ratio) than lucerne hay. Thus decorticated cotton cake contains about one part of nitrogenous matter to one and a half non-nitrogenous, or has an albuminoid ratio of one to one and a half.

This albuminoid ratio is of the greatest importance in the choice of rations for different animals, for the ratio which gives the best results varies considerably with different animals, and also with the same animal at different stages of its growth and according to the purpose for which it is fed. Thus, for dairy cattle a more nitrogenous food is required than for cattle fed for fattening purposes, a narrow ratio being found to increase the yield of milk, though feeding appears to have little influence on the nature of the milk.

Horses doing heavy work also require a greater proportion of nitrogenous material than those doing only light work.

Growing animals require, as a rule, a larger proportion of nitrogenous material and a larger total quantity of nutritive material than do mature animals, though they require less bulk in their food.

It is, therefore, evident that the selection of a properly balanced food, a food containing the correct proportions of nitrogenous to non-nitrogenous constituents, is a matter of the first importance, and depends upon the nature and age of the animal and the work which it is to do.

Digestibility.

A question of even greater importance than the selection of a properly balanced food, is the question of its digestibility. The digestibility of a food depends upon three principal factors—(*a*) the nature of the food itself; (*b*) the kind of food with which it is mixed; and (*c*) the nature of the animal. The variability of all these factors, and the difficulty of determining accurately the digestibility of different foods, makes this a rather intricate problem.

An enormous amount of experimental work has been done in Europe and the United States in determining the digestibility of the different constituents in mixed foods fed to different animals. Some idea of the differences shown may be judged from the fact that, for example, when bullocks and sheep are fed on clover-hay, only about half the total amount of nitrogenous matter present is digested by the animals, whereas 80 per cent. is digested from brewer's grains.

Again only about 20 per cent. of the fatty matter in hay is digested by the animals, whereas practically the whole of the fatty matter in brewer's grains is digestible.

Ruminants, again, are able to digest and make use of quite half the crude fibre contained in their food, owing to the more complete preparation the food undergoes in their system, whereas animals such as the horse are only able to digest a very small proportion of crude fibre. Then, again, the degree of maturity of plants affects their digestibility. According to European experiments, when clover hay was fed to oxen before flowering, 71 per cent. of the nitrogenous matter was found to be digestible, when fed in full bloom the amount digested diminished to 65 per cent., and when the blooming was over the percentage of nitrogenous matter digested by oxen was only 59 per cent.

It will be seen from these examples that the important question of the digestibility of foods becomes a very intricate one. The process of digestion varies considerably with different animals, rendering necessary a difference in their food. Briefly, it is as follows:—In all animals the food *during mastication is mixed thoroughly with saliva before being swallowed.* The flow of saliva is fairly considerable in most farm stock; the horse and the ox secrete about 100 lb. in the course of the day.

Besides mixing the food mechanically into a bolus suitable for swallowing, the saliva contains a ferment which changes the starch into sugar, this action continuing in the stomach. Passing into the stomach the food receives the gastric juice, which is poured upon it. The gastric juice is an acid liquid containing hydrochloric acid, rennet, and pepsin, and other soluble ferments. The special function of the pepsin in this acid solution is to convert the proteins into soluble substances easy of digestion.

The stomachs of different animals vary considerably in size and function. Ruminants have four distinct stomachs or compartments, the stomach of the ox holding about 230 to 260 quarts, whilst the single stomach of the pig holds only about 7 to 9 quarts, and that of the horse 17 to 19 quarts.

In ruminants the action of the first three stomachs is preparatory to the fourth, in which digestion occurs. *The single stomach of non-ruminants* corresponds with the fourth stomach of ruminants.

Passing into the small intestines, the food now receives three other fluid secretions, the bile, which is secreted by the liver; the pancreatic juice, secreted by the pancreas or sweetbread; and the so-called intestinal secretion.

The bile is an alkaline fluid, and its principal function is to render the fats and oils soluble, converting them into glycerine and soaps.

The pancreatic juice contains a number of ferments which continue the conversion of starch into sugar, and of fats and proteins into digestible substances. It also contains rennet, the substance which curdles milk.

In the larger intestine, the process of digestion is continued and completed; fermentation takes place, producing a partial digestion of the woody fibre of the food.

Digestion is a very slow process in animals and takes from three to four days at least. In the case of sheep it has been found that digestion was not completed till seven or eight days after the food has been taken.

Bulk and Flavour.

The bulk of the food supplied is also a matter of considerable importance in selecting a ration. All animals require a certain bulk in their ration, and feeding with concentrated foods alone does not give satisfactory results. This is especially the case with ruminants, which require in their food a large proportion of ingredients that are innutritious and that have only a *mechanical* action.

The ingredients which give bulk to the food are water and woody-fibre. Natural herbage, hay, straw, &c., provide these in the proper proportion, but when cake and more concentrated foods are resorted to, it is necessary to avoid the extremes of over-bulkiness or coarseness on the one hand, and of over-concentration on the other. If the food is too bulky the animal is unable to eat enough to provide itself with the proper nourishment; thus, rations containing an excessive amount of fibre are unpalatable, and those containing excessive quantities of water are laxative.

If, on the other hand, the ration given is too concentrated, it does not exert the necessary mechanical action upon the stomach, and the digestive juices do not act properly.

Palatability of the food supplied is another point which has to be considered in devising a ration. An animal fed on the same ration continually loses appetite, and does not derive the full benefit from its food. A highly nutritious ration persisted in without change may be of less economic value than a succession of less nutritious foods properly alternated. Palatability is largely influenced by variety, and by the amount of water, which gives succulence.

Classification of Feeding Stuffs.

It will be convenient to classify the different fodders that are on the market according to the particular ingredient in which they are especially rich, or which gives them their character as a food.

None of them are suitable for feeding without admixture for any length of time, and the feeder's art consists in so combining them as to provide a cheap and palatable food approaching in composition one or other of the rations which experience has shown to be the most suitable for the particular animal and the particular object in view. Feeding-stuffs can be divided into six classes, according to their richness in the different ingredients.

Class I. Foods rich in Protein.—First in order of nitrogen-content come the different oil-cakes, decorticated cotton-seed cake being the richest, with over 40 per cent. crude protein, followed by linseed and coco-nut cake, with about 30 and 20 per cent. respectively. The leguminous seeds come next, peas and beans containing from 20 to 22 per cent. crude protein. Another fairly nitrogenous feed is dried brewers' grains, the dried malt residues after the sugar has been extracted by the brewer; both these and malt sprouts (the dried shootlets of the germinating barley) are used extensively for feeding cattle in other countries.

Dried brewers' grains contain about the same amount of nitrogenous matter as beans and peas. Bran comes next with about 12 per cent., and then the cereals, oats, rice, wheat, barley, maize, with from 10 to 12 per cent. crude protein. The best clover hay contains about the same quantity, hay from the grasses being somewhat lower in nitrogen. Good lucerne hay contains as much as 14 per cent. nitrogenous matter.

Class II. Foods rich in Fat or Oil.—Amongst the fatty foods, some of the oily seeds, such as linseed, sunflower seed, &c., come easily first, linseed itself containing over 34 per cent. of oil. Such seeds in the shape of ground meal may be occasionally fed, but both on account of their cost and their extreme richness in oil need not be considered as ordinary stock foods, except under special circumstances. The crushed cakes of these seeds from which the oil has been pressed are waste-products of the highest economical value as a food. They are extremely rich, as we have already seen, in nitrogenous material, and contain a considerable proportion of oil, varying according to the nature of the original substance and the process by which the

oil has been extracted. Of these, linseed, cotton seed, rape seed, and cocoanut cake are the richest in oil, running from 8 per cent. in the case of rape cake up to 11 or 12 in the case of linseed or coco-nut.

Dried brewers' grains are also fairly rich in oil, containing as much as 8 per cent. Of the cereals, oats and maize are the richest in oils, with 5 to 6 per cent., whilst bran contains about 4 per cent.

Class III, Foods rich in Carbohydrates.—In this class are found the cereal grains, wheat and maize heading the list with over 70 per cent. carbohydrates (principally starch), bran containing about 50 per cent., and the pulses, peas and beans, about the same quantity. Brewers' grains and meadow hay come next with from 40 to 45 per cent., and these are followed by the straws of the different cereals, with an average content of 35 to 37 per cent., and the oil-cakes, which contain from 30 to 35 per cent. carbohydrates.

Class IV, Foods rich in Mineral Matter.—Of the foods rich in mineral matter, *the oil-cakes are all fairly high, with an average of 6 to 8 per cent.*, bran and hay (clover and grass) being a little lower. The cereal straws are also fairly rich in mineral matter, containing between 4 and 5 per cent. *The cereal grains are not particularly rich in salts, except rice, rice-meal* being sometimes exceptionally high, and containing as much as 8 per cent.

Recent work in animal nutrition studies indicates that special importance is attachable to the mineral or inorganic constituents in a fodder—more particularly to the nature and amounts of the constituent elements, rather than to the total "ash." Plants and fodders do not always contain a sufficiency of calcium, phosphoric acid, chlorine, &c.; the amounts vary according to the season, climatological and weather conditions, the condition of growth and the quality of the soil—deficiencies in the latter being reflected in the mineral content of the plant. For optimum results, the presence of a sufficiency of calcium and phosphoric acid appears to be essential.

The foods so far described are those in which one or other of the nutritive ingredients predominate, grouped into classes according to their richness in these essentials. A few of them, such as the oil-cakes, brewers' grains, &c., are rich in more than one such constituent. They are all concentrated foods, the percentage of water present in any of them never rising above 16 per cent., and the amount of fibre, or indigestible matter, never exceeding 10 to 11 per cent., except in the case of the hays and straws.

We have already seen that both succulence and bulk of food are factors of the first importance in the making up of rations; it is, therefore, necessary, in order to complete the list, to add the classes of bulky food characterised by succulence and by the amount of indigestible matter.

Class V, Succulent Foods.—The most watery of the ordinary farm foods is the turnip, which contains over 92 per cent. of water; the swede, mangel, carrot, and similar roots follow next, with cabbage and the green tops of roots and vegetables, their water content ranging from 89 to 85 per cent. Clover (growing) contains about 83 per cent., and pasture grass and potatoes about 75. Green fodder—that is, cereal crops cut for green feed—vary from 70 to 79 per cent. water. Of these foods, several of the roots may be characterised as sugar crops, notably turnip, swede, mangel, and beet, whereas the potato contains 16 per cent. or so of starch.

Class VI, Foods rich in Fibre.—The cereal straws and hay, both of clover and pasture grass, are included in this class; the straws containing from 68 to 75 per cent. indigestible fibre, clover and meadow hay, on the other hand, 25 to 26 per cent.

The Proportions Digested.

All the above figures require to be considered in the light of the different digestibility of the various ingredients. This varies, as we have seen, not only in the different kinds of food, but with different animals. Thus ruminants are able to digest 81 per cent. of the nitrogenous matter in lucerne hay, as against 73 per cent. digested by horses; 72 per cent. of the carbohydrates in lucerne hay and 45 per cent. of the fat are digestible by ruminants, whereas horses digest only 70 per cent. of the carbohydrates and not more than 14 per cent. of the fat. Pigs, again, are able to utilise 84 per cent. of the protein and 98 per cent. of the starch in potatoes, whereas ruminants can only assimilate 45 and 90½ per cent. respectively of these ingredients. Ruminants, again, can always digest a larger proportion of the fibrous material than can horses or pigs. They digest, for example, about one-half of the fibre in wheaten straw, whereas horses only assimilate about 18 per cent.

The digestibility of any one food also varies very considerably, according to the nature of the other feeds with which it is mixed. On account of the great difficulty of accurately carrying out digestion experiments, the science of the economical feeding of farm stock can only be said to be in its infancy.

Dietary Standards.

The composition of the ration will vary according to the animal to which it is fed, its age, and the purpose to which it is put.

We have to distinguish between a maintenance diet—the diet required for the animal when kept at rest or doing very light work—and that required by an animal doing more severe work.

Special rations are required for fattening animals, for dairy cows, for young growing animals, and so forth, and the requirements of animals under these different circumstances vary very considerably.

It will readily be seen that the subject is a very wide one. It is one that will amply repay a little careful study on the part of the farmer. In dairy-farming, more particularly, feeding on rational lines is an essential to the attainment of the best results.

These few notes are not intended to do anything more than to draw attention to the general principles of the subject, and to the different points which have to be considered in devising a suitable ration for different classes of farm stock.

These points may be summed up as follows:—

Kind of animal.
Age.
Purpose of feeding.
Composition of fodders of which the ration is composed.
Proportions of digestible nutriment in the ration.
Cost of the different fodders of which the ration is composed.
Palatability, variety, bulk, &c.

Vitamines.

In devising a ration, whether for men or animals, we have nowadays to take into account an additional factor hitherto unknown and about which little is understood at the present time, namely, the vitamine content. The literature on this subject is voluminous and for the most part so highly

technical and specialised that it is difficult to extract matter than can be reproduced in a form suitable to the general reader. Furthermore, the experimental work has hitherto been carried out principally in substances used as food for human beings, and very little beyond generalisation is possible in the discussion of stock foods. The following few notes may serve to indicate the facts already established and the chief points to be considered.

Interest was first aroused in the subject when a disease known as beri-beri was found to occur amongst people who subsisted on a diet of milled rice. Eijkman reproduced this disease in pigeons by feeding them on milled rice, and Fraser and Stanton were able to show that the disease (poly-neuritis) could be cured by feeding of rice-millings. Funk, in 1911, thought that he had isolated the active ingredient present in the rice-millings, and called it "vitamine." This was a specific for beri-beri, and was called anti-beri-beri or anti-neuritic vitamine.

The term vitamine is perhaps unfortunate and misleading. It was given by Funk, who thought that he had isolated a definite chemical compound having a composition analogous to that possessed by a group of organic substances known as amines, the prefix "vita" being added on account of their supposed importance to life.

The nomenclature of the vitamines is rather confusing, as English and American authorities adopt somewhat different designations. There are at present three principal substances recognised as vitamines (though the number is generally regarded as being increased to five by the subdivision of the functions of two of them), to which the following names have been given:—

1. *Anti-beri-beri, Anti-neuritic, or Water-soluble B.*—This was the first vitamine to be recognised, as has been explained. It is found in all natural food-stuffs, that is, in raw foods. It is comparatively plentiful in seeds of plants, and in eggs, and it is also plentiful in cellular organs, such as liver and brain. In the case of cereals it is contained in the outer skin, which is removed in milling, and yeast and yeast-extracts are particularly rich in it. It is relatively low in flesh.

2. *Anti-rachitic, or Fat-soluble A.*—This vitamine is abundantly present in animal fats, such as cream, butter, beef-fat; in fish-oils, as cod-liver and whale oil; in the yolk of eggs and in green-leaved vegetables, but not in roots.

3. *Anti-scorbutic or Water-soluble C.*—This vitamine is abundant in fresh vegetables, as cabbages; roots such as swedes and turnips; very abundant in lime, lemon, and orange juice. It is found only in small quantities in animal tissues and is very easily destroyed by heating or drying.

These three are the principal recognised vitamines, but the existence of at least two others is suspected, and they must be taken into account. Thus, in the case of the Water-soluble B vitamine which is present abundantly in yeast, it is considered by more recent investigators that the vitamine which is an essential to the proper development of the yeast-cell, differs from the Water-soluble B, and they have proposed to designate it as Water-soluble vitamine D. It is also now considered not unlikely that the Water-soluble B may itself be composed of two vitamines—the anti-neuritic and the growth-producing vitamines. Similarly, the Fat-soluble A may possibly consist of two vitamines, the one having anti-rachitic and the other anti-ophthalmic properties.

The distribution of the three principal vitamines and the relative proportions in which they exist in various substances are given in the following tables:—

* TABLE A.—Showing Relative Proportions of all three Vitamines in Substances.

Vitamines appreciably present in—		*Vitamines practically absent in—*	
Fat-soluble A type (anti-rachitic).			
Cod-liver oil	++++	Yeast	—
Butter-fat...	+++	Vegetable oils	—
Cream	++	Seeds	+ ?
Egg-fat	++	Lard	+ ?
Green leaves	++	Nuts	—
Water-soluble B type (anti-neuritic).			
Yeast	+++	Cod-liver oil	—
Germ of seeds	+++	Vegetable oils	—
Rice millings	+++	Lard	—
Natural grains	++	Butter-fat	—
Nuts	++	Milled products, as rice, flour, &c.	—
Some vegetables ...	++	Cooked foods	+ ?
Orange juice	++		
Skimmed milk	+		
Water-soluble C type (anti-scorbutic).			
Lime and lemon juice ...	+++	Yeast	—
Orange juice	+++	Cod-liver oil	—
Tomato	++	Nuts	—
Some fresh vegetables ...	++	Grain and seeds	—
Sprouted seeds	++	Canned foods	+ ?
Fresh unpasteurised milk	+	Cured meats	—
		Cooked foods	+ ?

* From "Vitamines," by A. D. Emmett.

* TABLE B.—Comparative Anti-scorbutic (Water-soluble C). Value of equivalent weights of Substances.

Fresh Lemon or Orange juice (raw)	100·0
,, Cabbage leaves or juice (raw)	100·0
,, ,, ,, (cooked 100°C. for 20 minutes)	30·0
,, ,, ,, (cooked 70°-80°C. for 70 minutes)...	10·0
,, Swede or turnip (raw)	60.0
,, Tomatoes (raw)	60.0
,, Green beans (raw)	30·0
Potatoes (cooked at 100°C. for 30 minutes)	7·5
Fresh Carrot juice (raw)	7·5
,, Beet-root juice (raw) ... ... Less than	7·5
,, Beet juice (raw)	7·5
Dry beans, peas, &c. (raw)	7·5
Fresh cow's milk (raw) ... ... 1·0 to	1·5
Germinated beans, peas, &c. (raw)	3·0

* Quoted by Emmett, from Chick and Dalyell, Brit. Med. Journal, Vol. 2, 1920.

* TABLE C.—Distribution of the three principal Vitamines among Cereals, Pulses, &c.

	Fat-soluble A.	Water-soluble B.	Anti-scorbutic.
Wheat, maize, rice (whole grain)	+	+	0
Wheat-germ	++	+++	0
Wheat and maize (bran)	0	+++	0
White wheaten flour, pure cornflour, polished rice, custard powder, egg substitutes	0	0	0
Linseed, millet	++	++	0
Dried peas, lentils, &c.	— —	++	0
Pea flour	0	0	0
Soja beans, haricot beans	+	++	0
Germinated pulses and cereals	+	++	++

* From "Milling," 24th December, 1921, by F.W.O.

From these tables it will be seen that the references to specific stock foods are rather scanty. There are, however, a few general observations which may be made use of in devising rations for stock. Heating as a general rule appears to reduce slightly vitamine content. The Water-soluble C vitamine is more stable towards heat than the fat-soluble. Milk, if properly pasteurised does not appear to lose its vitamines, but if not properly pasteurised and cooled quickly is almost devoid of this substance. Storing also tends to lower the vitamine content of foods. For these reasons (combined heating and storing) silage is less rich in these substances than the original material from which it is prepared. Similarly, bleached and burned hay is lower in vitamines than is hay that has been properly cured.

The fertility of the soil would appear to influence the vitamine content of the crops grown on it. Lucerne grown on rich land is generally rich in the vitamine A, but on poor soils both the lucerne and the milk and butter may be affected detrimentally in this respect. It is generally accepted that vitamines are not synthesized by animals which are dependent for them upon plants—that is to say, animal flesh and other products, such as milk or eggs or fats, are rich or poor in these bodies according to the richness or poverty of the animals' food in this respect.

The importance of milk as part of the ration, particularly for young stock and for animals suffering from disease due to diet-deficiency, has been studied by F. E. Place, of Roseworthy College, South Australia. He urges* that it is most profitable to keep young stock thriving, and that milk is an essential for them; that stoppage of growth may be rectified by the addition of milk to the diet, and that the stinting of milk in early life results in increased susceptibility to diet-deficiency diseases later on. Properly pasteurised milk is efficient. White-eye or opacity of the cornea in calves and young sheep is a symptom of vitamine deficiency, and disappears if milk is fed in the case of calves or fresh pasture in the case of sheep. In the case of diseases the dosage of milk may be large. Whole milk is rich in vitamine A, fairly rich in B, and contains C in variable quantities. Skimmed milk has lost some of its vitamine A.

It has already been mentioned that storing and heating are inimical to the vitamine content, and it may generally be said that fresh fodder, such as the grasses and particularly leafy vegetables (see tables on page 798)

* A paper read before the Australasian Association for the Advancement of Science, and published in the *Journal of Agriculture*, South Australia, May, 1921.

are specially rich in the Fat-soluble A type—more so than roots and tubers. Such foods are richest in this vitamine at an early stage of growth, as, for example, lucerne and carrots; bright green lucerne, properly cured, is a superior food, owing to its vitamine content, to light, bleached lucerne.

On germination, seeds have a higher content of both the anti-scorbutic and the anti-neuritic type. The nutritive value of eggs may be increased by feeding sprouted grain to poultry, especially in the winter.

The seasons and the climatic conditions also affect the vitamine content of fodder. In periods of drought the grasses are deficient in vitamines, a deficiency which is reflected in the milk.

If dairy-cattle are fed on stover without any grain, the milk produced will be deficient in these substances.

In the feeding of dairy-cattle the presence of vitamines in the ration is of great importance, much more so than in the case of beef-cattle. Milk, as stated above, is rich in vitamine A, fairly rich in B, and contains C in variable quantities. Meat (muscle), on the other hand, contains only small *quantities of vitamine A, whilst the presence of B and C is somewhat* doubtful. The vitamines present in the foods fed to cattle are stored only to a limited extent in the meat, but abundantly in the milk.*

Of the ordinary stock foods, the valuable oil cakes, coco-nut cake, and cotton-seed cake have been investigated for their vitamine-content. They are fairly rich in B, contain A, but no C. The oils themselves, such as coco-nut oil, linseed oil, and cotton-seed oil, contain none. The only oils and fats containing vitamines in any quantity are such as are not fed to stock, such as cod-liver oil and butter (which are rich in Fat-soluble A) and whale-oil, some animal fats, orange-peel oil, and a few others, in which A is present, though not so abundantly. Similarly, sugar and starch contain no vitamines, so that the high feeding value of rations rich in fats or oils and carbohydrates is due solely to their calorific value. Lucerne is rich in vitamines A and B, fresh lucerne being as rich in this vitamine as butter, and when fed to dairy-cattle increases the proportion of these vitamines in the butter produced.

Of seeds and grain used in stock and poultry feeding, maize (both yellow and white) is fairly rich in B, yellow maize containing in addition vitamine A.

Sprouted grains and malt are rich in C, fairly rich (?) in B, and contain A.

Whole wheat, oats, and rye, like yellow maize, are fairly rich in B, and contain A.

Bran is fairly rich (?) in B, and contains A.

Millet seed is fairly rich in both A and B.

The choice of poultry foods is influenced by the fact that eggs are fairly rich in A, contain B, and (doubtfully) C. Egg-yolk is very rich in Fat-soluble A.

It will be seen that there still remains a large amount of research work to be done in the direction of stock-feeding with reference to the vitamine content of the various foods and their relation to growth. As experiments of this nature are intricate and laborious, necessitating the study of diseases induced in animals under close observation (albino rats, pigeons, chicks, and tadpoles are the victims most favoured), and the cure of these diseased conditions by proper feeding, some considerable time must elapse before the influence of vitamines in stock rations can be established satisfactorily.

* "The Vitamines." H. C. Sherman and S. L. Smith.

FEEDING IN RELATION TO DISEASE.

The correct methods of feeding and the use of suitable feeding materials have a very important bearing on the health of stock.

In this article the principles which should govern the feeding of each class of stock are briefly referred to, but no attempt is made to go deeply into the chemical composition of feed or to adjust too nicely the balance of the different food constituents required. The various diseases which are commonly associated with errors in feeding are the main issue, together with the measures to be adopted to prevent these conditions.

The Value of Foodstuffs.

It may be well to point out that undue reliance must not be placed on chemical analysis only in estimating the value of a food, and that the nutritive values ascribed to various foodstuffs solely on that basis are liable to be very misleading. A most important modification in assessing these values is introduced by the question of digestibility, and in estimating this quality actual experience is of the greatest value, although much good work has been done by direct experimentation.

The difference in the requirements of the various classes of animals introduces a further modification, since the power of digesting many kinds of food varies greatly, as would be expected if the anatomical structure of the animals and the physiological processes of digestion were considered. Thus, rough, coarse material which can be well utilised by cattle will simply pass through horses in an undigested condition; and again, the amount of concentrated food which they can utilise is greater than that assimilable by horses. From the point of view of health, the composition of the food is, in practice, of more importance than its quality; and while improper methods (either avoidable or otherwise) are responsible for very heavy losses yearly, bad food—that is, food affected with rusts, moulds, &c.—or of such very poor quality as to be directly harmful, is only occasionally responsible for ill-health and death. This fact emphasises the responsibility of the stockowner himself. In not a few cases, however, the improper methods are almost unavoidable, either because suitable feeding stuff is not available or financial conditions prevent its purchase.

THE HORSE.

To attain the maximum of efficiency a horse requires food in which the concentrates (grain, &c.) and the roughage (chaff, hay, straw, &c.) are more or less correctly proportioned. For resting horses, or those doing little and slow work, all concentrates may be cut out, but the harder or faster the work to be performed, the greater the proportion of concentrated food required. This principle must not, however, be pushed too far, since on a diet of concentrates alone the horse fails properly to utilise the food given him, and a certain quantity of roughage is essential to digestion and comfort.

If the ration of the army horse, which is called upon to do regular and hard work, is taken as a basis, it will be seen that one of equal parts (roughly) of grain and hay or chaff, varying from 10 to 15 lb. of each for light and heavy horses respectively, the medium coming in between on 12 lb., was found to be the most satisfactory. The undoubted success which

attended the use of this ration inclines us to accept it as a standard. Whenever a reduction has to be made it is always preferable to make it in the chaff or hay. With horses in this country it is often difficult to estimate just what they are getting, owing to the custom of cutting oats and wheat in the unripened state for chaff; some of the best samples of chaff are very nearly equal to a half grain ration, while other samples are hardly above straw value. This must be taken into consideration in estimating the amount of grain to be added to produce a good ration.

Broadly speaking, there is a decided tendency to over-estimate the value of the average chaff ration and to undervalue the use of grain in conjunction with it. Instances have occurred during recent dry periods when it was cheaper to buy oats than chaff, taking into consideration their respective *food values and the quantity required as a maintenance ration.* One of the objections to a ration composed solely of chaff, especially if of inferior quality, is the large quantity required and the consequent amount of labour imposed on the digestive organs of the horse in extracting sufficient nutritive material to supply his wants. A smaller quantity of grain will give more nutritive material at the cost of less energy to the horse and less money in freight and trouble in handling to the owner.

Where horses are partly grass-fed and partly hand-fed, the value of grain as against chaff is very high because the horse is getting his roughage himself. When the grass is on the dry side, sufficient roughage is obtained in this way to supply his needs in that direction. To balance his ration, however, grain is required, and the comparative prices and food values should be considered when deciding which to purchase. Too often advice to improve a ration is interpreted to mean give more chaff, and so the animal is still further overloaded. A ration containing too great a proportion of concentrates will, if maintained for long, lead to impairment of digestion and waste, owing to improper assimilation, while a diet containing too much roughage will not permit of constant heavy work and is liable to lead to impaction.

Methods of Feeding.

Whatever the feed given it should be well divided. The horse does best if fed little and often, but conditions of work reduce the maximum number of feeds practicable to three or four, all of which should preferably contain both grain and chaff. Probably the best system, if it can be managed, consists of three roughly equal feeds of mixed grain and chaff and a feed of hay the last thing at night. But conditions differ so greatly in the town and the country, and the amount the horse gets from the paddocks varies so widely that each case has to be dealt with on its merits. Feeding should be as regular as possible if the best results are desired, and no sudden changes of food should be given if they can be avoided. New foods should be introduced gradually. Watering should precede feeding, and the horse should always have water available even when eating.

When arrangements to such an end are practicable, each horse should be fed separately; the custom of feeding many horses from long troughs is wasteful and leads to the bolting of the feed on the part of greedy animals and the underfeeding of those weaker or of slower-eating habit. Bolting of the food and consequent imperfect mastication prevent the animal deriving the full benefit of its ration, as much is passed through improperly digested—often with serious results. With teams continually on the move, long trough feeding may be unavoidable, but in standing camps and on farms the extra

labour and cost involved in providing partition rails should be more than recouped by feed economy and lessened risk. The use of nose bags is worthy of greater consideration than it receives, for they provide a method of accurate feeding, ensuring extra feed to those animals which require it. The idiosyncrasies of various animals with regard to diet are worth some study, as a ration which will keep in condition an animal with good digestive and assimilative powers, and one which eats slowly, may not be sufficient for other horses. Peculiarities of this nature can only be known and dealt with by the man in charge of the horses.

Salt is usually supplied to horses, and is much relished by them, but it is not taken in quantities large enough to have as much influence on parasitic or other disease as is usually supposed. It probably acts more as an aid to digestion and in rendering the food more appetising, and so improves the general health. Thus, as with everything which improves the general health, it increases the animal's power of resistance to the effects of parasites.

Horse Foodstuffs.

The preceding remarks on the general principles of horse-feeding may be usefully considered in conjunction with the following brief notes on the chief materials used as food in this State.

Oats.—The best of all grains for use in feeding horses, and not sufficiently appreciated in this country—a very safe grain to feed, as the amount of hull on the grain prevents overgorging and massing in the stomach. Especially useful for horses on hard and fast work. The various food constituents are very well balanced in oats.

Maize (corn).—A very valuable horse-feed, but the food constituents are not so well balanced as in oats, and better results are obtained if maize is fed with the addition of some bran, linseed meal, or hay, or chaff made from legumes such as clover or lucerne to supply the deficiencies. Providing the ration is otherwise satisfactory, maize is as good as oats for the average working horse, but not so good as oats for young growing animals.

Wheat.—An unsatisfactory grain to feed to horses on account of the danger of engorgement and its tendency to form a pasty mass. Unlike oats, it should always be fed mixed up in chaff to prevent trouble, and horses which have not been accustomed to wheat should be brought on to it carefully. Its nutritive value is high, but it is not so well balanced as oats.

Barley.—Not much used in this State, but a good horse-feed, especially if lightly crushed and fed with bran and chaff. It can replace oats or maize if the ration is otherwise balanced.

Chaff.—Oaten or wheaten chaff is the bulk food most used in this country, and is likely to remain so. Its value varies very greatly (as before mentioned), but when of good quality it is doubtful if any bulk food is superior to it in food value, handiness, economy and suitability for average working horses. Feeding exclusively on chaff of low quality has its drawbacks.

Bran.—A very excellent food for working horses in moderate quantities. Its value is not solely to be judged by its chemical analysis, which does not do it full justice. It has a mild laxative effect, supplies various salts much needed by growing animals, is very useful for sick animals, and can be utilised to balance rations poor in protein and mineral salts.

Lucerne (hay and chaff).—Not considered a very satisfactory sole bulk food for horses, but very nitrogenous; it will greatly increase the food value of a ration which is poor in such constituents, and will improve a diet which is principally of oaten or wheaten chaff, if added in moderate quantities.

Hay (grass or clover).—Both forms are valuable foods, clover being of most use in conjunction with a diet low in nitrogenous matter. Good grass hay and oats give a nearly perfectly balanced ration.

Linseed Meal.—Both this and other similar meals can be fed to horses in quantities of up to 2lb. daily, and can replace about twice the quantity of bran so far as ordinary food material goes. If too much is fed it is simply wasted, being passed through unassimilated.

Straw.—For horses which are not being worked, straw can be quite usefully employed as feed, especially if made palatable with molasses, which will also increase its food value. A judicious admixture of chaff and chaffed straw may also be utilised for horses doing easy work, and it is in fact widely used. It must be remembered that the mastication and digestion of straw requires a good deal of energy on the part of the animal. Oaten and barley straw are the best.

Molasses.—Of much value in making such feeds as straw, &c., palatable to horses, in increasing the carbohydrates contained in the food, and in acting as a mild laxative.

Many other materials can be utilised as horse-feed, and the adaptability of the horse to different fodders is remarkable, particularly if he is brought on to them gradually and fed on them regularly. Whatever the feed selected, care must be taken that the quality is good. Musty and mouldy food, new grain, dusty hay and chaff, and inferior food of all kinds are liable to lead to trouble.

Diseases Associated with Feeding.

Of the diseases associated with feeding in the horse, the most important is, of course, colic in one or other of its numerous forms; and among others may be noted azoturia, forage poisoning, laminitis and lymphangitis.

Colic.—The commonest causes of this complaint are errors in the quantities of food given and the size of the feeds. Sudden changes of food (particularly that from grass to grain), heavy feeding immediately before hard work, the bolting of quantities of indigestible grain, such as wheat, and the ingestion of large quantities of fibrous matter, such as the running stems of the paddy-melon (*Cucumis myriocarpus*)—all these are liable to cause colic in strong, well-conditioned horses, and there are also other causes likely to operate in animals debilitated through a continuous low ration or temporarily exhausted from excessive strain. The administration of even an ordinary grain food will at times cause trouble in these cases, and the giving of an extra large feed to a tired or exhausted animal may lead to serious results.

In cases of debility the tone of the digestive organs is so low that large quantities of concentrated food cannot be dealt with, and indigestion and colic result. Debilitated animals are also peculiarly prone to flatulent colic if food of a highly succulent and fermentative nature is given. Weak and exhausted animals should, above all others, receive small feeds at comparatively short intervals. They should also be worked with care, as it is in animals in that condition that colic is especially apt to be associated with watering. On the other hand, the danger of giving water to a warm horse has been much overestimated.

In many cases where improper feeding may not lead to attacks of colic it will induce a more or less serious indigestion—at times acute, and at others chronic—which is shown in a failure on the part of the animal properly to digest his food, and a consequent unthriftiness. In such cases the first step should be to investigate the methods and materials used in feeding and to correct any errors noted. This should always be done before resort is made to medicine, which will in many cases be then found unnecessary.

Azoturia.—The ill effects of maintaining a resting horse on the same high ration on which he has recently been working are seen in those cases of azoturia which occur frequently in cities and which seem to be due to the overloading of the resting system with a rich diet, and the sudden disturbance of metabolism involved in the change from work to leisure. An appropriate reduction of the diet and the provision of a laxative food such as a bran mash on the day before a holiday, will to some extent prevent such cases.

Forage Poisoning.—Mortality from this cause is nearly always associated with a supply of mouldy or dirty food, and can be largely prevented by assuring that such material is not used.

Laminitis.—Overgorging with wheat is often followed by this disease, but it is not likely to occur if the wheat is properly fed and the horses are not put on to it too suddenly.

Lymphangitis.—A complaint frequently seen in horses kept on full feed during rest days immediately following days of hard work. Under such circumstances the richness of the diet should be lowered before the rest.

CATTLE.

Owing to the natural conditions under which the majority of cattle are kept in this country, the diseases associated with feeding are intimately connected with seasonal variations, such as the frequent dry periods and the almost equally frequent, though much shorter, periods of heavy rain and floods, with the consequent rapid growth of succulent green herbage and grass. Forms of disease in which food deficiency, in some form or other, and sudden changes from dry to green feed, play an important part, are very prevalent. This is not the case in countries having an equable climate; digestive troubles there are principally found in cattle which are stall-fed, and though the number of cattle so treated in this country is only a very small proportion of the whole, it will tend to increase, and some attention must be given to methods of artificial feeding and the digestive troubles incidental to it.

The great influence of proper feeding on productivity, either of beef or milk, and the methods best calculated to maintain and increase this qualification, do not come within the scope of these articles, but before passing to the diseases connected with paddock-fed cattle, some reference will be made to the principles governing stall feeding. Naturally the methods of feeding an animal with a simple stomach of limited capacity, such as the horse, cannot be applied to cattle which have a compound stomach of large size. While the best results are obtained from frequent small feeds to the horse they are obtained by large feeds at longer intervals with cattle. The proportions of concentrated food to bulky food are also quite different, as cattle can deal with far more bulky material, and can usefully ingest food of a fibrous nature, which would be of very little value to the horse. In other respects, however, the same principles apply when the animals are stall-fed.

Regularity of feeding is of great importance, sudden changes of food should be avoided, musty or mouldy food is dangerous, and some care is required to *balance the ration from the point of view of disease. Certain deficiencies in* many of the natural pastures can well be supplied by some modified form of stall feeding, and disease incidental to such deficiency avoided in that way. Better results will usually be obtained from feeding cattle on a mixed ration than from using one composed entirely of the products of one particular plant.

Foodstuffs Used for Cattle.

The commoner materials used in feeding cattle may be briefly described although diseases of the digestive tract in cattle which are stall-fed are not so intimately connected with any particular food or foods as is the case with horses. The descriptions are merely examples of the different types of food used, and an approximate idea only is given of the best method of utilising them.

Lucerne (hay or chaff).—A most valuable food, which, on account of its high nitrogenous content can be largely utilised in place of more expensive concentrated food, and when mixed with corn or other silage and bran furnishes a very useful ration. A very safe food.

Silage (corn or sorghum).—A very useful bulk food, but care should be taken that no mouldy silage is fed. Owing to its succulence it is of great value to dairy cattle, and being slightly laxative the digestive tract is kept in good condition by its use.

Chaff (oaten and wheaten).—A useful bulk food, but requires more concentrates to balance the ration than does lucerne chaff.

Bran.—One of the best forms of concentrated food for cows, and of great value in maintaining health by its action on the digestive organs, its mineral content, and its power of protecting stock from some disease conditions associated with food deficiency.

Hay (grass and clover).—Although not much utilised in this country, hay furnishes excellent roughage for cattle, and if made from a mixture of grass and clover is especially valuable. It forms an excellent medium for supplying the long rough feed which is so beneficial to all ruminants, and which enables them more perfectly to digest the chaff, bran, and meal which form the larger portion of their food. By improving rumination and digestion *this food aids in preventing colic, tympany, and indigestion.*

Corn and Corn Meal.—Valuable concentrated foods but lack protein; they are best given with lucerne or clover hay.

Oats.—Good concentrated food but does not possess the same high value *for cattle as for horses. If the ration is well balanced it can replace corn.*

Linseed Meal.—A concentrated food rich in protein and mineral salts. Can be used to balance much of the lack of protein in chaff. Slightly laxative.

Pumpkins.—Useful as part of the bulk food but requires the addition of a considerable amount of concentrates to make a balanced ration. The same thing applies to melons, &c., and roots.

Diseases Associated with Feeding in Cattle.

Tympanites—Hoven.—This is due to the formation of gases in the rumen or paunch, and very frequently follows the feeding of cattle on luxuriant and succulent green food. It is more often observed, even in well-fed stock, when they are first turned on to clover, trefoil, lucerne, and other leguminous plants,

but it is more likely to occur if the animals are hungry and are put on to the pasture in the early morning. Even a small amount of dry food given previously will tend to counteract the likelihood of tympanites occurring, and cattle may safely be put on to growing crops after the sun has been on them for a few hours, even though the same crops might have caused trouble before such exposure to the sun. It should also be remembered that cattle become accustomed to a food, and that the first occasion on which they are put on to these crops is likely to be the most dangerous. Consequently, the first day they should be allowed to feed for a few minutes only, and well watched, the time being increased gradually each day. Should rain occur, however, and a fresh, quick shoot result, care will again be required.

The same conditions may result when stock which have been for long on dry food are first given a quantity of green food of any description; this may occur among travelling stock coming empty on to green, succulent food. The reputation of some plants, such as pigweed (*Portulaca oleracea*), as poisonous, has not improbably resulted from mortality from this cause.

As each case must be dealt with according to local circumstances, the only advice possible is that care should be taken when animals come on to succulent food after a long spell on dry innutritious feed, or after a railway journey during which they have been deprived of food and water.

Impaction of the Rumen.—Many cases described under this heading would be more correctly described as atony of the rumen, as the impacted condition not infrequently results from a weakened state of the organ itself. It occurs under two rather different sets of conditions. Cattle which have been for long on a diet of innutritious food of a bulky nature may become so lowered in health, although maintaining fair condition, that what is known as the "tone" of the animal is not up to the standard required for dealing with the food. The digestive tract appears to be one of the first portions of the body to suffer from this lack of tone—the rumen consequently fails to deal properly with the mass of ingesta and it accumulates. Naturally the more the weakened rumen is overloaded the less capable it becomes, and the result is a stoppage of its movements and action. Correction of the diet in the direction of replacing portion of the bulky food with nutritious concentrates, such as grain, meal, and bran, represents the best method of relieving the condition, but it must be done in the early stages. Once a weak rumen is heavily overloaded the provision of good food is of small value, as it will not be properly digested.

Scrub-fed cattle are particularly likely to suffer from a general impaction of the digestive system, including the rumen, partly because of the very low feeding value of any scrub—and this is so no matter how valuable such scrub may be in keeping animals alive through time of drought—and partly on account of the astringent character of many of the plants used in scrub feeding. Scrub alone can only provide sufficient nutriment to keep stock alive, and, as a rule, they steadily lose tone while fed on it. This condition may eventually lead to impaction, which, however, may not show until the stock are put to some strain, such as travelling, when it may very quickly become evident.

Atony of the rumen, leading to impaction, may also occur among well kept cows which are entirely fed on concentrates and chaff without any admixture of hay or long food, and are, at the same time, deprived of grazing. There is no doubt that ruminants, to maintain themselves in a really fit

condition, require a certain amount of rough fibrous material. Lacking the stimulus of this type of food, the digestive organs are apt to become deranged, and impaction results.

Impaction of the Omasum.—Generally, this complaint is found following other diseases, but it often occurs as a result of lowered vitality in cattle on dry, innutritious food, when water is scarce, and, in spring and autumn, when fresh grass is shooting among a lot of dry, dead stuff. In all such cases, the condition of this organ is probably due to chronic indigestion and derangement of the functions of the system from prolonged dry feeding, and from the change on to green food. Where animals are kept in good tone with regular nutritious feeding, and no other disease is present, the condition is not common.

Depraved Appetite.—This is a common occurrence among cattle on coastal areas. The animals devour bones, sticks, stones, dead rabbits, and all kinds of indigestible rubbish. The causes are many and various, the most important, probably, being an insufficiency of certain mineral matters in the soil (dealt with below under the heading *Osteomalacia*), but other cases occur which may generally be ascribed to indigestion from some obscure cause. In all cases the essential line of treatment consists in alteration and enrichment of the food supply, change of paddocks, provision of some artificial feeding, and a supply of salt.

Osteomalacia.—This disease is very generally associated with certain poor types of soils, and is usually shown by the bone-chewing habit of the animal. It can best be combated by supplying food fairly rich in mineral salts, such as bran, lucerne chaff, clover-hay, or other suitable artificial foodstuff. In addition, sterilised bone meal should be added to the food, as much as 2 oz. per day being given at times. Salt is not very often required by such cattle to any great extent, though with all dairy cattle a supply of rock salt is necessary if they show any desire for it.

It will be noted that the great majority of the diseases of cattle which are associated with feeding—a few of which are mentioned above—are really deficiency troubles in some form or other, and this is the main point it is desired to urge in connection with cattle. It is not necessarily bulk weight which is deficient—it may be nutritive constituents. The scrub-fed cattle, which cannot travel without breaking up, the bone-chewing dairy cow of the coast, and the unthrifty pot-bellied youngsters, are all affected in different ways by some variety of the same thing, and these conditions—and the many other diseases which come more or less directly as sequels to these—can all be prevented by attention to feeding. If grazed continuously and never manured, the natural pastures cannot provide the necessary food material in sufficient quantities during the whole year—certainly not in time of drought. A gradual impoverishment of many of the grazing lands is thus taking place, and with that impoverishment will come an increase in disease.

The addition of artificially-grown food to the natural pastures must be made if this is to be prevented, and will be required sooner in some parts of the State than others, according to the natural fertility of the country, and the length of time it has been grazed. Those food constituents which are most likely to be wanting are the proteins and mineral salts, and in supplying the former the very great value of the legumes—lucerne, clover, trefoil, and peas—should always be borne in mind. The mineral salts most

lacking will be lime salts and phosphates. For the former the leguminous plants are again of high value, and for the latter bran and the oilcakes and meals are useful.

It will be remarked that these diseases are really in contrast to the diseases in horses, which are nearly all due to errors in methods of feeding.

Poisoning.—Although often reported, poisoning in cattle is seldom proved, but a few of our native and introduced plants must be held responsible for mortality at times. As instances, sorghum, blue couch, rosewood, and possibly others at times kill by the formation of prussic acid; certain types of Darling pea cause the well known symptom of a pea-stricken animal; burrawang leads to a peculiar nervous condition commonly, but erroneously, called rickets; the cape tulip will at times kill cattle unaccustomed to it, and there are many plants which require further investigation before definite pronouncement can be made as to their toxic properties.

Prevention in all such cases is the obvious course, but this is at times impossible, or nearly so. Only with regard to the prussic acid forming plants can effective measures be taken. If cut and dried they are practically harmless, whereas they are most dangerous in young, quick growth, and when stunted and growing up after once being eaten off.

Indigestion in Calves.—Owing to the artificial manner in which most calves in dairying districts are reared, indigestion and its consequences, general unthriftiness, diarrhoea, and stunted growth are very common; these troubles may be due to any one or combination of the following causes:—Overloading the very young animal's stomach through endeavouring to give sufficient nourishment to cause it to thrive in too few feeds; replacing full milk with skim milk or milk substitutes too early or too suddenly; giving the feed cold or only slightly warmed instead of at the normal temperature of milk fresh from the cow; sudden changes of food, as from skim milk to substitutes, and back again; so feeding a bunch of calves that the little animals gulp it down as quickly as possible to prevent others from getting it; and giving such a small ration that the calves are driven to eating rough forage, and hay, &c., at too early an age.

In order to prevent disease in calves from improper feeding, the following points require attention:—Cleanliness in feeding, which should preferably be from metal receptacles which can be scalded out; separate feeding of the calves to insure that each one gets a fair feed and is not unduly hurried; feeding the milk and other material at blood heat; the gradual substitution of skim milk for whole milk, and the replacing of the nutritive material thus lost by meal obtained from cereals or other concentrated food; regularity in times of feeding and of quantity of material used; gradual change of food when necessary, and gradual weaning. The skim milk which is used should be as fresh as possible, since the longer it is kept the more likely it is to be contaminated and so cause diarrhoea. The skim milk, buttermilk, and whey obtained from creameries and factories is particularly dangerous, since the feeder has no control over the possible contamination of the material; it should be pasteurised before being used.

Tuberculosis.—Contracted by cattle when young by feeding on the milk and milk products of tuberculous cows, and by grazing over badly contaminated paddocks at a later stage. To prevent infection, stockowners should do everything in their power to get rid of tuberculous cattle, and if using the milk or milk products from mixed herds for the purpose of feeding their calves should pasteurise or boil it.

Actinomycosis.—This disease is contracted from the feed, and very little can be done to prevent it except to destroy animals affected, and so prevent reinfection of pastures.

Grass Seed Abscesses.—Due to grass seeds penetrating the soft tissues of the mouth. It is difficult to prevent; but overstocking the pastures on which dangerous grasses such as barley grass grow might effect something.

SHEEP.

The principles affecting the feeding of sheep are studied still less than those affecting the feeding of other animals, but in drought periods their consideration is often a matter of very great importance, demanding attention in relation both to cost and to prevention of mortality.

Sheep grazing in paddocks are subject to the diseased conditions associated with the same method of feeding in cattle—that is, tympanites when brought on to succulent feed suddenly, impaction of various organs of digestion after a long course of dry feeding, acute poisoning from prussic acid developing plants, and slow poisoning from Darling pea, &c. Tympanites or hoven usually occurs in mobs of travelling sheep, sheep just off trucks, and those recently brought from a dry area to more favoured spots. The losses are at times exceedingly heavy, and those measures of prevention which can be utilised with animals on a farm or holding—methods such as only allowing the animals to remain a short time on such succulent grazing or supplying them with some dry food before allowing them on it—are often not practicable. Any such steps as are possible, however, should be taken.

The second common cause of mortality—impaction of various organs—is not so readily recognised or dealt with, since it is apt to be of slow onset and to follow a long period of dry feeding. The tendency is to regard the fact that sheep have lived for some considerable period on scrub or very dry innutritious food as evidence that the food is sufficient for them, but as a matter of fact a continuous lowering in tone is taking place, varying in degree according to the quantity and quality of the food. This lowering in tone may be so slight that no ill-effects are observed, and when good feed comes again the sheep recover their tone; on the other hand, it may be so marked that the digestive system becomes unable to deal with the food, impaction results, and heavy mortality may follow. This is particularly liable to occur in pregnant ewes towards lambing time, and in sheep that are travelled or put to some other strain. In between these manifestations are all gradations of the trouble, and in many cases only small numbers of the weaker sheep die. What the animals suffer from is actually slow starvation. The impaction is certainly increased by the astringent nature of so many scrub fodders. It is impossible to lay down any hard and fast rules as to when and under what particular conditions mortality will occur, but it is obvious that the longer the period of innutritious feeding the more likely it is to have unfavourable results. Experience with the particular fodders used and the conditions existent on each holding must serve as the owner's guide.

It is plain that prevention of such mortality as is under consideration depends on the supply of food which will counterbalance both the lack of nutritive quality and the astringent nature of the scrubs and rough, dry fodders. Although to prevent all ill-effects this must be undertaken throughout the period of dry feeding, it is remarkable how rapidly sheep will recover from very severe loss of tone and impaction—even after deaths have occurred in the flock from these causes—if food is changed. Loss of lambs through deficiency of milk in the ewes (an indirect effect of the trouble discussed) may also be guarded against at the same time by use of the same measures.

The most useful way of considering the question of measures likely to prevent losses will be to take in turn the various feeding materials used in carrying sheep through a dry time and to note their value, and the most satisfactory method of utilising them. In doing so it must be borne in mind that financial considerations and the number of sheep to be dealt with must modify the decision on these points to a degree varying with any particular case.

Oats.—While this is a very good grain food for sheep, it does not appear to equal maize; as a sole food, owing to its larger husk content, it is superior to wheat. It is usually fed either by scattering or in troughs, but (as with all grains) scattering has considerable drawbacks, as a certain quantity is wasted, and in picking it off the ground the sheep are bound to become sanded to a certain extent. In some instances sanding has increased the ill-effects of impaction, if it has not directly caused mortality. It may be said here that no grain alone can be a satisfactory feed for a ruminant animal over long periods, and the fact that sheep have been brought through certain periods of drought on a grain ration does not invalidate this fact. Owing to their comparatively high nitrogen content oats form a useful adjunct to silage, straw, and chaff feeding.

Maize.—This appears to be about the most suitable grain to feed to sheep, and owing to its larger size there is probably less lost in scattering it than is the case with oats and wheat. It does not alone provide such a balanced feed as oats, however. It will give better results if fed with lucerne chaff than with oaten or wheaten, or a small ration of meal may be combined with wheaten chaff to create the balance.

Wheat.—Much used in feeding sheep by both methods. Pretty well equal in value to maize. Best if fed with lucerne chaff. General remarks on oats as feed apply to maize and wheat also.

Bran.—A most valuable feed for breeding ewes. Keeps the digestive tract in good order, and, being fairly rich in nitrogeneous matter, can be used with wheaten or oaten chaff without the addition of grain. A small chaff and bran ration of roughly equal parts, trough-fed, is very useful when sheep are on scrub or dry innutritious fodder.

Chaff (oaten and wheaten).—Has not the same value as lucerne, but is a good bulk food. Really good chaff, as produced in this country, can be fed

alone, and will provide good sustenance without additional food, though it is better to add bran for breeding ewes. Poor chaff is not very much better than straw.

Straw.—Can be very largely utilised in the feeding of sheep; and while barley straw is probably the best, oat and wheat straw can both be made use of. Its palatability is greatly increased and its nutritive value raised if given with molasses. If a lucerne ration is being fed, straw can be used to replace portion of this ration without lowering the value of the ration to a serious extent

Silage.—Silage is always of value. To obtain the best results some portion of the feed should be dry roughage, such as lucerne hay or straw.

Linseed and other Meals.—Supplied in small quantities to sheep being trough-fed on chaff or straw, these can entirely replace bran and grain, as they are rich in nitrogenous material and in mineral salts.

Improved Feeding Methods Necessary.

These notes apply to the feeding of sheep in dry periods with a view to preventing mortality apart from actual starvation—although, as already indicated, nearly all such mortality is really at basis slow starvation. It it not intended here to discuss feeding from the point of view of fattening, but it may advisedly be pointed out that so long as our sheep are exposed to the extremes of feeding which exist in New South Wales, so long must heavy mortality be expected. The maintenance of food supplies on a more even basis would prevent a very great deal of this mortality, and though such ideas are impracticable to a great extent in the case of the large sheep-run, they are not so on many sheep farms. The most obvious methods of ensuring it are the conservation of hay and silage, the subdivision and spelling of paddocks, and the growing of crops for grazing. The future must inevitably see a great increase in the application of such methods of reducing mortality.

As already pointed out, much loss occurs from continued dry feeding, and yet further loss is involved in the sudden change to extremely succulent food. Surprise is often expressed that mortality in sheep is so heavy after the appearance of what is referred to as good food, but as a matter of fact such rapid-growing, succulent food as appears after copious rains following drought possess very little body, and in the already weakened condition of the animal will not sustain life, particularly as at such times the animal requires the production of a good deal of bodily heat. The question then arises of the possibility of supplying some dry roughage in addition to the green food.

Apart from these direct effects of feeding on mortality, it has, it may be reiterated, a somewhat indirect influence in leading to many deaths among ewes prior to lambing. It is not suggested that every such case is dietetic in origin, but it is desired to stress the intimate connection between feeding and many such cases of heavy loss. These deaths are in all probability due to a

complexity of causes, beginning with lack of digestible and nutritive food, leading to a slowly developing atonic condition of the digestive tract, which becomes less and less capable of dealing with what food is available. The strain of advancing pregnancy is added to these difficulties, a tendency to constipation is induced by the fibrous astringent food, and as a result of these multiple causes the weakened animals succumb. If, at the first sign of such mortality, food of the nature of bran, lucerne, linseed meal, &c., can be provided, it may be almost entirely checked.

Poisoning.

At times heavy losses occur in sheep as a result of plant-poisoning. Blue couch and rosewood have been responsible for many deaths as a result of the formation of prussic acid, and variegated thistle has killed many, probably from the same cause. Very little can be done to prevent this, as there is no indication when the plants are likely to be poisonous, but warnings issued with regard to particular patches of country have at times been disregarded, with disastrous results.

The commonest form of chronic poisoning is that due to Darling pea, which can only be dealt with by getting rid of the plant. There are, in addition, many other plants concerning which our information is very vague and unsatisfactory, and concerning which there is urgent need for investigation.

PIGS.

Feeding and disease are not so intimately connected in the pig as in other animals—largely because in the majority of cases the feeding is more controlled, and because, whereas with other stock most of the trouble is due to the nature of the food, with pigs the most serious disease (that is, tuberculosis) is due to infected food. It may safely be said that the great majority of cases of tuberculosis of the pig in this country are due to infection by tubercular milk and milk products, and the only satisfactory method to safeguard the animals is to boil such food before feeding it.

The amount of mineral salts (particularly lime and phosphates) in the food of pigs is of considerable importance, and the disease commonly known as rickets is largely due to deficiency of these ingredients. In cases where the pigs are affected a change of diet is advisable, and food fairly rich in these salts, such as bran, pollard, lucerne-hay, clover-hay, &c., should be tried.

One of the common forms of poisoning in the pig occurs from the administration of brine with the food, either through ignorance or carelessness. Otherwise, poisoning is generally due to the careless handling of rabbit poison.

ANALYSES OF FODDERS.

The following table has been prepared in order to provide a handy reference to the composition of the more common fodders obtainable on the local markets, and of a number of plants that furnish fodder in times of scarcity, especially in pastoral districts.

It must be understood, however, that the inclusion of any plant or substance in this list does not necessarily mean a recommendation for its use as a fodder. The figures given represent as nearly as possible the compositions of the various substances, but it must be remembered that in some cases, particularly in green fodders, hay, grass, straw, &c., the composition is liable to variation, because differences due to the treatment or making are added to differences induced by the soil and the season.

The variations in composition between oat straw from different fields or different varieties is greater than the differences between oat straw and barley or wheat straw, and the same would apply to other products.

The analyses were made in the Chemical Laboratory, Department of Agriculture.

	Water.	Ash.	Albuminoids.	Crude Fibre.	Nitrogen-free extract.	Ether Extract.	Albuminoid Ratio.	Nutritive Value.
Green Fodders.								
Lucerne...	73·5	2·3	6·6	6·2	11·0	0·4	1 : 1·8	18·5
Barley (Cape)	65·4	1·6	3·9	7·4	21·4	0·3	1 : 5·7	26·6
,, (Skinless)	70·9	2·2	4·1	7·8	14·6	0·4	1 : 3·8	19·6
Wheat (Bunyip)	68·1	1·9	4·4	10·3	14·5	0·5	1 : 3·6	20·0
,, (Cleveland)	63·0	2·2	4·8	11·6	17·8	0·6	1 : 4·0	24·0
,, all varieties)	72·0	2·0	2·6	9·5	13·2	0·7	1 : 5·7	17·4
Oats (Algerian)	69·1	1·8	3·9	8·6	16·3	0·3	1 : 4·4	20·9
Sorghum (*Sorghum vulgare*, Pers., var. *saccharatum*)	74·9	1·2	2·2	5·4	15·7	0·6	1 : 7·5	18·7
Black line Kafir corn (*Sorghum vulgare*, Pers.)	75·0	1·2	1·9	6·6	14·8	0·5	1 : 8·4	17·8
Indian cane (*Saccharum officinarum*) ...	60·6	1·0	2·3	6·8	10·1	0·2	1 : 4·8	13·3
Broom millet	75·0	1·6	3·1	9·8	10·2	0·3	1 : 3·5	14·0
Millet, China white	75·0	1·0	2·2	5·8	15·5	0·5	1 : 7·8	18·8
,, ,, yellow	75·0	0·8	3·3	6·9	13·3	0·7	1 : 4·5	15·2
Rice (dry land Paddy)	75·0	2·2	5·1	6·2	11·0	0·5	1 : 2·4	17·2
Rape fodder	79·1	1·9	2·0	4·0	12·3	0·7	1 : 6·9	15·9
Mangold fodder	86·2	0·9	1·9	1·1	9·5	0·4	1 : 5·5	12·3
Cabbage ,, ...	86·3	1·1	1·2	1·8	9·1	0·5	1 : 8·5	11·4
Pea ,, ...	81·8	1·2	3·1	7·9	5·2	0·8	1 : 2·3	10·1
Oat ,, ...	80·1	1·7	2·6	6·7	7·7	1·2	1 : 4·0	13·0
Rye ,, ...	75·0	1·7	2·2	9·1	11·5	0·5	1 : 5·7	14·8
Tares	86·9	1·2	3·2	3·2	5·0	0·5	1 : 1·9	9·3
White lupine	81·9	1·8	3·8	3·6	8·4	0·5	1 : 2·5	13·3
Clover (Crimson, *Trifolium incarnatum*) ...	78·7	2·9	4·6	3·9	9·3	0·6	1 : 2·3	15 3
,, (Ball, *Trifolium* sp.)...	75·0	1·6	4·0	8·1	11·1	0·2	1 : 2·9	15·6
Teosinte (*Euchlæna luxurians*)	75·0	1·2	2·5	6·9	14·0	0·4	1 : 6·0	17·4
Medic (burr) (*Medicago denticulata*) ...	70·0	1·0	2·1	1·5	24·9	0·5	1 : 12·4	28·1
,, (cut-leaved) (*Medicago laciniata*) ...	70·0	1·2	2·7	2·5	22·9	0·7	1 : 9·0	27·2

Analyses of Fodders—*continued.*

	Water.	Ash.	Albuminoids.	Crude Fibre.	Nitrogen free extract.	Ether Extract.	Albuminoid Ratio.	Nutritive Value.
Green Fodders—*continued.*								
Medic (black) (*Medicago lupulina*) ...	70·0	3·1	7·7	4·7	12·7	0·8	1 : 2·0	23·2
Tagosaste (Tree lucerne) (*Cytisus proliferus*)	75·0	2·4	7·4	6·0	9·2	0·4	1 : 1·5	17·0
Guinea grass	70·6	2·5	3·1	10·3	13·5	0·3	1 : 4·5	17·6
Mallow, small flowered (*Malva parviflor i*) ...	70·6	0·6	3·3	1·2	24·1	0·3	1 : 7·6	28·4
Barley grass (*Hordeum murinum*)	70·0	2·6	3·6	10·0	13·5	0·3	1 : 3·9	17·8
Cut grass	70·6	1·4	2·2	13·1	13·0	0·3	1 : 6·2	15·9
Paspalum stoloniferum	74·2	2·6	4·4	7·3	9·4	1·1	1 : 2·7	16·3
,, *virgatum*	70·0	1·7	2·5	11·0	14·3	0·5	1 : 6·2	17·9
,, *dilatatum*	70·6	2·2	2·6	11·1	13·6	0·5	1 : 5·7	17·3
Rhodes grass (*Chloris gayana*)	70·6	2·2	3·0	8·1	16·1	0·6	1 : 5·9	20·5
Italian rye (*Lolium italicum*)...	70·0	2·1	2·7	8·3	16·2	0·7	1 : 6·6	20·5
Sheep's Burnet (*Poterium sanguisorba*) ...	70·9	2·6	3·3	6·8	15·5	1·5	1 : 5·8	22·5
Cocksfoot (*Dactylis glomerata*)	70·0	2·1	2·7	9·3	15·2	0·7	1 : 6·2	19·5
Perennial rye (*Lolium perenne*)	70·0	2·1	2·3	7·6	17·4	0·6	1 : 8·2	21·1
Rib grass (*Plantago varia*)	70·0	2·9	4·0	5·1	17·4	0·6	1 : 4·7	22·8
Texas Blue grass (*Poa arachnifera*)	70·0	2·2	2·9	10·1	14·2	0·6	1 : 5·4	18·5
Fat-hen (*Chenopodium album*)	81·6	3·1	6·5	2·2	5·9	0·7	1 : 1·2	14·0
Broad bean (stalks)	84·3	1·7	4·2	4·3	5·3	0·2	1 : 1·4	10·0
Phalaris bulbosa (*P. commutata*)	70·0	2·6	2·5	8·6	15·4	0·9	1 : 7·0	19·9
Hooker's Fescue grass (*Schedonorus hookerianus*).	70·0	1·9	2·2	9·8	15·5	0·6	1 : 7·1	19·1
Danthonia penicillata	70·0	3·1	2·0	8·6	15·7	0·6	1 : 8·5	19·1
Coolah grass (*Panicum prolutum*)	70·0	2·0	2·4	7·6	17·2	0·7	1 : 7·9	21·3
Festuca bromoides	70·8	7·3	4·1	5·7	10·9	1·2	1 : 3·3	17·7
Cape weed (*Cryptostemma calendulaceum*) ...	91·0	1·8	1·0	1·7	4·1	0·4	1 : 5·0	6·0
Pig face (*Mesembryanthemum æquilaterale*)...	90·2	2·1	1·8	1·3	4·5	0·1	1 : 2·6	6·5
Elephant grass or Napier's fodder grass (*Pennisetum purpureum*).	65·8	2·7	3·0	13·2	14·2	0·5	1 : 4·3	18·0
Dry Fodders.								
Hay, wheaten (typical)	11·0	7·1	9·4	23·1	40·7	2·7	1 : 5·6	62·2
,, ,, ...	10·8	5·5	6·6	22·4	53·0	1·7	1 : 8·6	63·4
,, ,, (Firbank)	10·7	5·1	8·8	29·7	45·0	0·7	1 : 5·3	55·4
,, ,, (Huguenot)	10·3	4·9	5·6	31·5	46·8	0·9	1 : 8·7	54·4
,, ,, (Zealand)	10·8	5·7	7·6	31·7	43·0	1·2	1 : 6·0	53·3
,, ,, (Marshall's No. 3)	14·5	4·8	6·3	26·6	46·8	1·0	1 : 7·8	55·4
,, ,, (Federation)	11·8	5·2	6·3	28·1	47·8	0·8	1 : 7·9	*55·9

Analyses of Fodders—*continued.*

	Water.	Ash.	Albuminoids.	Crude Fibre.	Nitrogen-free extract.	Ether Extract.	Albuminoid Ratio.	Nutritive Value.
Dry Fodders—*continued.*								
Hay, oaten	11·8	6·2	8·4	32·4	39·6	1·6	1 : 5·1	54·6
Chaff, wheaten (average)	13·1	5·8	4·8	31·0	44·0	1·3	1 : 9·8	51·3
,, oaten	12·5	3·1	4·3	33·2	46·9	0·0	1 : 11·2	52·3
,, rye	10·1	4·6	6·6	42·7	33·9	2·1	1 : 5·9	45·2
,, "Cocky"	10·8	6·2	7·2	24·3	49·9	1·6	1 : 7·4	60·7
Straw, wheaten	11·5	5·6	3·8	29·2	49·0	0·9	1 : 13·4	54·8
,, barley	10·1	5·0	4·0	33·1	46·7	1·1	1 : 12·3	55·2
Paspalum hay	10·6	6·4	10·3	28·0	43·4	1·3	1 : 4·5	56·6
Hungarian millet hay	12·9	6·7	10·7	31·4	36·6	1·7	1 : 3·8	51·1
Pith of maize cob	13·6	1·6	4·5	35·3	44·4	0·6	1 : 10·2	50·3
Pigeon-pea hulls	11·8	3·7	8·8	31·7	43·3	0·7	1 : 5·1	53·7
Brewer's combings or malt combings ...	12·3	5·9	23·5	13·6	44·1	0·6	1 : 1·1	69·0
Corn chaff (maize)	15·6	4·2	10·3	17·6	51·3	1·0	1 : 5·2	63·9
Lucerne hay	10·0	8·9	16·0	24·6	37·7	2·8	1 : 2·8	60·0
Lucerne dust	8·6	15·1	19·1	11·2	42·0	4·0	1 : 2·7	70·1
Silage.								
Mixture, composition unknown	60·9	4·7	4·2	13·7	15·5	1·2	1 : 4·3	32·2
,, ,, ,, ...	60·2	1·9	4·8	11·7	20·7	0·7	1 : 4·6	31·1
,, ,, ,, ...	68·3	3·1	6·7	12·8	6·6	2·5	1 : 1·8	18·9
,, ,, ,, ...	55·0	5·1	8·4	8·9	21·2	1·4	1 : 2·9	32·8
,, ,, ,, ...	52·8	3·4	8·4	13·7	20·0	1·7	1 : 2·8	32·2
Self-sown malting barley and other plants...	60·5	5·3	4·1	8·6	19·4	2·1	1 : 10·3	46·5
Wheat and wild oats	35·2	4·8	5·0	15·4	37·7	1·9	1 : 8·4	47·0
Maize stalk and leaf	64·0	2·2	3·1	11·0	19·3	0·4	1 : 6·5	25·3
Dry maize stalks with lucerne and molasses added.	68·4	1·1	5·1	6·6	18·2	0·6	1 : 3·8	24·7
Prickly-pear silage	85·1	2·3	1·8	1·9	8·7	0·2	1 : 5·1	11·0
Roots, Tubers, Bulbs.								
Canna bulbs	77·1	0·9	2·1	0·6	19·1	0·2	1 : 9·3	21·7
Chufa or earth almond	39·2	1·8	4·0	6·8	39·7	8·5	1 : 14·7	62·8
Giant lily bulb	75·1	0·8	4·6	2·0	17·4	0·1	1 : 3·8	22·2
Potato	78·3	1·1	2·1	0·4	18·0	0·1	1 : 8·7	20·3
Romulea rosea leaves (dangerous weed) ...	51·5	2·3	2·7	3·1	39·1	1·3	1 : 15·6	44·7
Taro	62·7	1·2	3·5	0·5	31·5	0·6	1 : 9·4	36·4

Analyses of Fodders—*continued.*

	Water.	Ash.	Albuminoids.	Fibre.	Nitrogen-free extract.	Ether Extract.	Albuminoid Ratio.	Nutritive Value.
Grains and other Seeds.								
Barley	12·3	2·4	11·6	4·1	67·7	1·9	1 : 6·2	83·6
Beans	13·3	2·2	26·5	5·5	51·2	1·3	1 : 2·1	80·6
Bean, Sweard	12·3	2·9	28·9	6·9	46·3	2·7	1 : 1·8	81·3
,, French	13·1	3·4	26·3	3·6	52·0	1·6	1 : 2·1	81·9
,, Lima	12·4	3·7	22·4	3·4	56·8	1·3	1 : 2·7	82·1
Cowpea, Black-eyed	11·9	2·8	21·3	3·2	59·3	1·5	1 : 2·9	84·0
Dhoutra meal	12·3	1·2	10·9	3·9	69·1	2·6	1 : 6·9	85·9
Lentils	*12·0*	*2·1*	*23·1*	*2·7*	*59·5*	*0·6*	*1 : 2·6*	*84·0*
Millet (seed)	12·8	2·0	14·2	3·6	65·4	2·0	1 : 4·9	84·1
Maize, white	12·7	1·4	11·0	1·6	69·8	3·5	1 : 7·1	88·7
,, yellow	12·8	1·3	11·4	1·5	68·4	4·6	1 : 6·9	90·2
,, Northern River, yellow ...	11·4	1·3	10·1	1·5	71·1	4·6	1 : 8·1	91·6
,, black	12·0	1·1	7·7	1·2	73·9	4·1	1 : 10·8	90·8
Oats (Algerian)	10·9	3·3	8·5	11·8	60·6	4·9	1 : 8·4	80·1
Pea, marrowfat	11·9	2·5	23·0	5·5	53·4	1·7	1 : 2·3	82·2
,, blue	12·5	2·1	18·4	4·5	61·3	1·2	1 : 3·5	82·4
,, grey	14·1	2·0	19·3	4·8	58·3	1·5	1 : 3·7	81·0
Wheat (average quality)	13·7	1·5	8·7	2·4	72·8	0·9	1 : 8·6	83·5
Mill Products.								
Bran, wheaten, from hard wheat ...	13·4	6·8	18·6	7·9	50·8	2·5	1 : 3·0	75·0
,, ,, ,, medium wheat ...	15·2	3·9	20·4	6·6	52·1	1·8	1 : 2·7	76·3
,, ,, ,, soft wheat	14·7	4·5	13·4	7·5	58·0	1·9	1 : 4·6	75·7
,, ,, macaroni wheat ...	13·1	4·0	16·9	5·9	56·1	4·0	1 : 3·9	82·0
,, ,, (average quality)	12·5	3·8	16·9	6·8	57·8	2·2	1 : 3·7	79·7
,, oaten	7·7	4·3	14·0	21·8	46·3	5·9	1 : 4·3	73·6
Pollard from hard wheat	11·7	4·3	19·5	3·7	56·7	4·1	1 : 3·4	85·4
,, ,, medium wheat... ...	13·6	2·4	19·4	3·5	58·8	2·3	1 : 3·3	83·4
,, ,, soft wheat	11·3	2·5	13·7	3·6	66·3	2·6	1 : 5·5	85·9
,, ,, macaroni wheat	11·6	3·7	17·4	4·5	56·1	3·7	1 : 3·9	84·8
,, (average quality)	12·3	2·5	17·2	3·0	61·2	3·8	1 : 4·1	87·0
Whole meal (wheaten)	12·1	0·8	14·3	0·8	70·7	1·3	1 : 5·1	87·9
Oat hulls	8·4	4·4	4·3	27·8	53·5	1·6	1 : 11·0	60·4
,, bran	7·7	4·3	14·0	21·8	46·3	5·9	1 : 4·3	73·6
,, pollard	8·1	2·4	15·8	2·1	66·7	4·9	1 : 4·9	93·5
,, screenings	9·2	3·3	9·2	13·7	57·3	7·3	1 : 8·6	82·9
Rice meal or *rice bran*	*10·9*	*8·3*	*14·4*	*5·3*	*45·1*	*16·0*	*1 : 5·6*	*95·5*
Maize meal	13·3	1·7	12·7	1·4	67·4	3·5	1 : 5·9	88·0

Analyses of Fodders—*continued.*

	Water.	Ash.	Albuminoids.	Fibre.	Nitrogen-free extract.	Ether Extract.	Albuminoid Ratio.	Nutritive Value.
Oil Cakes, &c.								
Brow cake	14·5	5·2	42·3	4·0	25·3	8·7	1 : 1·5	87·2
Castor cake	18·8	7·1	25·9	20·6	13·7	12·9	1 : 1·6	69·6
Coconut-oil cake (typ·)	10·0	5·5	20·0	8·5	47·0	9·0	1 : 3·4	87·3
Linseed	11·3	5·1	30·8	8·3	40·7	3·8	1 . 1·6	80·1
Pea cake	16·1	4·6	45·2	4·4	17·2	12·4	1 : 1·0	90·4
Miscellaneous.								
Biscuit sweepings	9·2	1·1	9·4	0·1	60·8	22·4	1 : 17·8	117·6
,, meal	6·6	1·0	8·5	0·1	72·4	11·9	1 : 12·4	107·2
Rabbit meal	10·7	13·6	52·3	0·3	10·2	2·9	1 : 0·3	79·0
Blood .. ..'	12	6·0	78·4	..	1·7	0·3	1 : 0·02	80·8
Green bone	6·2	63·4	18·7	2·0	8·5	1·2	1 : 0·6	29·9
Marshmallow, seeds	9·6	5·2	18·1	34·7	32·8	0·2	1 : 1·8	51·4
,, fresh leaves, &c.	78·4	4·7	6·2	3·1	7·1	0·6	1 : 1·4	14·6
Molasses and megass	26·0	6·6	4·9	5·2	50·8	0·4	1 : 12·3	62·6
Molascuit (molasses and hay)	17·7	5·6	2·9	4·1	66·6	0·1	1 : 29·0	69·7
Dry molasses fodder	18·4	8·8	6·4	0·3	54·7	0·4	1 : 6·6	64·0
Molasses	24·0	10·5	4·6	...	60·9	...	1 : 13·2	65·5
Milk	87·3	0·7	3·5	...	4·6	3·9	1 : 3·8	16·0
Saltbush.								
Atriplex nummularia (cultivated)	75·0	5·9	4·6	3·3	10·6	0·6	1 : 2·6	10·0
,, ,, (uncultivated) ...	75·0	9·4	4·3	2·3	8·6	0·4	1 : 2·2	13·8
,, *halimoides*	75·0	7·7	3·9	3·4	9·5	0·5	1 : 2·7	14·5
,, *angulata*	75·0	12·2	2·3	5·5	3·6	0·8	1 : 1·9	8·2
Rhagodia parabolica	75·0	7·6	4·1	4·7	8·1	0·5	1 : 2·2	13·3
,, *billardieri*	75·0	8·6	5·7	2·8	7·4	0·5	1 : 1·5	14·2
,, *hastata*	75·0	4·2	9·1	2·4	8·3	1·0	1 : 1·2	19·0
Unidentified	75·0	8·4	3·1	3·1	9·9	0·5	1 : 3·6	14·1
Prickly-pear.								
Opuntia ficus-indica	93·8	1·6	0·5	0·0	3·5	0·4	1 : 8·8	4·0
,, *stelior*	89·8	1·9	0·7	1·4	5·8	0·4	1 : 9·6	7·4
,, *brasiliensis*	86·2	2·4	0·9	1·5	8·5	0·5	1 : 10·7	10·5
,, *cochenillifera*	87·9	1·7	0·8	1·0	8·3	0·3	1 : 11·2	9·1
Leaves of Common Scrub Plants.								
Boolgal (*Eucalyptus largiflorens*, F.v.M.) ...	16·1	4·1	0·8	9·1	56·7	7·2	1 : 10·7	7·97
Apple-tree (*Eucalyptus stuartiana*, F.v.M.) ..	34·6	3·3	0·4	9·7	42·8	3·2	1 : 7·7	5·64
Stringybark (*Eucalyptus macrorhyncha*, F.v.M.)	39·5	2·6	5·6	6·4	40·8	5·1	1 : 9·3	57·9

Analyses of Fodders—*continued.*

	Water.	Ash.	Albuminoids.	Fibre.	Nitrogen-free extract.	Ether Extract.	Albuminoid Ratio.	Nutritive Value.
Leaves of Common Scrub Plants—*continued*								
River oak (*Casuarina cunninghamiana*, Miq.)	42·3	3·0	6·8	20·9	25·3	1·7	1 : 4·3	35·9
Cattle gum (*Eucalyptus coriacea*, A. Cunn.)...	36·8	2·9	8·8	8·6	36·9	6·0	1 : 5·7	59·2
Kuttajong (*Sterculia diversifolia*, G. Don) ...	35·6	5·0	10·4	14·5	32·8	1·7	1 : 3·5	47·0
Rosewood or blue or apple bush (*Heterodendron oleæfolium*, Desf.)	23·7	4·0	12·8	16·5	40·2	2·8	1 : 3·6	59·3
Belar (*Casuarina* sp.)	15·6	4·8	9·4	37·0	30·1	3·1	1 : 8·9	46·5
Dogwood (*Myoporum* sp.)	28·6	3·5	9·3	10·9	45·4	2·3	1 : 5·4	59·9
Warriah	11·3	5·1	11·9	35·9	32·0	3·8	1 : 3·4	52·5
Wilga (*Geijera parviflora*, Lindl.)	40·3	5·2	13·3	7·8	22·0	2·4	1 : 2·1	40·7
Whitewood (*Atalaya hemiglauca*, F.v.M.) ...	36·7	6·3	13·1	20·8	21·6	1·5	1 : 1·9	38·1
Cuttawong (*Acacia* sp.)	13·5	2·0	12·9	30·6	38·1	2·0	1 : 3·3	55·5
Bunbutt	23·6	7·7	13·5	16·7	34·5	4·0	1 : 3·2	57·0
Needle bush (*Hakea leucoptera*, R.Br.) ...	12·6	4·8	6·4	39·1	36·4	·7	1 : 5·9	44·4
Beefwood (*Grevillea striata*, R.Br.)	37·1	2·9	5·6	26·6	26·9	·9	1 : 5·2	34·5
Mulga (*Acacia anura*, F.v.M.)	39·1	3·6	9·1	29·9	15·7	2·6	1 : 2·4	30·7
Emu bush (*Eremophila longifolia*, F.v.M.) ...	51·6	3·7	8·9	5·4	29·6	·8	1 : 3·6	41·3
Supple Jack	33·2	6·6	11·0	15·0	33·0	1·2	1 : 3·2	46·7
Leopard-wood (*Flindersia maculosa*, F.v.M.)	41·7	3·4	9·3	11·4	30·3	3·9	1 : 4·2	48·4
Gidgea (*Acacia homalophylla*, Cunn.) ...	41·0	8·7	7·3	22·6	18·3	·1	1 : 3·2	30·2
Sandalwood (*Eremophila* sp.)	41·8	5·6	8·6	8·8	33·5	1·7	1 : 4·3	45·9
Quinine (*Alstonia constricta*, F.v.M.) ...	51·7	3·7	9·0	9·2	24·5	1·9	1 : 3·2	37·8
Broom bush (*Alpophyllum anomalum*, R.Br.)	19·8	13·2	9·9	44·8	10·7	1·6	1 : 1·4	24·2
Currant bush (? *Leptomeria aphylla*, R.Br.)	18·0	5·0	5·6	33·1	33·8	4·5	1 : 7·8	40·5
Wild fuchsia (*Myoporum acuminatum*, R.Br.)	33·3	3·9	9·1	5·1	47·1	1·5	1 : 5·5	59·6
Colone (*Owenia acidula*, F.v.M.)	40·0	6·9	9·2	12·5	21·3	1·1	1 : 2·6	33·0
Myall (*Acacia pendula*, Cunn.)	48·5	4·5	9·6	19·6	16·6	1·2	1 : 2·0	28·9
Bramble or wild orange (*Capparis mitchelli*, Lindl.).	28·0	8·1	13·1	19·0	30·5	1·3	1 : 2·6	46·5
Bastard myall (*Acacia cunninghamii*) ...	26·5	4·3	11·2	25·7	29·5	2·8	1 : 3·2	47·0
Tea-tree (*Leptospermum attenuatum*) ...	10·3	2·7	7·9	12·5	63·0	3·6	1 : 9·0	79·0
Coral-tree (*Erythrina* sp.).	74·8	1·7	3·5	1·9	17·8	·3	1 : 5·3	22·0
Lyonsia eucalyptifolia	31·5	5·8	10·4	16·2	29·0	7·1	1 : 4·3	55·4
"Napunyah" or Yellow Jacket (*Eucalyptus ochrophloia*, F.v.M.).	7·0	·8	7·6	9·7	66·2	8·7	1 : 11·3	93·4
Wattle (*Acacia decurrens*)	10·4	3·3	13·1	20·5	40·2	3·5	1 : 4·4	76·2
Zamia Palm (*Macrozamia spiralis*,) kernel ...	61·8	1·1	...	4·7	12·2	·2	.....	12·7
,, ,, ,, leaves...	26·7	1·0	2·6	6·2	13·3	·2	1 : 5·3	16·3

SECTION XIII.

Weeds on the Farm.

Most of our worst weeds have been introduced, and have become widespread from a few plants, the destruction of which, when first seen, would have saved landowners and the State from enormous losses. A number of weeds, *notably St. John's Wort*, were introduced as garden plants, and found the conditions so congenial that they spread through the pastures and cultivated land and established themselves as serious pests; in other cases weeds have been introduced in fodder or seed. But the important point for landowners to bear in mind is that these weeds have had small beginnings, and this experience indicates that we must be on guard in order to prevent other weeds, which can become quite as serious, from becoming established. Landowners should endeavour to make themselves familiar with all the plants growing on their properties, and to view with suspicion any newcomer, a specimen of which should be forwarded to the Director, Botanic Gardens, Sydney. *The history of most plants is known*, and experience in other countries may serve to indicate whether there is a possibility of the plant becoming a weed under our conditions. The active co-operation of landowners is most important, for the reason that our climatic and soil conditions vary so much and generally are so favourable to the growth of plants that many which are not of much importance as weeds in other countries may cause serious loss in our State. Even, therefore, with the experience of others at our disposal, we must be watchful, and immediately take steps to eradicate completely any plant which shows a tendency to become noxious.

The Harmful Effect of Weeds.

As a pest of farm crops it may be briefly stated that weeds rob the crop of soil moisture and of plant-food, harbour insect pests and diseases, reduce yields, and, when harvested with the crop, detract from its market value.

From a stock-raising aspect, the poisonous properties of certain species, the effect of the seeds of other sorts on the mouths and even the skins and wool of animals, the indigestible nature of the foliage of yet other species, and the reduction of the stock-carrying capacity of the land make their control, and, if possible, their extermination, a necessary part of farm practice.

How Weeds are Distributed.

Many species of weeds seem to be fitted with devices specially designed to enable the distribution and reproduction of the type in the face of much opposition. Some (such as the thistles) have parachute arrangements on the seeds, others hairs, others again wing-like structures, all of which enable the seed to be distributed over a large area by the wind. Some seeds are so small that they are carried by the wind without any of these helps, and yet others have seeds that are rolled along the ground for considerable distances by the wind.

Many weeds become distributed through fodder and unclean seed. In the past it has occasionally been necessary to import fodder from abroad, and undoubtedly many of our weeds have been introduced to the fields through fodder taken on to the farms. It is difficult to prevent weeds being introduced in this way, as even the most careful examination of fodder may fail to disclose the presence of weed seeds, and the first indication a farmer has is the presence of the weeds in his fields. Usually, however, the plants are not numerous at first, and any farmer who has to bring fodder to his farm should keep a careful watch and immediately destroy any strange plants that appear. The use of unclean seed is also likely to lead to the introduction of weeds. In order to minimise the risk, an act was brought into force some years ago with the object of ensuring that seed for sale should be free from noxious weed seeds. This has been of great value, but at the same time there is always a danger of weeds being introduced in this way. As in the case of fodder, farmers who bring seed on to their farms should be on the alert to detect any strange plants which subsequently grow on the land.

Floods, coats and feet of animals, manure, and birds, are some of the many agencies by means of which seeds of weeds are taken from an infested to a clean area.

Weed seeds, too, are remarkable for their hardiness and vitality, being capable of germination under conditions that would not suit more useful species of plants; in many cases they are capable of remaining dormant in the soil for long periods—to germinate when more favourable conditions result from cultural or other action.

PREVENTION AND CONTROL.

Once some species of weeds become firmly established, eradication is practically impossible; effective control of these is only possible before they become established. Where weeds have taken possession and land-owners realise that cutting is impossible, they look with hope to the use of chemicals as a means of destruction; but the question of cost must be considered, and although chemicals have been found to be effective in destroying weeds, on the whole the cost is prohibitive where the weed is *firmly established*.

The old method of destroying plants by hand-hoeing or cultivation still remain as practically the only effective one that can be adopted. Provided the weeds are attacked in time and continuous care is exercised in cutting out new plants as they appear, weeds can be kept in control by this means at a comparatively low cost. Nevertheless, from various causes, weeds may eventually become so firmly established that other methods must be adopted, and the following suggestions are made so that farmers and graziers may adapt them to their needs in accordance with the severity of the infestation and the means at their disposal.

Destruction by Cultivation.

Certain weeds that are crop pests have roots or underground stems of such a nature that the plant reproduces freely from them, and as a consequence these weeds (amongst them are Johnson Grass, Sorrel, Bindweed, &c.) are difficult to control. The most effective means of controlling weeds

of this type is to plough the land deeply about September, and to cultivate it in such a way that the soil moisture is dried out. This can usually be done by cultivating the land very deeply with springtooth or rigid tine cultivators. The object should be to loosen the land as much as possible, and at the same time to bring the roots to the surface. Provided the weather remains dry, this method is fairly effective, and if the weed is not killed entirely it is thinned out to a considerable extent. Obviously, however, the method is only successful when the weather is fairly dry and it does not give good results in districts with a heavy rainfall.

Smothering Crops.

In conjunction with the cultivation method, smothering crops can be used with excellent results. After cultivating the land thoroughly in the way suggested a rapid-growing crop such as wheat or oats should be sown. The cultivation of the land puts it in good condition for the crop and the rapid growth under fairly favourable conditions prevents weed growth and establishes control.

Enforced Germination.

Another method of bringing weeds under control by cultivation is to work the land in such a way that the most favourable conditions are created for the germination of seed, and then to destroy the seedlings. Every farmer knows that when crop seed is being sown the soil must be put into a favourable condition for germination, and if the object is to destroy weeds, similar conditions must prevail. The time and method of cultivating the soil will depend on the habits of the weed. If the weed is one which grows in the spring the soil workings must be made with the object of having the soil in proper condition at that period, while on the other hand, if they are winter-growing weeds the soil must be prepared for favourable germination during the autumn. Generally the practice should be to plough the land at least a month to two before the period at which germination is expected, to allow weathering, and then to work with cultivators and harrows to reduce the soil to a fine tilth. In some cases, especially if the soil is in a loose condition, it may be advisable to use a roller in order to make it firm, as germination always occurs more satisfactorily when the seed is in a firm soil with from 1 inch to 2 inches of loose fine soil on the surface. The young seedlings are then destroyed by the subsequent cultivations given to preserve the mulch and to prepare the seed-bed for the crop.

For weeds such as Saffron thistle, Star thistle, and others of a similar character which infest the wheat-growing areas, this is the most effective method, but to control these and other weeds which affect the wheat crop it is necessary to adopt a system of long fallow and to have the land under cultivated fallow for about twelve months.

Preventing Weeds from Seeding.

Weeds, particularly annuals, frequently infest the land so completely that entire destruction is impossible, except when the land can be placed under cultivation. Much land, however, cannot be cropped owing to its character or to unsuitable rainfall conditions, while often, even if the land is arable, the owner is disinclined to place it under cultivation. Under such circumstances the most practicable method of controlling the weeds is to

prevent the formation of seed. This can be fairly effectively done wherever the land is of such a character that the weeds can be mown by cutting them with either a mowing machine, or, better still, an old binder with the platform cut out. The binder is more suitable than the mower as the knives do not break so easily.

The best time to deal with weeds in this way is just after the seed heads have formed, but before the seed has developed to any extent. If the work is delayed, some of the seed may have become matured sufficiently to germinate, even though it has not filled out completely. On the other hand, if the weeds are cut too soon they will sucker and set a second crop of seed which, owing to the shortness of the plants, will be difficult to cut.

After mowing, the land should be stocked fairly heavily in order that the sheep will eat a considerable amount of the second growth which will occur under any circumstances. It will frequently pay to overstock paddocks to some extent and starve the sheep a little, in order to compel them to eat any second growth that comes. Mowing is of considerable assistance with such weeds as Saffron thistle, Star thistle, Black thistle, and Stinkwort.

Control by Pasture Improvement.

Experience during the past few years has shown that the improvement of the pasture by top-dressing with superphosphate helps considerably in checking weed growth, especially thistles, which have become so troublesome. The application of superphosphate at the rate of about 1 cwt. per acre early in the autumn stimulates the growth of grass and herbage, particularly clover, and this helps to smother out the thistles. In addition the superphosphate seems to make the thistles themselves more palatable and many are eaten out while young by stock. It is evident that top-dressing considerably reduces the infestation with Saffron and Star thistles.

Grazing-off.

The depasturing of sheep on the crop of herbage that is produced on the stubbles is recognised as sound practice on sheep and wheat farms. It not only turns into wool and mutton the young and succulent weed growth, but it prevents the undue reproduction of the weeds and is a useful method of maintaining the humus content of the soil.

Rotation of Crops.

Certain species of weeds are continuously associated with a particular crop, mainly by reason of the fact that the cultural operations in regard to that crop are such as to allow an amount of leniency to the weed. A rotation of crops, besides being good practice from other points of view, can be made to control these weeds if a crop is introduced which, by its cultural requirements, results in conditions unfavourable to the growth of the weed.

Control of Rabbits.

The spread of noxious weeds is undoubtedly due partly to rabbits eating out the best grasses which otherwise would compete with the weeds and help to keep them in check. For this reason, as a means of control of weeds, rabbits should be exterminated in order that the good grasses will be left as competitors with the weeds.

Chemical Exterminators.

Much has been expected from chemical preparations as a means of controlling noxious weeds which cannot be economically dealt with by the ordinary methods. Chemicals, however, have only a limited use. Most attention has been given to them in connection with the destruction of prickly-pear, and for this purpose they have been found very valuable. *Prickly-pear, however, is of a special character which renders it difficult to* deal with by any other method. It is very bulky and contains a considerable amount of moisture, and when cut must either be buried or burned, or each part of it will grow again. Burning and burying are both costly, while the numerous prickles on the pear render it most unpleasant to handle. On the other hand the high percentage of moisture seems to render it peculiarly susceptible to poisoning, and therefore chemicals are largely used to control prickly-pear.

For most other weeds, however, poisons have not been found economical. They will undoubtedly kill many weeds, but the objection to their use is that of cost. Where the weeds are of a perennial nature, with deep roots from which the plants are able to reproduce themselves, one application is never effective and control can only be obtained by repeated applications—and even then some weeds are not completely destroyed. For weeds such as Saffron thistle, Stinkwort, Bathurst burr, Galvanised burr, and others of similar character which grow either as scattered plants or fairly thickly over land of comparatively low value, and which come again readily from seed, poisons are not effective, as the cost of each application is high, and when the operation has been carried out, it only gives temporary relief, as probably the land will again become infested.

Poisons, however, have been found useful with some weeds such as blackberries and Lantana. The great top growth of these makes them costly to deal with by hand-cutting, but the top can be killed by spraying and then burned, and the suckers can be dealt with either by further applications of spray or by hand-cutting.

The poison which has been found most effective is arsenic in some form. Most of the weed-killers on the market have arsenic as their base. Often these are sold at a high price, but landowners can make up the mixture for themselves much more cheaply by purchasing and mixing the essential chemicals. Arsenic—the ordinary white arsenious oxide of commerce—is not soluble in water to any great extent, and soda, either the ordinary washing soda or caustic soda, has to be used to dissolve it, producing sodium arsenite, which is one of the most convenient forms in which to use the poison. When large amounts of the solution are required, washing soda will be the cheaper, but for small quantities of solution, caustic soda will possibly be found the handiest.

A useful formula for quick and effective work is:—Arsenic, 1 lb.; washing soda, 1 lb. or caustic soda, ½ lb.; water, 4 gallons. An empty kerosene tin makes a useful measure for dissolving in, as it holds 4 gallons.

When preparing the solution, whether caustic soda or washing soda is used, first dissolve the soda in a convenient amount of water, using heat, if desirable to hasten the process, then slowly add the arsenic, which has been previously made into a thin paste (as the housewife treats her cornflour), stirring all the time; place on a strong fire, and after it has come to the boil, allow it to remain boiling for at least half an hour; stir from time to time, but be careful to stand on the side away from the fumes, as they are

poisonous and are apt to cause sickness. When the arsenic is thoroughly dissolved, the solution may be made up to the required bulk by adding the remainder of the water, either hot or cold.

The mixture is sprayed over the weeds with either a hand spray or power spray, according to the amount of work to be done.

Salt.

Salt has been found very useful for killing some weeds, but particularly St. John's Wort. Ordinary coarse salt is used and is applied by simply spreading it around the plant to a depth of from 1 to 2 inches. It is, however, a very costly treatment, often costing up to £30 per acre, and is only *justified as a means of destroying plants which, if allowed to remain and* seed, will infest large areas of valuable clean country.

Sodium Chlorate.

During recent years valuable results have been obtained in the United States from the use of sodium chlorate for killing weeds. This is used at the rate of 100 lb. of sodium chlorate to 100 gallons of water. In this State also recent experiments have indicated the possibilities of sodium chlorate for weed control, but as the material costs about 35s. per cwt. and 100 gallons of the solution at least is required to spray an acre, and probably two applications will be required, it is obvious that the treatment is costly, and it can only be recommended where other methods are impracticable.

SOME OF THE WORST WEEDS.

The weeds discussed in the following pages are among the worst that infest this State. They are described and figured in order that farmers and pastoralists may become familiar with those weeds that do not already occur in their district, and may take measures to prevent their spreading should they appear. The particular control methods that may be adopted, details of which are given in the preceding pages, are briefly indicated in each case.

Bathurst Burr (*Xanthium spinosum* Linn.).

The Bathurst burr is a much-branched annual shrub, 1 to 3 feet high, and very spinous. The fruit is nearly egg-shaped and covered with hooked prickles, which readily attach it to the hides and fleeces of animals and the clothes of man. The presence of burr greatly detracts from the value of wool.

Preventive measures should be adopted as far as possible. The seeds can be introduced to land on the wool of sheep and by adhering to the hair of cattle and horses, and any stock carrying weeds should be kept off the farm. If it is necessary to bring "burry" sheep on to the land, they should, if possible, be shorn before being turned out into the paddocks.

Bathurst burrs can be effectively controlled by systematic hand-hoeing of the plants before they seed. Even in badly infested areas they can be prevented from becoming a serious menace by this means, but if they are neglected, the land becomes so infested that hand-cutting is out of the question. Where the land can be cultivated with disc cultivators before the

burrs seed, they can be destroyed, but the cultivation encourages the germination of any seed that is in the ground, and the work must be continued until the burrs are entirely eradicated.

True Star Thistle (*Centaurea calcitrapa* Linn.).

A weak-stemmed, somewhat spreading plant with small pink or purple thistle-like flowers. It forms masses 2 or 3 feet high and more than that in diameter. The prickly leaves and flowers are sufficiently formidable to cause it to be handled very carefully. Its spreading habit protects the main stem, so that it is not easy to get at the root for the purpose of destroying the plant.

Bathurst Burr
(*Xanthium spinosum* Linn.).

A—Fruiting head (burr) covered with prickles.
B & C—Leaf, showing the strong trifid spines.

Star Thistle (*Centaurea calcitrapa*).

A—Radicle leaves and roots.
B—Stem, leaves, and flower-heads.
C—Tubular floret; pappus hairs at base.
D—Tubular floret opened to show stamens.
E—Style.
F—Flower-head in section to show tubular florets within head.
G—Seed. H—Floral-bract.

The methods of control recommended are hand-hoeing of isolated plants, and the cultivation and cropping of the land.

Noogoora Burr (*Xanthium chinense* Mill., syn. *X. occidentale* Bertol).

This plant, which is sometimes called Cockle burr, grows very much like a castor-oil plant when young; it attains a height of 5 or 6 feet, and has spreading branches which cover an area 5 or 6 feet in diameter. Hoven in animals is sometimes attributed to their feeding on young growth of this weed, though it is doubtful if it is actually poisonous as is sometimes suggested.

The methods recommended for the control of Bathurst burr are suitable also for this weed, though pulling up the plants, where it can be done, is preferable to hoeing.

Blue Weed, or Paterson's Curse (*Echium plantagineum* Linn.).

That Paterson's Curse produces some feed is undoubted, but it is a smothering, rough, coarse plant that chokes out all other grass and vegetation. On good soil it reaches a height of 5 feet, and may stool considerably, but where it is very thick, each plant is usually limited to one flower-head and to a height of 1 to 3 feet.

Noogoora, or Cockie Burr
(*Xanthium chinense*).

A—Fruit (burr).
B—Transverse section of fruit.
C—Convex and flat (furrowed) sides of seed.

Blue Weed, or Paterson's Curse
(*Echium plantagineum* Linn.).

A—Inflorescence.
B—Corolla split and opened out.
C—Ovarium with style.

Isolated plants should be hand-cut, and where the weed is very thick it should be destroyed by cultivation, by mowing the weeds before they seed, and by stocking heavily with sheep in the young stages of the plant's growth.

Black or Spear Thistle (*Cirsium lanceolatum* syn. *Carduus lanceolatus* Linn.).

This plant is often known as the Green thistle, and occasionally as the Scotch thistle, from which it differs in some measure. It attains a height of 3 or 4 feet, and is very prickly; the seeds are greyish, striped, smooth and shiny.

Isolated plants should be hand-cut, and where the thistle is very thick the land should be cultivated with disc implements, or the thistles cut before flowering by mowing.

Stinkwort (*Inula graveolens* Desf.).

This is an upright, much branched plant with lemon coloured daisy-like flowers. This plant has a nasty smell, which is noticeable also in the milk of cows, and even in the mutton of sheep depastured on it for some time. The weed is reasonably palatable when it occurs in small quantities, but when plentiful it is not relished by stock.

Black or Spear Thistle
(*Cardnus lanceolatus*).

A—Under side of a leaf.
B—Pappus.
C—Individual bristle of a pappus.
D—Fruit.

Stinkwort (*Inula graveolens*).

A—Portion of plant.
B—Flower-heads in axils of the leaves
C—Floret, with seed and pappus.
D—Tubular-floret, with seed and pappus.
E—Seed, with pappus fully matured.
F—A leaf, showing venation and hispid glandular hairs.

The work of eradication must be commenced in the early stages of infestation to be effective, for where the weed is neglected it gets a firm hold, and is then costly to eradicate. In many parts of the State it has not yet become established, and individual plants should be cut or pulled out before they seed.

Where the land is heavily infested the weeds should be destroyed by cultivating with the disc before seeding, followed by cropping if possible. Improvement of the pasture by top-dressing with superphosphate will also serve as a means of control, by improving the palatability of the weed, and making it more readily eaten by sheep. The hoe should be used, if possible, on any plants that escape the cultivation, or are not eaten by the sheep.

Saffron or False Star Thistle (*Carthamus lanatus* Linn.).

This weed is often called Star thistle, though it must be distinguished from the True Star thistle (see page 826), and it is known by the name of Chinese thistle in other districts. It is a prickly plant that grows in bushy masses and attains a height of 2 or 3 feet. The flowers are yellow and are surrounded by prickly clasping leaves, almost the same shape as those that clasp the stem. The stem is a little furrowed, and usually more or less silvery in appearance. The plant, particularly the upper portion of it, is more or less thinly woolly.

Saffron Thistle (*Carthamus lanatus*).

A—Small plant, showing general habit.
B—Part of flower-head, showing outer spiny bracts and a few tubular florets.
C—An individual tubular floret.
D—Side view of seed with scales.
E—Upper part of seed, showing scales.
F—Seed.

Mexican Poppy (*Argemone mexicana* Linn.).

A—Open capsule.
B—Ovary (sepals, petals and stamens removed).
C—Arrangement of the stamens round the ovary.
D—The pilled seeds.

Where it is not firmly established, Saffron thistle should be hand-cut, and where it is thick, destroyed by cultivation, and, if possible, by cropping. It is necessary to fallow before cropping, and to work the fallows thoroughly to destroy any plants. On grazing land the thistles should be mown just before seeding. Top-dressing with superphosphate, by improving the growth of grass, helps to smother the thistle and make it more palatable to stock.

Mexican Poppy (*Argemone mexicana* Linn.).

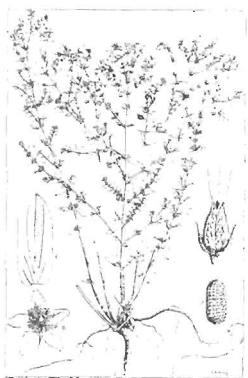
This weed is a rather tall prickly plant with large yellow flowers; it is sometimes known as Prickly Poppy, Blue thistle, White thistle, Yellow Poppy, or Binneguy thistle. Stock do not eat it under any circumstances,

and it is thus a very hard weed to control. It seems to grow all the year round and not to be affected by seasonal conditions; it inhabits all classes of land and is common on waste areas.

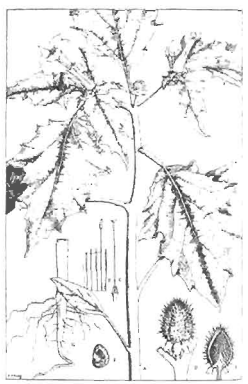
Isolated plants should be destroyed by hand-cutting, and thick patches by disc ploughing. If this is not possible the weeds should be cut with a mower before seed is formed.

St. John's Wort (*Hypericum perforatum* Linn.).

St. John's Wort is an erect plant, 1 to 3 feet high, with large yellow flowers; the under side of the leaves is a paler green than the upper surface. The plant is most easily recognised by the oil-glands in the leaf. These can be seen when it is held against the light, giving the leaf a perforated appearance. The oil-dots pervade the whole plant, and are mixed with fewer dark-purple, opaque dots, especially on the flower, where the dark dots are frequently crowded along the margin of the petals.



St. John's Wort (*Hypericum perforatum*).
A—Plant, showing habit and creeping root-system.
B—A solitary flower, showing 5 petals and numerous stamens.
C—Fruit, showing 3 valves and styles.
D—Seed.
E—A leaf, showing oil-dots.



Thorn Apple, or False Castor Oil (*Datura stramonium*).
A—Portion of plant, showing leaves, bud, expanded flower, and immature fruit.
B—Portion of corolla tube opened out to show the attachment of 5 stamens.
C—Ovary and style.
D—Capsule or fruit.
E—Longitudinal section of capsule to show the numerous seeds.
F—Seed.
G—Lower portion of stem and roots.

This is one of the most troublesome weeds with which we have to contend. It occurs principally on the tablelands, but scattered plants are found in many parts of the State. It is now firmly established in some districts.

principally on the Southern Tableland and in the colder country in the central-west. In some places it has become so firmly established, and is so harmful, that the land has been abandoned. In view of its ill effects landowners throughout the State should make themselves familiar with its appearance and take steps to destroy the plant immediately it appears.

St. John's Wort is distinctly harmful; under favourable conditions it monopolises the land and prevents the growth of nutritious grasses and herbage, and, in addition, the plant contains an active principle which is absorbed by the animal system, rendering the light-coloured parts of the skin peculiarly sensitive to sunlight, with the result that upon exposure the skin is injured. The swelling, bleeding, and excoriation of the surfaces which follow are due to the animal's efforts, by biting, gnawing, and rubbing, to relieve the intolerable itching which supervenes. Apart from this injury to the skin, St. John's Wort appears to exercise an effect on the nervous system, which may cause mental depression, or even the reverse effect—intense excitement approximating to mania.

St. John's Wort is perennial in habit and reproduces itself both from seed and by suckering from the roots, which penetrate deeply into the ground. When the plant is cut or burned it comes again from the roots, and it is, therefore, necessary either to dig the roots out or destroy them by poisoning or salting.

Isolated plants may be dealt with by digging out or by the application of salt, but when the land becomes heavily infested either method is, of course, very costly, though justified for the purpose of destroying the source of infestation and protecting clean land. Some shires have spent considerable sums of money in applying salt, which, when the land is heavily infested, costs up to £30 per acre.

Salt should be applied in the spring, preferably after burning off, and should be deposited on and around the plants.

Arsenite of soda sprayed on to the plants destroys the top growth and a considerable portion of the root growth, but repeated applications are necessary to kill the wort. This is also the case when salt is applied, as some of the old roots throw out fresh growth, and plants also come from seed.

Recent experiments indicate that sodium chlorate may be useful in the control of this and other weeds.

On land which is arable, the wort can be brought under control if careful attention is given to cultivation and suitable crops are grown. Where land is heavily infested the best results will be obtained by burning the St. John's Wort just before the seed is dropped, if conditions favour this course, and then ploughing and cultivating the land frequently from the time the first growth is noticed, through the following summer. This means a considerable amount of work in cultivating, and the loss of the land during the period, but it is necessary if the wort is to be controlled. After this cultivation throughout the summer, wheat or oats should be sown early in the autumn, using about 2 bushels of seed. An early variety should be selected in order that the crop can be taken off before the St. John's Wort seed ripens. If the land has been thoroughly cultivated and is in a proper condition for the germination of the cereal seed, very little wort will be in the crop, and by cutting early there will be no danger of St. John's Wort seed being in the fodder. As an alternative to using the cereal crop for hay it can be made into silage, or it can be fed off to

sheep or dairy cattle. A point of extreme importance is that, if the St. John's Wort seed ripens before the hay crop is cut, the fodder becomes a means of distributing the wort. If there is any likelihood of this happening, the crop should not be cut for hay, though it could safely be made into silage.

One of the reasons why land has become infested with St. John's Wort is that rabbits have eaten out all the natural grasses which helped to check the growth of weeds. The first step in control should be to destroy the rabbits in order that the grasses will be given a chance to grow and to compete with the weeds.

Thorn Apple or False Castor Oil Plant (*Datura stramonium* Linn.).

Throughout the greater part of New South Wales the common name of this weed is Castor Oil Plant, and it is greatly confused with the True Castor Oil Plant (*Ricinus communis*). It is a somewhat succulent, bright green, heavy-smelling herb of 2 or 3 feet high, growing in waste places. The leaves are rather large, irregularly cut or toothed, and paler on the underside. The flowers are large, white, and are usually described as trumpet-shaped. The fruit (the "prickly pod" of farmers) is rather large, much rougher than a nutmeg grater, and sheds a large number of black, kidney-shaped seeds, which have little dots over them.

Thorn apple is now widely distributed over New South Wales; it appears to be poisonous to stock in some cases and the seeds are poisonous to human beings when eaten.

This weed should be controlled by hand-cutting, and by cultivation where the conditions are favourable.

Cockspur or Saucy Jack (*Centaurea melitensis* Linn.).

A so-called thistle with yellow flowers; this weed is also known as Burr, Yellow burr, and Chinese burr; it is frequently confused with other star thistles. The flower-head is surrounded with prickly involucral bracts. The leaves are hoary and even slightly silky, and the edges are wavy; it will be observed that they clasp and run down the stem.

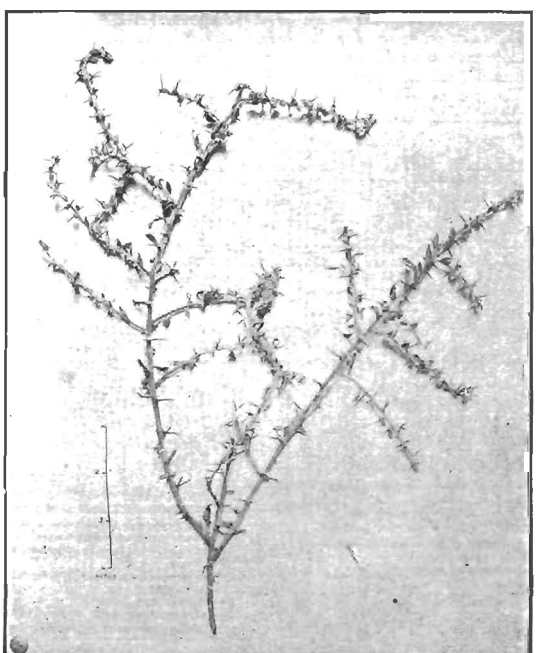
Cockspur inhabits both cultivated and uncultivated land to the detriment of crops and the exclusion of better and more useful plants. It has a bitter taste, and stock will not eat it if other food is available.

This weed should be controlled by cultivation and by mowing before the seed has formed. Burning-off will also destroy large quantities of the seed.

Galvanised Burr (*Bassia Birchii* F.v.M.).

Galvanised burr is a native plant of spreading habit, 2 to 3 feet high, and very intricately branched. The leaves are small and narrow, about ½-inch long, and clothed, as are the stems, in white cottony tomentum. The inconspicuous flowers are very numerous, occuring in practically every leaf axil, and later develop into a hard spiny, burr-like fruit. These fruiting perianths or "burrs" are provided with five fairly stout spines, the longest about ½-inch long, giving the plant a rather formidable appearance. At times the whole of the plant, or portion of it, becomes broken off from the

ground and is carried along by the wind, often forming quite considerable ball-like masses. In this respect it resembles a closely allied species, *Bassia quinquecuspis* ("roley-poley"), the latter species being even more brittle and prone to form balls. It is fairly widely distributed over western New South Wales, and appears to be spreading in such localities as Narromine, Walgett, Gunnedah, and Gilgandra. Owing to its spiny character stock will not touch it, and the burrs adhere to the wool.



Galvanised Burr (*Bassia Birchii*).

In some parts of the State Galvanised burr is now firmly established, and it will be difficult to bring it under control. Landowners should be on the alert to prevent its spread, and young plants, as they appear, should be cut and destroyed by burning.

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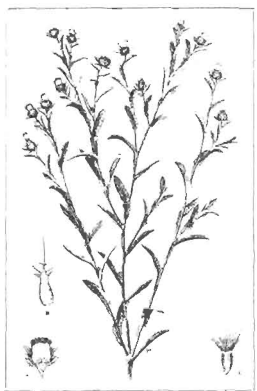
Skeleton Weed (*Chondrilla juncea* Linn.).

This weed, also known by such names as Naked Weed and Gum Succory, is one of the most troublesome weeds found in wheat districts, having such a peculiar habit of growth that it can withstand even frequent cultivation of the fallow and heavy grazing of the stubble and fallow by sheep. The plant commences growth in winter, the leaves spreading out close to the ground. Later it sends up a branching stalk which produces flowers and seeds in late summer. This stalk dies at the end of the autumn, but unfortunately the *root, which penetrates very deeply into the soil, remains alive, and new* shoots are sent up from the parent root stock. The root is known to be biennial, and it is thought that it is even longer lived. The plant is usually found in clumps which steadily increase in area. It is usually found in the



Cockspur or Saucy Jack (*Centaurea melitensis* Linn).

A—Section of flower head, showing young seeds.
B—Involucral bract.
C—Seed.

Skeleton Weed (*Chondrilla juncea*).

A—Basal leaves, showing root-system and lower part of stem with bristles.
B—Portion of plant, showing upper narrow leaves.
C—Two unexpanded and one fully expanded flower-heads.
D—A ligulate floret.
E—Fully developed muricated seed with stalked parachute-like pappus.

medium to light loams of the more favoured portions of the Riverina and South-western Slopes. It appears to prefer the light to medium soil rather than the heavy clay, and to date has rarely been found growing in the latter type of soil. *The plant is eaten by sheep, and for this reason* did not cause any alarm for a few years. It can, however, withstand close grazing in stubble or on fallow without being eradicated.

Even when the land is ploughed to a depth of 4 or 5 inches, new shoots are sent up from the original root. Frequent deep summer cultivations of the fallow, although they destroy and prevent top growth, do not kill the plant, and when the wheat crop is sown, shoots are quickly sent up from the root and grow as quickly, if not quicker than the wheat. The weed exerts a powerful influence on wheat or oats growing in its vicinity, and although the plants are frequently not sufficiently numerous to choke all wheat growth, any wheat plants that do survive are extremely weak and sickly, due apparently to some influence other than the mere physical effect of mild crowding.

Although seeds are produced under field conditions, they are not the chief cause of the spread of Skeleton weed. Seedlings are apparently destroyed by ordinary fallowing methods, but once the roots become well established and penetrate to the lower levels of the soil even long summer fallowing, including frequent summer cultivations, will not destroy the weed.

It is spread chiefly by farm implements—ploughs, disc or springtooth cultivators, and even harrows break the root stocks, drag them along, and transplant them elsewhere in the paddock, and many new clumps are thus commenced. Care must therefore be taken in cultivating the land to see that the weed is not spread by the implements.

The application of coarse salt is one of the most effective means of poisoning Skeleton weed. If the salt is applied at the rate of a liberal double handful to each individual plant, it will kill the top growth and cause the upper portion of the root to rot, and thus destroy the plant. Apparently the best time to apply the salt is in July or August, when the plants are commencing growth.

Expense must necessarily be taken into account when considering means of eradication, but the application of salt is certainly an economical and practical way of eradicating the weed where the infestation is only light.

If these measures are promptly adopted as soon as the weed is found on the farm, they will eradicate it and prevent its spread.

Where Skeleton weed has become well established and widespread in a paddock, however, it is quite out of the question to attempt to eradicate it by means of salt or poison, because of the excessive expense that would be incurred, and because the work must be carried out in a most thorough manner or the results will not be satisfactory. Under these circumstances a crop of wheat or oats should be sown, together with 4 lb. of Wimmera rye grass, 3 lb. of Subterranean clover, and 1½ cwt. of superphosphate to the acre. The cereal should be harvested for grain, and the paddock then left out of cultivation for three or four years, during which time the Wimmera rye grass and Subterranean clover will provide excellent grazing and increase the carrying capacity considerably. Each autumn the paddock should be top-dressed with about 84 lb. of superphosphate to the acre.

If this scheme is adopted a very vigorous pasture will result, which should be heavily grazed. The rye grass and clover, stimulated by the superphosphate, would have the effect of choking the Skeleton weed out under grazing conditions, as the plant seems to need an occasional cultivation to make its most vigorous growth. After being grazed for three or four years it would probably be found that only a few plants had survived, and these could then be treated with salt. The behaviour of the plant certainly indicates that once it has so got out of hand in a paddock that wheat yields are seriously reduced, cultivation should cease if the plant is to be eradicated cheaply.

Devil's Claw (*Martynia proboscidea* Glox).

This weed is also commonly known as Unicorn Plant, Elephant's Trunk and Ram's Horn. It is a soft, pumpkin-like plant with a short, thick stem and branches, the branches usually spreading along the ground for 1 to 3

Devil's Claw (*Martynia proboscidea*).

A—Portion of plant, showing inflorescence.
B—Lower part of plant, showing root-system and unopened fruits.
C—Seed fully matured, showing ridges.
D—Ripe fruit, opened out, with outer cuticle peeled off.

Nut Grass (*Cyperus rotundus*).

1—Spikelet.
2—Transverse section of flower stalk.
3—Transverse section of leaf.
4—Spikelet scale.
5—Seed (not fully ripe).
6—Transverse section of same.

feet or more, according to local conditions. The leaves are large, roundish to heart-shaped, soft and velvety, but cold and clammy to the touch; 3 to 9 inches broad; leaf stalks long. Several flowers occur together on a spike 3 to 6 inches long; they are tubular, or somewhat funnel-shaped, yellowish white, variegated with green, pale purple, and violet spots, and are 1½ to 2 inches long. The ripe seed capsule is lead coloured, 4 to 6 inches long, the hard woody base having a row of short spines or bristles along the

lower side, and with a few light depressions on both sides near the end, the upper portion terminating in two long claw-like spines. Twenty to forty rough, lead-coloured seeds, nearly ¼ inch long, are produced in the capsule. The capsules are so constructed that they do not shed all the seed at once; the seeds in the central chamber are the first to be released, and in the course of time, when the hard substance disintegrates from the side chambers, their contents are set free. The long claw-like spines are specially adapted to catch in almost any object they come in contact with, and being strong and sharp, they work their way into the tender part of the feet of sheep and cattle, and sometimes cause serious lameness.

As a rule, stock do not take to this plant; they appear to have very strong aversion to plants emitting a strong odour, and this one discharges a slimy or clammy substance.

Devil's Claw is killed as easily as a pumpkin vine. Once severed from the root it will not grow again, as its only means of reproduction is from seed. If the area is cut over once or twice during the growing season before the seed capsules develop, the weed can be successfully overcome, especially if the infestation is a new one. On old infested areas it may take two or three years to eradicate it, as the seeds do not all germinate at the same time, some being preserved in old capsules for long periods. It is advisable, therefore, to gather up and burn any old capsules to prevent further infestations, and also to prevent them from coming in contact with stock.

Nut Grass (*Cyperus rotundus* Linn.).

Nut grass is a perennial with a creeping root stock which forms, here and there, small dark-coloured tubers. The stems are slender and triangular towards the top, and the leaves are numerous, glossy-green, narrow, with the mid-vein prominent on the under-side. The spikelets are reddish-brown and arranged in short spikes or clusters on unequal stems. The pest spreads rapidly by means of the scaly, fibrous root stocks, which produce tubers in great abundance, from which shoots are sent to the surface.

Repeated hoeing or frequent use of the cultivator throughout the season, wherever it is possible to use these implements, or digging out with a hand-fork, taking care to lift out the tubers attached to the roots, are the best methods of controlling nut grass. It is also possible to diminish the pest by smothering it with sod-forming grasses, or by the growing of lucerne, clover, or plants, such as New Zealand Spinach, Cowpea, Rice bean, Horse gram, Kudzu, and Velvet beans.

On low lands adjacent to creeks or rivers, badly infested areas may be inundated with water for a few weeks when the plants are in full growth, and it will be found that the plants will perish and the underground tubers

will rot. Tan-bark, fresh stable manure, and similar substances will materially assist in preventing the growth and formation of tubers, but this method can only be adopted for small areas, as it is too expensive for large areas.

Another suggestion for getting rid of Nut grass is to loosen the tubers by ploughing and to turn pigs on to the loosened soil to eat the tubers.

Caltrops (*Tribulus terrestris*).
A—Plant, showing creeping habit.
B—Flower, showing sepals, petals, and stamens.
C—Fruit, showing spiny carpels.
D—Seed.

Caltrops (*Tribulus terrestris* Linn.).

This weed is a native of this State. It is a creeper, running closely along the ground, as much as 8 feet in several directions from the main stem, bearing small yellow flowers about one-third of an inch in diameter, with five petals. It has a hard fruit, divided into five sections, each of which has a hard and sharp spine. It can lame all classes of animals, and is especially severe on horses, wounding the frog of the foot, where it causes intense irritation and suppuration. It dies away in winter, but leaves enormous quantities of seed on the ground, each of the five sections of which will develop into a plant. Where it is thick it should be burnt off when dry enough, as the fire will destroy large numbers of the burrs.

St. Barnaby's Thistle

(*Centaurea solstitialis* Linn.).

An annual plant, with a yellow, prickly thistle-like flower; the whole plant covered with a short whitish cottony covering; the lower leaves dissected, the terminal lobe larger than the lower ones; the upper leaves linear, with wavy edges.

This thistle is somewhat similar in its habits to Saffron thistle (see page 829), and the same methods of control may be adopted.

Onion Weed or Asphodel (*Asphodelus fistulosus* Linn.).

This is a perennial plant, like a spring onion. The base, near the roots, is enveloped in a silvery-white membrane ("onion-skin"). The flowers are whitish, with a faint purplish flush, and down each petal is a pinkish or purplish stripe. The fruit contains the seed in a jelly-like bladder. It spreads by both seeds and offsets.

The methods of control recommended for Nut grass (see page 837) apply to this weed also.

Cape Weed (*Cryptostemma calendulaceum* R.Br.).

This is a spreading herb with a rosette of leaves deeply "cut," and hoary on the underside. The flowers are yellow and daisy-like; the seeds are enveloped in a woolly covering. It belongs to the Daisy family, reputed to be a non-poisonous family, but the seeds are covered with fibre and they are licked up by grazing animals, and may form hair-balls (phyto-bezoars) in their stomachs, which may even cause death.

Cape Weed (*Cryptostemma calendulaceum* R.Br.).

A—Ray floret. B—Disk floret. C—Style and stigma. D—Column of stamens flattened out.
E—Woolly covering of the achene. F—Achene.

Cape weed is principally a weed of cultivated land, and often seriously affects wheat yields. Where efficient fallowing methods are adopted, however, it can be kept under control; the land should be well fallowed and cultivated frequently to destroy the young plants. Heavy quantities of seed and fertiliser should be used; a good stand of wheat or oats will smother the weed, and every effort should therefore be made to get the soil into such a condition that a good germination and vigorous growth of the cereal crop will result.

Slender Thistle (*Carduus pycnocephalus* Linn.).

This weed is an erect herbaceous plant, annual or rarely biennial. The slender stems are from 1 to 3 feet high, and the whole plant is more or less spiny, and hoary white with soft hairs. The flower heads are arranged in clusters with spine-like bracts and purplish florets.

The methods of control recommended for Saffron thistle (see page 829) also apply to the Slender thistle.

Khaki Weed (*Alternanthera echinata* Sm.).

These plants are usually of a creeping habit, rooting at every joint, the branches more or less covered with woolly hairs. The leaves ovate lanceolate to oblong or somewhat rounded, and usually light-green tending to ashy in colour, smooth on the surface, or nearly so. The flowers are arranged in heads usually in the axils of the leaves, the perianth segments and bracts supporting the florets usually being somewhat straw-coloured, and stiff, inclined to be sharp pointed when fully matured.

Khaki Weed (*Alternanthera echinata*, syn. *A. achyranthera* var. *echinata*.)
A—Plant, showing prostrate habit and root-system.
B—Portion of plant with clusters of flowers.
C—Cluster of flowers enlarged to show sharp-pointed scales.
D—A solitary flower.
E—Seed.

Cape Tulip (*Homeria collina*).
A—Upper part of plant, showing the inflorescence and leaf, also bulb.
B—Stamens (2), and style, with 3 laciniated stigmatic lobes.
C—Capsules, showing opening of upper parts to shed their seeds.

This weed often grows prolifically around sheds and yards, and in recreation areas, and as the seed is readily carried by motor-car tyres and other means to grass land, it is important to destroy the weed at these places. It lies close to the ground and often escapes notice. Where it is established thickly it should be sprayed with arsenite of soda to prevent the formation of seed.

Isolated plants should be cut.

Yellow Pea (*Cassia sophera* Linn.).

These plants are of a bushy habit and are 3 to 6 feet high. The leaves are pinnate with four to ten pairs of dark-green, narrow, lance-shaped leaflets. The flowers are bright yellow. The pods are somewhat cylindrical, 2 to 4 inches long by ¼ inch in diameter, and contain numerous seeds of an

olive green colour. Yellow pea is a native of the northern parts of this State and Queensland. On account of the prolific crop of seeds produced by this plant it has spread at an alarming rate.

The best methods of controlling this pea are to hoe out scattered plants, and to mow areas where the plant is thickly established in order to prevent seed formation. Where arable land is thickly infested the land should be cultivated and sown with suitable crops such as cereals or lucerne.

Bindweed (*Convolvulus arvensis* Linn.).

A perennial plant of a twining habit, the roots penetrating deeply into the soil. The leaves are alternate and heart-shaped, but tending to become arrow-shaped on the upper part of the vine. The flowers are white, or rarely pink, and about 1 inch in diameter.

This weed is most troublesome in cultivated land where the rainfall is fairly heavy. It causes a considerable amount of loss on some of the coastal areas and in parts of the tablelands. It is capable of reproducing itself from roots as well as from the seed, and consequently is difficult to eradicate. Where the land is suitable for lucerne it can be controlled by laying the land down to this crop for a period of years. The continual mowing of lucerne eventually kills out the Bindweed.

If it is not desirable to sow the land with lucerne, it is recommended that land be deeply ploughed about September and frequently cultivated deeply with a tined cultivator, in order to dry the land as much as possible and to bring the roots to the surface. If dry weather is experienced, much of the weed will be destroyed in this way.

In the United States Bindweed causes considerable losses and has been found difficult to control, but recent experiments indicate that spraying with sodium chlorate, 4 per cent. solution, is fairly effective.

Furze or Gorse (*Ulex europaeus* Linn.).

A densely thorny shrub, usually from 3 to 5 feet high. It is branched and somewhat spreading and furnished with furrowed, rigid, irregular spines. The flowers are bright yellow, arranged in racemes and somewhat odorous. The pods are ¾ inch long, black, and covered with brownish coloured hairs.

This plant is becoming firmly established on parts of the Southern Tableland, and if neglected is likely to become a serious pest on grazing lands. All isolated plants should be dug out. For thickly established areas it is suggested that the top growth be killed by spraying with arsenite of soda, burned, and the young growth either sprayed again with the arsenite or destroyed by hand-cutting.

Cape Tulip (*Homeria collina* Vent.).

A bulbous plant with stiff, somewhat angular stems, and solitary grass-like leaves, usually much larger than the stem, and prominently ribbed. The flowers have six perianth segments (petals and sepals) and are blunt. They are orange-red or pink in colour, with a greenish yellow base. A yellow-flowered form is also found in some districts.

This is a very dangerous weed principally because of the losses it causes amongst stock by poisoning. Drastic measures should therefore be taken to eradicate it, and whenever plants appear they should be hoed out and the bulbs destroyed by burning. In some places it has a strong hold and

eradication would be expensive; in these cases it is advisable to spray with an arsenite preparation. The spraying should be done just prior to flowering. One application will not be sufficient, but the plants will be destroyed by frequent applications. Care should be exercised to keep stock off the sprayed area for some time, otherwise there is a risk of poisoning.

Horehound (*Marrubium vulgare* Linn.).

A herbaceous plant 1 to 2 feet high, with a short stout root-stock, the whole plant being more or less covered with woolly hairs. The leaves broadly egg-shaped. The flowers are white with saw-like edges.

This plant is usually found in the neighbourhood of buildings, and especially round disused cow yards. Except in such places, it is not very troublesome, but in some districts it appears to be spreading in the paddocks. When it becomes thickly established, the more nutritious grasses are prevented from growing. Where the land can be cultivated, it should be ploughed and cropped; this will effectively destroy Horehound. In other cases the weed should be hoed out.

Blackberry or Bramble (*Rubus fruticosus* Linn.).

Blackberry is a scrambling plant with a perennial root stock, and long erect or recurved stems armed with prickles. The leaves are divided into three to five leaflets, saw-toothed, dark green on the upper surface, and paler or greyish underneath. The flowers are white or pink in terminal racemes. The fruits have numerous drupes of a black or reddish purple colour. The young branches or stems are more or less covered with bristles and gland-tipped hairs, especially the flowerless shoots, which are sub-erect or arched and root very freely at the tip, thus giving rise to innumerable individuals.

When blackberry is well established, it is difficult to bring under control owing to the fact that the roots sucker freely. If, however, precautionary measures are adopted and blackberries are destroyed as soon as they appear, no very great difficulty is experienced in keeping them under control. Owing to the thorny nature of the plant, the work of "brushing" it is very unpleasant. This can be overcome by spraying the plants with sodium arsenite and burning when they become dry. Further applications of the spray can then be given to destroy the young plants, or these can be hoed out. The most suitable time for treatment is just when the plants are fruiting as suckering does not occur so freely as at other periods of the year. Where the land is suitable for sheep, young plants can be kept down by keeping a few crossbred wethers or by running goats in the paddock. Kikuyu grass sown after burning helps to smother the suckers.

Paddy's Lucerne (*Sida rhombifolia* syn. *S. retusa* Linn.).

Paddy's Lucerne is of a slender or twiggy habit and varies from 2 to 4 feet in height. The leaves are simple, with saw-like edges, rather pale on the underside and from ½ to ¾ inch long or rarely exceeding 1 inch. The flowers are pale lemon-yellow in colour, ¾ inch to ½ inch in diameter, and on a very slender thread-like stalk. A large quantity of seed is produced by an individual plant.

When the land can be cultivated, it should be deeply ploughed with a disc, and sown with a crop that will smother the plants. Suitable crops are wheat and oats, while the real lucerne is also suitable for the frequent cutting destroys the Paddy's Lucerne. In other cases, the Paddy's Lucerne should be hoed out, or if it is thickly established, it may be sprayed with sodium arsenite.

Wild Mignonette (*Reseda luteola* Linn.).

An erect annual or biennial, with a hard, stiff, scarcely branched stem 1 to 2 feet high. The leaves are fairly narrow, 2 to 3 inches long, entire, *but slightly waved on the edges. The flowers are yellowish-green in long* stiff spikes. The capsules are nearly globular, with three or sometimes four teeth, and twice as many external furrows. The seeds are black.

This weed is not widely distributed, but a watch should be kept for it, and any plants that appear destroyed by hand-cutting.

Paddy's Lucerne (*Sida rhombifolia*).

A—Section of a flower.
B—Early fruit.
C—Calyx (5-angled and 10-ribbed).
D—Carpels ("seeds"), with two awns.

Wild Mignonette (*Reseda luteola*).

A—Upper portion of plant, showing flowering system; also the root-system.
B—A solitary flower.
C—Ovary and stamens.
D—Petals (usually 5, all 3-cleft or laciniate).
E—A single petal, showing laciniation.
F—Capsule, fully matured, with seeds.
G—A solitary seed.

Lantana (*Lantana camara* Linn.).

The Lantana is a shrub ranging from 4 to 7 feet in height, with a wide spreading or scrambling habit. The leaves are ovate or oblong, with saw-like edges, and the upper surface is covered with stiff hairs. The leaves and branches are very aromatic when bruised. The flowers are arranged

in flattish heads with numerous florets which are of a yellowish tint, and change to red when fully developed. The drupe-like fruits are shiny and black in colour. Lantana is common in parts of the State, especially in the northern river districts.

Lantana presents the same difficulty as Blackberry. The most practicable means of controlling it is to pull the old plants out by means of horses with a wire cable. When the plants die, they should be burned and the *land sown with grass. The most suitable grass for this purpose is Kikuyu,* as its strong growth helps to prevent the Lantana from growing and, as the grass runs freely, it climbs over any plants that grow and smothers them.

Sweet Briar (*Rosa rubiginosa* Linn.).

This plant is of a bushy habit with branches covered with hooked spines and glandular hairs or bristles. The leaves are pinnate, and the leaflets are *densely glandular and give out the strong aromatic sweet briar odour. The* flowers have five white or pink petals and numerous yellowish stamens. The fruits are globose or oblong and of a reddish colour when ripe. The weed is now established in many of the cooler parts of this State.

This plant is not so difficult to control as Lantana or Blackberry, as it has not the same spreading habit. It should be pulled out with horses when the ground is wet, and young plants destroyed by hoeing them out as they appear.

Boxthorn (*Lycium ferocissimum* Miers.).

A rather low shrub with somewhat drooping spiny branches. The leaves are more or less clustered, rather thick, and vary much in size. The flowers are solitary or occasionally in pairs, pale violet in colour, funnel-*shaped and nearly twice the length of the 2-lipped calyx. The fruits are* orange-red in colour when fully matured.

This plant has spread in some districts to some extent, and it should therefore be watched, otherwise it may become thickly established. It can be destroyed by pulling out with horses when the land is in a suitable condition.

Hexham Scent (*Melilotus indica* All.).

This plant is an annual; it is usually 2 to 3 feet high and much branched. The leaves are pinnately tri-foliate, the venation ending in teeth-like projections along the margins of the leaflets. The flowers are pale lemon-yellow in colour, and are arranged in axillary racemes, more or less of a drooping habit. The pods are small, dark-brown or nearly black when ripe, and *contain one or two seeds.*

This plant is not a very serious weed, except when growing thickly in pastures used for dairying, or amongst the wheat crop. It imparts an objectionable odour to dairy produce when cows are grazed on it, and to wheat harvested from paddocks in which it is growing. Where difficulties are being experienced because of the taint, the cows should be taken off the pasture for a few hours before milking. When wheat paddocks are infested following should be practised and care should be exercised to see that only pure seed-wheat is used.

Creeping Thistle (*Cnicus arrensis* Hoffm.).

This is an erect, perennial thistle with a jointed, horizontal root-stock, which creeps for long distances beneath the surface of the ground, sending up new plants at short intervals. The stems are 1 to 4 feet tall, slender, grooved, and woody. The leaves are 3 to 6 inches long, clasp the stem slightly at their base, deeply cut, and toothed with hard, white needle-like spines. The flower heads are rose-purple and in clusters, the topmost opening first.

Creeping Thistle, or so-called Canada Thistle (*Cnicus arrensis*).

A—Upper part of plant, showing flowering system.
B—A flower-head, opened out to show numerous tubular florets.
C—A tubular floret, opened out to show stamens.
D—A solitary stamen.
E—Style.
F—A solitary flower.
G—Pappus (plumose).
H—Seed.
I—Root-system.

Buffalo Burr (*Solanum rostratum*).

A—Plant, showing natural habit.
B—Flower-bud, showing spiny calyx-lobes.
C—Portion of flower opened out to show 5 stamens.
D—Calyx-tube and style.
E—Portion of leaf to show stellate hairs.
F—Cluster of seeds.
G—Solitary seed.

This pest spreads both from seeds and from the root-stock, broken pieces of which will develop into new plants, and may become a most dangerous weed. Plants should be destroyed immediately they appear by digging out every part of the root and burning. If established it should be destroyed by ploughing and frequent cultivation. Roots and plants should be gathered and burnt.

Buffalo Burr (*Solanum rostratum* Dunc.).

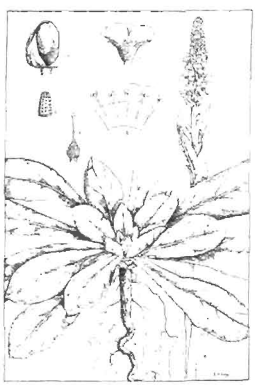
A much-branched annual plant of 1 to 2 feet in height, covered with yellowish, star-shaped hairs, and densely set with slender needle-like yellow spines. The leaves are deeply cut (the segments being irregular in size),

covered with star-like hairs and with the mid-ribs and stalks prickly. The flowers are yellow, about ¾-inch to 1-inch across; the calyx is densely prickly, becoming a burr that encloses the fruit.

The control measures recommended for Star thistle (page 826) should be used for this weed.

Mullein or Shepherd's Blanket (*Verbascum thapsus* Linn.)

A stout, erect densely-white, woolly, biennial plant. The stem is unbranched, or with one or two branches at the top. The lower leaves are tufted, spreading on the ground in a large thick rosette; they are oblong,



Mullein or Shepherd's Blanket
(*Verbascum thapsus*).

A—Basal leaves and root system.
B—Upper portion of flowering stem.
C—Solitary flower showing sepals, petals, and stigma.
D—A flower opened out to show the stamen.
E—Ovary and style.
F—Mature capsule.
G—Seed (pitted).

Yellow Forget-me-not, or Burr Weed
(*Amsinckia hispida*).

A—Plant, showing natural habit.
B—A flower, showing 5 hispid sepals and 5 corolla-lobes.
C—Torus and style, with one carpel attached.
D—Capsule, with 4 carpels.
E—A leaf, showing tubercle-based bristle-like hairs.

light green, densely woolly, tapering to the base, 4 to 12 inches long. The flowers are yellow and on long, densely-flowered cylindrical spikes. The capsule is globular, two-celled, downy, and filled with many brown seeds.

Isolated plants should be cut, or the weed kept under control by cultivation.

Yellow Forget-me-not (*Amsinckia hispida* R. & P.).

A rough, hairy, annual with erect stems branching near the top. The leaves are rather thick, lance-shaped to linear, and thickly covered with fine, bristly hairs. The flowers are very small, yellow, and occur in curved spikes which become long and loose in fruit; corolla five-lobed, the tube enclosed in a bristly calyx with very narrow-pointed lobes. The fruits consist of four nutlets, which are roughly wrinkled on the outer face. The stiff bristles on the calyx of the fruit enable it to cling to clothing and the coats of animals, thus becoming widely distributed.

Destroy isolated plants, and control by cultivation where the plants are growing thickly.

Clary or Wild Sage (*Salvia verbenaca* Linn.).

A herbaceous plant with a woody root-stock and leafy stem, 1 to 2 feet in height. The leaves are 2 to 4 inches long and wrinkled, the basal leaves having a long leaf stalk and the upper leaves none, all having more or less saw-like edges. The flowers are of a bluish or purplish colour. A prolific seed-bearer, this weed has spread very rapidly in the cooler parts of the State.

This weed has not yet got a strong foothold, but it may become troublesome, particularly along roads. Plants should be destroyed by hoeing whenever they appear.

SECTION XIV.

The Handy Man on the Farm.

HARNESS, HARNESS FITTING, AND REPAIRING.

MUCH depends upon the tractive power of the horse, and its effective utilisation necessitates the adoption of harness which will not in any degree tend to depreciate the value of his strength. The price of all horses, whether used for light or heavy draught, is generally high, and, even apart from considerations of comfort, it does not pay owners to have their horses laid by through injuries contracted in the course of their work. The harness is necessary to enable the animal to exert his strength efficiently, and in selecting the harness it must be remembered that, while securing this, it must not cause more than the unavoidable minimum of discomfort. No horse put in harness should suffer any inconvenience except that arising from fatigue. Unfortunately, however, through lack of knowledge of the proper adjustment of harness, many horses do suffer considerable pain whilst at work. This gradually leads up to temporary incapacity, and in some cases to permanent injuries such as fistulous withers, &c.

Many vices—for example, jibbing and bolting—have their origin in badly-fitting harness. When the horse is compelled to work in an unsuitable collar, the undue pressure on any part of the shoulder causes chafing and soreness, and the horse naturally recoils from what causes him agony. Ultimately the best-tempered beast becomes vicious and uncontrollable, through nothing but culpable ignorance on the part of his driver.

Every horse differs in size and shape, and, to fit him properly, it is necessary to use much care. It is not sufficient to depend upon the saddler to fit horses with their harness. The owner should know the use and proper adjustment of every part. Wrung shoulders frequently occur through leaving the selection to the saddler, who, rather than go to the trouble of obtaining a proper collar for a horse that is difficult to suit, may choose the nearest fit in his ready-made stock, and justifies his choice by the contention that the collar will soon adjust itself to the shape of the shoulder. If it is not a good fit in the first instance, it will never become so, and in the so-called self-adjustment it is quite possible that the horse will be permanently injured.

Plough Harness.

This is the simplest form of harness, and consists merely of winkers, collar, and hames, backband, and chains.

Winkers are almost exclusively used as the headgear for horses doing heavy draught work. Open bridles are seldom used, as with them the horse, unless he is particularly willing, develops a cunning habit of shirking his work.

The eye-pieces of the winkers should project outwards from the eyes at the front, but must fit closely behind. The bit should be sufficiently strong to stand the work required of it, but should not be cumbersome. An ordinary snaffle-bit is suitable for most work. It should be fitted to the winkers so that it lies within a quarter of an inch of the bars of the lips—that is, the junction of the upper and lower lips. If drawn up tightly, the bit produces chapped lips, and is responsible for much pain; while if it is too low, it is also likely to cause inconvenience, and may be pushed out of the mouth.

On the winkers for draught horses it is an advantage to have the bit attached on one side with a short, light strap, so that it can be easily and quickly slipped out of the mouth if desired, without removing the winkers.

Bearing-reins are required to prevent the horse cropping at the grass as he moves along. When at work they are buckled over the tops of the hames, just sufficiently tight to allow of the free carriage of the head. Where a pair are used with a pole, the bearing-reins prevent the horses lowering their heads and so catching their headgear on the pole.

The collar is the most important part, as it is upon that the horse exerts his strength. For heavy horses they are either simply curved or rounded at the lower part, or are piped to allow of freer action of the windpipe. The latter are the more satisfactory, especially on horses with prominent windpipes.

Scrupulous care should be exercised in the selection of the collar. It should not fit too tightly on the whole or any one part of the shoulder, and it should not be too large. Chafing is caused principally by large fittings rubbing over a part, just as large boots chafe the feet.

The chief seat of injury is the point of the shoulder. This is the most prominent part, and when the collar fits badly most of the pressure is taken by it instead of being distributed over the full surface.

Injuries frequently occur at the withers. Such usually happen when the collars fit badly, or when the horses have to carry weight upon their necks, as they have in pole work. It is a form of injury which is particularly dangerous, as it may lead to an incurable fistula. The necks of some horses are very thick at the top, and the ordinary collars are not wide enough. It is necessary to get collars specially made for such horses.

The shape of the shoulder changes considerably when the horse is put to fast work, and the fit of the collar then must be noticed. It can be seen by examining the collar and surface of the shoulder immediately he is taken out after work.

Nothing is so liable to cause injury to the shoulders and to prevent the horse exerting his full strength as a flat collar. A well-fitting collar, when new, is roundly stuffed, and fits closely over the shoulder. It possesses a springiness which makes it comfortable, but after a little use the stuffing is compressed, and the inner surface becomes flat. All collars, after they have been used for a time, should be restuffed.

Collars are lined with serge or leather. The latter material is cooler and easier to keep clean, but is liable to crack. This is a discouragement to its use in all but light harness. Sweat and dirt accumulate on the surface, and should be regularly removed. If allowed to remain, a hard condition is produced, which causes chafing.

Young or fat horses have tender shoulders, and are liable to chafe, especially in the summer, and they should be carefully used until accustomed to work. Whilst a horse is in work a careful watch must be kept for indications of soreness. Immediately he is taken from his work, the harness should be removed and a careful examination made for undue heating in any particular part. Bathing the shoulders with salt and water hardens the skin and renders it less susceptible to injury.

Where galls already exist on the shoulders, it is often a difficult matter to adjust the collar so that the horse can continue his work. The best method of surmounting the difficulty is to select a collar which fits perfectly, and then make a depression in the lining immediately over the gall, sufficiently deep and wide to prevent the collar coming in contact with it. The depression is made by removing some of the stuffing and drawing in the lining with a few stitches. This is called "chambering" the collar.

Another method is to have small pads stitched to the collar above and below the seat of injury, to remove the pressure. Some horse-owners, in the absence of a saddler, use stockings stuffed with horse-hair as a substitute for the pads. By adopting means such as these, the horse can be worked while the injury is healing.

For heavy work the hames are usually made of steel, either single or double plated. The latter are more expensive, but more durable, and less likely to suddenly snap when the horse throws himself into the collar.

Hames for drays are made with short tug-chains attached, but on the farm it is more convenient to have them fitted with hooks, so that they can be used with separate short tugs for dray-work, or with chains for ploughing.

They should fit perfectly in the groove of the collar. A chain connects them at the bottom, and this can be lengthened or shortened to enable the hames to be adjusted to the size of the collar. This coupling must not be made too long, or in buckling the hames at the top they will be drawn in too closely and pinch the neck; if, on the other hand, the connecting chain is too short, they do not fit well round the collar.

The hook for attaching the tug or plough chains must be placed in such a position that the draught is not thrown on to the movable shoulder-joint. If the point of attachment is too low, the upper end of the collar is drawn slightly forward.

In some horses the body swells outwards considerably beyond the shoulders, and the chains chafe the sides. This can be prevented in most cases by putting a thick leather pad beneath the hame-hooks, to throw them outwards. If this fails, the chains must be covered with leather or strong cloth.

In plough-harness the backband is very simple, and serves merely to carry the reins and to prevent the chains falling too low and getting under the feet in turning. It should be of such a length that when the chains are tightened it rests comfortably on the back, and is not thrown up above it. When it is in the proper position the flaps should be about 9 inches behind the elbow-joint.

The chains vary in weight according to the class of work. They should be strong but fairly light, except where leading horses are used, when heavier chains are required. The length should be sufficient to allow the swingle-bars to clear the heels when turning the horses. If too long they

interfere to some extent with the draught, and may get under the feet in turning; while if too short, the swingle-bars catch against the heels. In hard, uneven ground, plough-chains should be fairly long. The swivels must be kept in good order to prevent twisting of the chains, with consequent risk of breakage.

The reins or lines are usually of rope in plough harness. A clasp at one end is a convenience in attaching them to the bit. Heavy lines should not be used, as they cause a drag on the horse's mouth, especially when wet. Rope of 1¼ inches circumference is the most suitable for ordinary work.

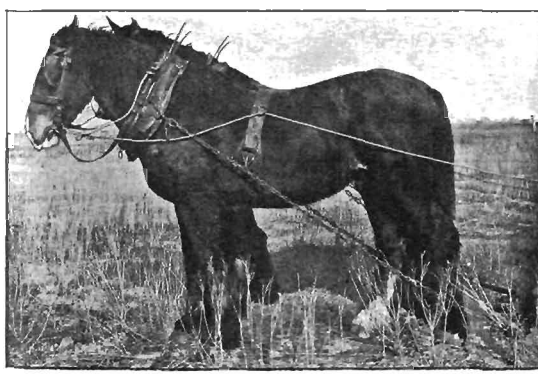


Fig. 1.—Plough Harness.

Showing the correct position of the hame hook, the position of the backband, and the method of attaching the lines.

They are passed through the terrets or rings on the backband, but not through those on the hames. If they are passed through the latter the horse's head is pulled upwards rather than outwards, and he does not answer to the rein well. They should not be too long, and if they must be taken up in length, it can be done most conveniently at the bit by tying a bowline knot; the spare rope can be tied up to the hames out of the way. (Fig. 1.)

Leading Harness.

This differs from plough harness principally in that a heavier backband and more complicated fittings are required to support the chains. The winkers, collar, and hames are essentially the same. A broad band of leather, divided into two straps at the fore end, passes through a loop in the backband, along the back to the tail, where it ends in a crupper. Two meeter straps are attached with a loop and keeper to the hames, or are stitched to the collar itself about 5 inches below the top of the collar, and the straps attached to the backband are buckled to these to keep it in position.

The chains pass through two rings on each side of the backband, and are held up behind by hip-straps. These straps should be of such a length that they prevent the chains and spreader dropping too low (Fig. 2). The chains must not be held too high by them, or the horse will pull down against his own back; neither should they be too low.

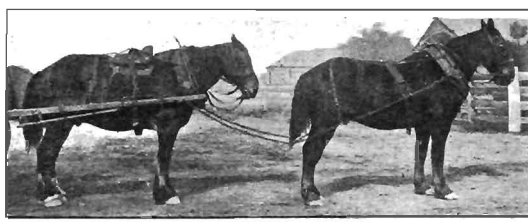


Fig. 2.—Leading Harness.
Showing the correct points of attachment of backband, hip-straps, and spreader to the chains.

The right point for the attachment of the hip-straps to the chains is about 6 or 8 links in front of the spreader. A carrier-strap is frequently brought down over the hips and attached to the spreader. This should be buckled round the spreader about 6 inches in from the chain.

The spreader keeps the chains apart and prevents them from coming in contact with the horse's sides. It should be attached to the chains immediately behind the horse, but leaving sufficient space for the free movement of the legs. When the chains are tight the spreader should be just a shade behind a perpendicular line through the hocks.

Dray Harness.

The winkers, collar, and hames may be those used in plough harness, but they are often more elaborately mounted. This, however, does not add to their utility. The hames may have tug-chains attached, or may be fitted with hooks for the attachment of separate tugs. A saddle is used to carry the shafts, and attached to this is the breeching, designed to hold the saddle in position, and to enable the dray to be held back by the breeching-chains. The saddle consists essentially of pads to protect the back, and a groove to carry the back-chain. It must be well stuffed and properly adjusted to prevent injury to the back. Galls are almost as frequently caused by ill-fitting saddles as by collars.

The shafts are supported by the back-chain, which passes over the saddle and is attached to hooks on the runners or travelling bars on the shafts. The runners should have their centres directly perpendicular with the groove on the saddle when the tug-chains are tight. They are sometimes placed in the wrong position, and must be shifted.

The back-chain should not be too long nor too short. When the shafts are hooked up the points should be about 3 inches below where the tug-chains leave the hames. If hooked up too short the horse actually pulls against himself.

The tug-chains are hooked up so that the back-chain is kept in the centre of the runners under normal conditions, with freedom to move backwards or forwards in sympathy with the movements of the horse (see Fig. 3).

The breeching-chains should be just slack enough to allow free action of the hind legs. It is not infrequently noticed that the tug-chains are too long, and, instead of the load being drawn by them, it is drawn by the back-chain. The breeching-chains, also, are often too long, and when the horse attempts to hold the load the breeching cannot perform its function, and the load is held back by the back-chain. This pushes the saddle forward against the withers, causing pinching, and probably setting up the conditions which lead to fistula.

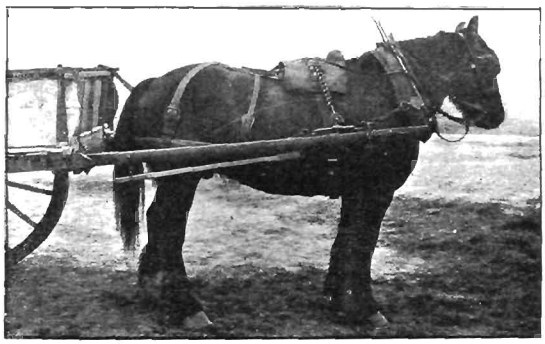


Fig. 3.—Dray Harness.

Showing the correct length of the back-chain, tug, and breeching-chains; and also the right position of the travelling-bar on the shaft.

Light Harness.

In the choice of light harness, whether it be sulky, buggy, van, or any other type, the same scrupulous discrimination must be exercised as in the selection of heavy harness. Too frequently the same set is used for whatever horse is driven, but, while this is quite permissible with certain parts when the horses are of average size, each must at least have his own collar, and preferably his own winkers also. Most of the other parts are adjustable to the size of the horse, and it is only necessary to make the required changes by taking up or letting out straps.

The parts are more elaborately mounted than in farm harness, but the principles underlying the fitting are essentially the same. Leather is used almost entirely, except in some van harness, in which chains are sometimes used for traces. The weight depends chiefly upon the type of vehicle used.

It is a matter of controversy whether winkers or bridles should be used. The arguments advanced against the use of winkers are that the eyes are enclosed, and become hot and irritated, and that the horse is more likely to be frightened by anything coming from behind. Horses, especially those

used in crowded thoroughfares, are certainly less likely to bolt when worked in bridles. A full vision of everything before and behind is obtained, and the horse is not so easily frightened by anything rushing by suddenly. All drivers know that a horse is less frightened by an object coming towards him, than by one appearing unexpectedly. A further advantage is that if the head-gear happens to be rubbed off, the horse accustomed to the restricted vision afforded by winkers, becomes frightened and probably bolts, while the one used to a bridle is unperturbed. One of the main obstacles to the use of open bridles is the patience which is required in accustoming young horses to them. The winkers have a subduing effect immediately they are put on, which the bridle does not possess.

With good going horses, it matters little whether bridles or winkers are adopted; but where teams are used, and the driver has not the horse directly under his eye, winkers are necessary to prevent the horse seeing behind him. A lazy horse which can see behind is constantly watching his driver, rather than sticking closely to business and minding where he is going. He works well when his driver is watching; but acquires the habit of loafing when he is not. When the winkers are used, a steady pace is usually maintained.

The heat and irritation caused by close-fitting eye-pieces can be prevented by using winkers with the eye-pieces thrown well outwards at the front.

The collar must fit perfectly; otherwise it causes discomfort, and frequently creates the habit of jibbing. Few horses are naturally vicious or obstinate, and in most cases the stupidity of drivers is the prime factor in the formation in them of habits alien to their nature. Jibbing can frequently be cured by the removal of the cause and by kindly treatment, especially if the handling is done by some person who has not been responsible for the trouble.

In light harness the hames buckle at the top and bottom, but it is more convenient to use the lower buckle. The best traces have buckles near the hames, by which they can be lengthened to suit the horse. The point of attachment to the hames should be just above the point of the shoulder, so that the movable joint between the shoulder-blade and the humerus does not receive the pressure of the draught.

If the traces are too long, the vehicle is not drawn by them, but by the backband. On the other hand, if they are too short, the shafts push the saddle-pad forward against the withers, and also draw the crupper up tightly under the tail, causing chafing.

Breast-plates are used to some extent instead of the collar, but whilst little exception can be taken to them for very light work, they cannot be recommended where the draught is at all heavy. When they are used the traces interfere with the free movement of the shoulder-joint, and cause discomfort to the horse. With the ordinary collar, provided the hames are properly adjusted, the force exerted by the horse is against the portion of the collar lying against the immovable shoulder-blade, and consequently the free movement of the joint is not interfered with.

The shafts are supported by shaft-tugs attached to the saddle-pad. These should be long enough to suspend the shafts level with the swell of the flaps. The pad is kept in position by a band running along the back and terminating in a crupper, and by the belly-band. The crupper should be fairly thick to avoid chafing. The breeching is also attached to this band.

The correct position for the pad is just where the withers swell upwards. If kept further back it has a tendency to slip forward, drawing the crupper too tight.

The right position for the breeching is about 3 or 4 inches below the hip joints. Here it does not interfere with the action of the horse, and he is able to throw his whole weight into it if necessary. If allowed to drop down too low it causes irritation, and may lead to kicking.

The breeching-straps should not be buckled too tightly, or the breeching will interfere with the free action of the hindquarters and also cause kicking. It should be just so tight that when the horse is fully extended it does not tighten on the legs.

Kicking-straps are required on some horses doing vehicle work. A kicking strap is a strong leather band which is passed over the rump, and attached to the shafts just behind the breeching staples. The further it can be kept back towards the tail the more effective it is. It is kept in position by attaching it to the crupper.

The reins sometimes consist of black leather throughout, but for the sake of cleanliness some stained leather is frequently used for the grip. They should be sufficiently long to leave a margin of about 3 feet when the horse is trotting. If too long, the loose ends are troublesome.

It is a controversial point whether bearing-reins should be tolerated. If misused, they are an instrument of torture, but on some horses are very useful when carefully adjusted. Some are such inveterate pullers that, without the bearing-reins, they pull heavily on the hands of the driver, to his exceeding discomfort. When used, the bearing-reins are brought up and hung over a hook placed in the saddle-pad. They should be long enough to allow the ordinary free carriage of the head.

Care of Harness.

Harness perishes very quickly if neglected, but if reasonable care is exercised it will last for years. Plated harness should not be kept in the stables, as the gases arising from the decomposition of the excreta tarnish the fittings. Immediately the harness is brought in the dust should be carefully wiped off with a soft cloth or leather, and mud or sweat removed by washing with water, but on no account should too much be used. The bits should be well washed in clean water, thoroughly dried, and rubbed over with a little neatsfoot oil. The leather should be kept soft and pliable by using some dressing. Any one of the proved commercial compositions is suitable and cheap.

Heavy harness does not require the same attention, but it must be kept pliable and tough by oiling at regular intervals. Leather which is not treated soon becomes hard under our dry conditions, and cracks, while the stitching decays. A very suitable dressing is pure neatsfoot oil. Some very effective and cheap mixtures are on the market for dressing heavy harness.

The Line of Draught.

By the line of draught is meant the direction in which a force acts in moving a load. In practice the line of draught in ploughing lies for part of its distance in the chains. The direction may be correct or incorrect; if the latter, it means that a portion of the horse's energy is being expended uselessly. To obtain the fullest advantage from his strength, it is necessary that the line of draught be so placed that nothing obstructs its direct action on the load.

The force exerted by the horse in traction consists of pushing. The term "pulling," although customary, is incorrect, inasmuch as a horse can only pull when he is attached to a load by the tail. The force is obtained by the propulsion of his own weight, the forward movement being due to the contraction or expansion of the muscles attached to the various bones. These bones form a system of levers, acted upon by the muscles. Propulsion can only take place when one extremity of the lever is fixed while the other is movable. This is the case with the horse. The fixed point is the foot, which is against the ground, while the movable point is the surface of the shoulder carrying the collar. In practice it is found that this force can be exerted most efficiently when the traces are attached to the hames just above the point of the shoulder (Fig. 1), provided, of course, that the proper line of draught between this point and the load is maintained.

The weight of the horse, which is very important when considering his power, becomes effective only when the body is thrown forward beyond the centre of gravity. In the horse this lies about the seventh rib, in the middle of the girth. It is evident that the heavier the shoulders, neck, and head of the horse, the greater is the force which he can exert.

This is appreciated and taken advantage of by draymen, who load their drays "heavy on"—that is, in such a way that a portion of the weight is thrown on to the horse's back. This increases the weight which can be thrown into the collar; but in loading in this way, care must be taken that the horse is not overweighted. A considerable strain is thrown upon the front feet, which rapidly causes fatigue, and may lead to injury. The weight thrown on to the horse should not be more than can be fairly comfortably lifted by raising the point of the shafts.

In light vehicles no weight should be thrown on to the back, especially on slippery roads, as the horse is more likely to stumble.

The weight can only be exerted efficiently against the collar when the line of draught is right. The feet act as a fulcrum, and the system of bones, embracing the legs, haunch, spinal column, &c., acts as the lever. The weight is more effective when it acts downwards on this lever against the fulcrum. If the horse were attached to the load in such a manner that the line of draught lay above his back, the effect would be to lift him from his feet, and consequently render his weight ineffective. This occurs when a dray is loaded so "light on" that the shafts are lifted, and are only prevented from rising into the air by the belly-band. This takes a part of the horse's weight off the fulcrum (the feet), and renders it useless.

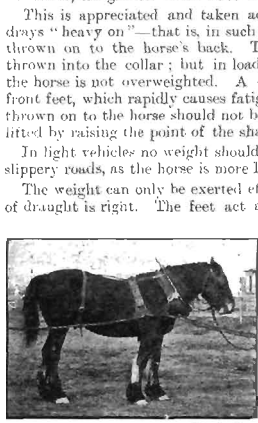


Fig. 4.—An incorrect method of attaching leading chains to those of the rear horse.

By lowering the line of draught to the horizontal, greater effectiveness would be secured, but the horse would still be unable to exert his full power.

The actual efficient angle of the correct line of draught varies according to the height of the horse, and also his length, but generally it should form an angle of about 20 degrees with a horizontal line taken through the

point where the force acts on the load. In ordinary plough harness, with the chains tight and long enough to prevent the swingle-bar catching the heels, this angle places the swingle-bar just a shade lower than the hocks.

When attached to the back-chain, the shafts must not be brought up too high, or they will be pulled downwards by the tugs, and portion of the horses strength will be expended against his own back. The back-chain,

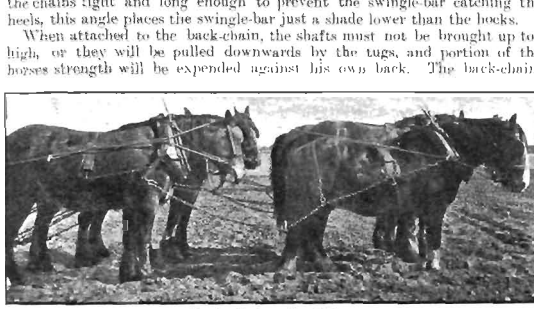


Fig. 5.—Six-horse Plough Team.

when of the proper length, allows the points of the shafts to lie about 3 inches below the hame hooks (*Fig. 3*).

In team work, where horses are harnessed in tandem, inattention to the importance of securing a direct line of draught may lead to a serious loss of power. In some cases the chains of the leading horse are hooked to those of the horse immediately behind, close up to the hames (Fig. 4), with the result that the leading horse draws downwards on the chains. This means that the strength of the *rear horse, instead of acting* directly on the load, acts partly against the power exerted by the leader, and is thus to some extent rendered ineffective.

Fig. 6.—An appliance for obtaining a correct line of draught when leading harness is used in ploughing.

A direct line of draught can be secured by adopting some simple arrangement. A good appliance is shown in Fig. 6. This is a simple half-inch iron bar, 12 inches in length, with a ring at each end and one at the centre. The rear chains are attached to the ring in the centre, while the upper ring is attached to the hame hook, and the lower ring receives the chains of the leader (Fig. 5).

Another simple and very effective arrangement, which can be fitted by anyone, is obtained by the attachment of short auxiliary chains to the rear chains to receive the leading chains. These auxiliaries are attached to the rear chains about 18 inches or 2 feet from the large end links, and are held up by short drop chains. They take the leading chains, and preserve the direct line of draught, preventing the downward pull on the rear chains.

Repair of Harness.

Although this is commonly considered to be within the province of the saddler, and consequently is neglected by the farmer, there is no reason why the latter should not undertake many of his own repairs. Those required are often very simple, and the following details are given, so that those who are not in a position to obtain training may be able, by studying them carefully, to acquire a knowledge of the work.

It is necessary to bear in mind that, although the process may appear complicated, it is not really so, and can easily be mastered. Time is always available for doing odd jobs, and by following the instructions no difficulty will be encountered in making ordinary repairs, and the harness will be kept in good order at little expense.

It is not proposed to deal with the more complicated work, such as the restuffing of collars, &c.—this must be left to the trained man—but merely to show how many simple repairs can be neatly and strongly made.

The following list comprises a fairly complete outfit for effecting repairs Whilst with these almost any class of work can be done, the possession of them all is not essential; for instance, much useful work can be accomplished with an awl, needle, and thread:—

1 pair clams; 1 pair pliers, No. 3; 1 dozen awls, assorted; 1 dozen awl-handles; 1 dozen collar needles, assorted; 2 packets needles, Nos. 2 and 4; 1 saddler's compass; 1 round knife; 1 hand knife; 1 saddler's hammer; 1 edge tool, No. 2; 2 tongue punches, Nos. 35 and 37; 4 round punches, Nos. 3, 4, 5, and 6; 1 fine saddler's shoulder-crease; 1 single hand-crease; 1 saddler's palm.

A saddler's plough facilitates the cutting of leather, but is not essential.

The different materials required in renovating harness are:—

Pitch, resin, beeswax, black wax, best brown hemp, (No. 2), tacks, bridle leather *harness leather*, *collar-check*, *brown serge*.

A small leather apron, about 12 inches by 4 inches, is required. This is suspended from the waist and hangs over the right thigh. A small S hook, for holding the hemp whilst making the thread, is also needed. A suitable bench is shown in Fig. 11.

Use of the Tools.

The Plough is somewhat expensive, and its work can be done by other tools, such as the round knife. The chief parts are a cutting blade and gauge. By setting it to the right width a strip of leather can be rapidly and accurately cut. (Fig. 7.)

The Round Knife is almost indispensable. It is the most suitable tool for shaving or bevelling leather, and is also used for cutting leather into straps or any other form. The line of cutting is marked with the compasses, and the round knife entered and steadily pushed forward along the line, keeping the left hand in front to hold the leather firm. The cutting is done on wood in the direction of the grain, and the surface must be free from nails. (Fig. 8.)

Compasses are required for marking the lines for cutting, and for marking distances.

The Edge Tool is used for taking the sharp edges off the leather after it has been cut. If these edges are left, the leather readily frays or cracks. The tool is run along the edge with the right hand, and the work steadied by keeping the left hand in front. (Fig. 9.)

Punches are used for making the different holes required in leather working. The round form is used for making the holes in straps for receiving the tongue of the buckle. The tongue punches are used for cutting the hole for the bed of the tongue.

The Creases are used for making ornamental lines on the leather (Fig. 10). These lines do not increase the strength of the leather, but add much to its appearance. The crease is heated over a candle, and after wiping off the candle-black the crease is pushed along the leather until a sufficiently marked depression is made.

Awls and Awl-handles.—The awl-blades are attached to the handles by first pushing the heel of the blade into the handle as far as possible with the hand. The handle and blade are carefully examined to see that they are fitted truly, and then the blade is securely held in the vice, while the handle is driven down on to it with a light hammer.

Three kinds of awls are used:—

(1) A curved awl, slightly flattened at the point, but otherwise round. This is used when the work cannot be stitched right through, but from one side only.

(2) A round straight awl, tapering gradually from the handle to the point. This makes a round hole, the size of which depends upon the distance the awl is pushed through. It is used where single holes are required, and in beginning and ending long stitching.

(3) A diamond awl, used in ordinary stitching. Several of these, to suit the different sized threads used, are required.

Confidence is the chief requirement in handling the tools, and a little practice soon makes the learner familiar with their use.

The Thread.

A good thread is the first essential in making strong, lasting repairs. Good hemp must be selected, and considerable care exercised in the making. For convenience the hemp is kept in a small tin, with the end passed through a hole in the lid. The end is caught between the second and third fingers of the left hand, passed round the S hook, which should be about 3 feet away, and brought back and caught by the thumb and first finger of the same hand. Break the hemp by gently pulling with the left hand, while unravelling by rolling it downwards and away on the apron with the right hand. The breaking must be carefully done to obtain a fine tapering point.

This process of passing the hemp round the hook is repeated until sufficient strands are brought together to give a thread of the required strength. This is determined by the class of work to be done. In light work two strands are used, while five or six are usually required for heavy stitching.

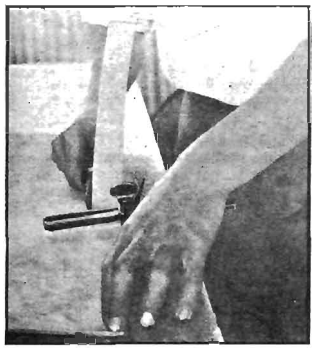


Fig. 7.—Cutting leather with the Saddler's Plough.

Fig. 8.—Cutting with the Round Knife

Fig. 9 —Trimming a strap with the Edge Tool.

Fig. 10.—Creasing a strap.

When sufficient strands have been brought together, the end is taken between the thumb and first finger of the left hand, and the thread twisted by rolling with the right hand on the apron. The twist is kept in by catching the thread up by the finger and thumb of the left hand. The amount of twist determines its fineness, strength, and evenness. When well

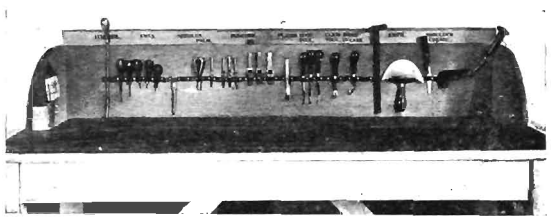


Fig. 11.—A convenient bench for leather-working, showing arrangement of tools.

twisted, wax freely but quickly by rubbing the wax briskly up and down right to the tips. A little more wax is applied to the tips than to the remainder, so that the needle can be more easily and securely attached.

It must be remembered that the threads are not doubled before twisting. A fine tapering tip is required at each end for the attachment of a needle, and this can only be obtained by twisting the thread from end to end without doubling.

Wax.

Wax is applied to retain the twist, to give strength and smoothness, and to preserve the thread. Two kinds are used, beeswax where black threads are not desirable, and cobbler's-wax.

The latter is most suitable for heavy stitching, and is composed of—

1 lb. pitch, 4 oz. resin.

The pitch and resin are heated until thoroughly liquefied and intermingled, when the composition is poured into cold water, in which it can be conveniently preserved. When required for use, a piece about as big as the top of the thumb is cut off with a wet knife, and held whilst being used in a piece of soft leather to prevent it sticking to the fingers.

These proportions of pitch and resin make a suitable wax for use in warm weather, but in winter it becomes hard and brittle. This can be overcome by making a mixture of—

1 lb. pitch, 3 oz. resin, 3 oz. mutton fat.

The thread sometimes becomes hard or sticky when cold, and will not run well. This can be remedied by smearing the fingers with raw beef or mutton fat and passing them up and down the thread a few times.

Threading the Needle.

In saddlers' work stitching is not done with a needle and thread such as is used in stitching cloth. A single thread is used, and a needle attached to each end. The needles must be threaded securely, and in such a way that the thread, where it leaves the eye, is not thicker than the needle. If it is larger, either the thread or the needle will be broken in stitching.

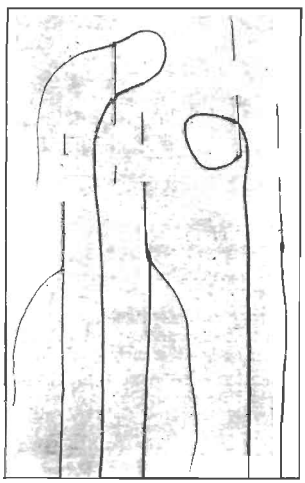


Fig. 12.—Threading the Needle.

To thread the needle, pass about 1½ to 2 inches of the tip through the eye (see A, Fig. 12); pass the needle through the thread (B); draw the thread through as far as it will go, and twist the loose end which is shown, well round the thread (C); draw the needle through the thread two or three times at a place near to the point where the end of the tip has reached, but between that point and the eye of the needle (D). By drawing the needle and thread through itself in this way, the tip is woven to the thread and kept from unravelling. The finished thread, after smoothing down with the finger and thumb, is shown at E.

The Requirements of Good Stitching.

To obtain good stitching, it is necessary that—

1. Thread of a kind and strength suited to the nature of the work be selected.
2. The thread be smooth, well twisted, and well waxed.
3. The stitches be all drawn equally tight, and made as firm as possible without cutting the leather.
4. The needles be used in the right way.
5. The right kind of awls be selected and correctly used.

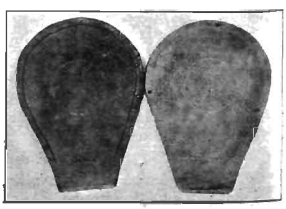


Fig. 13.—Marks left by the Wheel-pricker as a guide to stitching.

6. The stitches be made towards the operator.
7. The work be closely and firmly held in the clams.
8. The stitches be of equal length.
9. The holes be of equal size and angle.

Preparing for Stitching.

When neat work is required, wheel-prickers are used to mark the line of stitching. These can be fitted with wheels to mark for any number of stitches per inch. The points on the wheel cut into the leather and make a distinct mark where the holes are to be made with the awl (Fig. 13).

It is necessary to have the work securely fastened so that it will not move whilst being stitched. Cut tacks are used for this purpose, and are drawn when the work is finished.

Fig. 14.—Shaving leather with the Round Knife.

The sharp edges of the leather must be removed. This is done with the edge tool. Edge tools are made in various sizes to suit the class of leather.

The ends of the leather must frequently be bevelled before stitching, to obtain an even thickness and smooth surface; as, for instance, in stitching on a buckle. This is done by shaving the ends down with a round knife (Fig. 14).

Stitching.

The work, whilst being stitched, is held by the clams. These are held between the knees, and are kept in position by resting the end on the floor, passing the clams under the right leg, and resting them on the left. By their use the hands are left free for stitching. The operator must sit with his thighs horizontal, or the clams will tend to slip away.

Fig. 15.—Using the awl.

The awl is pushed through the leather from the upper side at a slight angle. This, besides preventing the holes tearing

into each other, allows the thread to be drawn tighter. To facilitate the use of the awl, saddlers usually cut a flat place on the handle, and by always keeping the thumb on this, the right angle is secured without difficulty. (Fig. 15.)

When the first hole has been made the needle is passed up from below, and the thread drawn through until an equal length is on each side. The next hole is then made with the awl and the lower needle brought upwards through this, and when the thread has been drawn through about 3 inches, the upper needle is passed downwards through the same hole (*see* Fig. 16). The awl makes a diamond-shaped hole, and the thread brought up from below must be kept in the angle nearest the stitching already done—the lower end—while the thread taken downwards must be kept in the upper angle. This can be done by pulling downwards a little with the upper hand, while the lower hand is drawn slightly towards the operator. Each thread must be firmly drawn when pulled through.

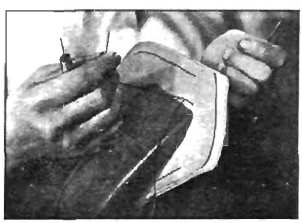


Fig. 16.—Stitching.

This is continued until the required amount of stitching has been done, when the thread is secured by turning back a stitch, using a round awl for making the hole. The thread when passed through is cut off flush with the surface of the leather.

By following the above directions, much useful repairing may be done by the farmer in his spare hours, and besides being profitable the work will be found interesting.

Broken winkers can be repaired, lost buckles replaced, and backbands and belly-bands, which are damaged, made strong again. Traces can be made safe, and the unsightly, dangerous knots, often seen in reins and other parts of the harness, replaced by strong, neatly-stitched repairs. It will be found that neat, strong work can be easily done, and that the details are soon mastered. Much of the work is merely cutting-out and stitching, and by close examination of the harness and imitation of it, nearly all repairs can be accomplished. Many articles, such as bridles, straps, belly-bands, &c., can also be made without difficulty. These can be cheaply bought, but provided good leather and hemp are obtained, the home-made article will probably have the merit of greater strength and durability.

Horse Rugs.

Some difficulty is often experienced in securing a rug to the horse so that it fits him comfortably without slipping off. The best method of accomplishing this is to attach flank straps, instead of the crupper that is often used, and to have the usual girth and chest straps. When flank straps are adopted it is not necessary to buckle any of the straps as tightly as when a crupper is used.

Although rugs can be bought cheaply, they are often home-made, and the following instructions will be useful:—The rug consists of a canvas covering and an inside lining of some warm material such as serge. For ordinary horses the covering is made 6 feet square, and when the strips of canvas have been stitched together, a curved piece is cut out over the withers. This piece is cut out 10 inches deep in the centre, and is 4 feet wide at the base.

The edges of the canvas are doubled up twice to give a good firm hem about half an inch wide. The inside lining is 4 feet wide, leaving 1 foot on each side of the canvas covering unlined.

The buckles for the flank straps are put just in front of the back hem, 1 foot in from the edges on the outside, and the straps taken through a slit near the hem of the canvas. A "D" is stitched on the inside of the rug about 20 inches forward from the back hem, and 1 foot in from the side, for the attachment of the flank straps by clips. The straps are made about

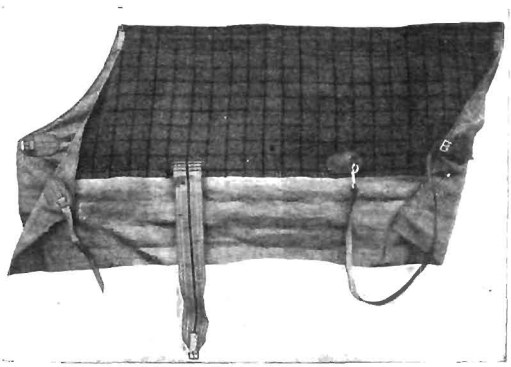


Fig. 17.—Horse-rug, showing the position of the straps, buckles, &c.

5 feet long so that they can be adjusted to the size of the horse. The girth, which is 2 feet 6 inches long, is stitched on the inside, 22 inches back from the front hem, and 1 foot in from the side.

The girth strap is 18 inches long, and is attached in the same relative position as the girth on the opposite side. The chest strap and buckle are placed on the front hem on the outside, 1 foot from the side. To make the rug stronger, a strip of leather about 2½ inches wide, may be stitched down the centre on the outside.

In attaching all buckles and straps, care should be taken to have them stitched on to the inside lining as well as the canvas covering, and not placed where the stitches will pass through the canvas only.

Fig. 17 illustrates a horse-rug and the positions of the buckles and straps.

THE USE AND CARE OF ROPE.

A large assortment of fibres, either pure or in mixtures, are made into cordage. In a rapid survey of all these rope-making materials, none stands out with such pre-eminence as Manila hemp. The fibre is produced from the Abacá (*Musa textilis*), a plant closely related to the banana. Its cultivation is almost exclusive to the Philippines, where it forms three-quarters of the total export. The fibre is 6 to 12 feet long, and is wonderfully resistant forming one of the strongest and most satisfactory ropes for farm work now manufactured. It is moderately pliable, nice to handle, and will stand the wet so successfully that it is rarely if ever tarred.

Manila hemp is one of the few fibres that can be used with success in self-binding machinery. Sisal is also used quite extensively for binder twine either pure or mixed with New Zealand and Manila hemp, and, with the rapid development of self-binding machinery, its use will probably become more and more extensive where Manila cannot be procured. A trial of sisal in the reapers and binders was conducted at Hawkesbury Agricultural College some years ago, but it was found too stiff and liable to kink, while the tie did not hold with the tenacity of Manila. It is estimated that sisal has only about two-thirds the working strength of the best Manila.

The maximum strain could be resisted by a rope if the fibres were laid parallel. This being impracticable, the fibres are first twisted into yarns; these are laid up into strands; and finally three strands go to make the rope. The object of twisting is to make the rope portable, and to ensure that, by mutual friction, the fibre, yarns, and strands may hold together when the strain is applied. Laying up or twisting a rope decreases the strength, but increases its durability. The tarring of rope results similarly in excluding the wet, and preserving the rope at the expense of the breaking strain.

Rope is measured by its circumference, and sold by weight. The following table will give an idea of the approximate weights of convenient lengths of Manila:—

TABLE showing Approximate Weights for given Lengths of Manila Rope.

Coils.	Size.	Weight.	Coils.	Size.	Weight.
feet.	inches.	cwt. qr. lb.	feet.	inches.	cwt. qr. lb.
800	½	0 0 14	100	3½	0 1 16
800	1	0 1 0	100	4	0 2 0
800	1½	0 2 10	100	5	0 3 4
800	2	1 0 5	100	6	1 0 14
800	2½	1 1 22			
800	3	2 0 12			

To prevent rope, and more especially binder twine, from kinking, it is necessary when commencing to use it from the centre of the coil, to make it unwind in the opposite way to that in which the hands of a clock revolve. The end is usually protruding from the correct side of a ball of binder twine, but before threading it, or tying it to the upper ball in the twine box, this point should be looked to, and if necessary the end pushed through to the other side.

Splicing.

In studying splicing, it is essential to have a clear understanding of the tructure of a rope. The yarns are formed by twisting the fibres to the ight, *i.e.*, clockwise. Several yarns twisted anti-clockwise form a strand, hile three strands laid clockwise, like the yarns, go to form the ordinary hree-strand rope (Fig. 1.)

Before continuing further, the fact should be emphasised that this article vill prove practically valueless unless the reader takes a three-strand ope into his hand, and endeavours to follow out the instructions given vith the aid of the illustrations. It should not take more than an hour o learn the elementary principles, and it will be found surprising how ften a knowledge of splicing can be applied in everyday work.

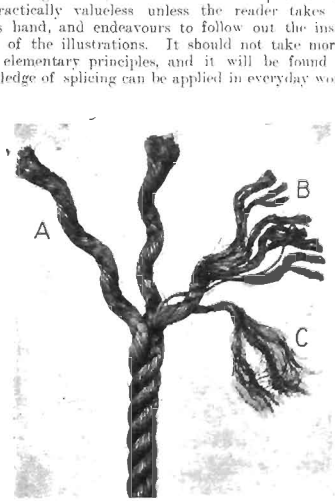


Fig. 1.—A Three-strand Rope showing the structure.

A. Strands. B. Yarns. C. Yarns unravelled to show fibres.

There are two common splices, the short and the long. For average vork on the farm, where the rope is not to be used in block and tackle, short splice is all that is necessary. But where a uniform thickness is equired throughout, the long splice is essential. There is little difference n the relative strength of ropes spliced by these two methods; the uality of the work is a far more influential factor in determining which hould be used. A well-made splice will reduce the strength of a rope y about one-eighth.

The Short Splice.

In a short splice the strands are laid back a distance which will depend upon the thickness of the rope. A little practice will soon enable one to gauge how far, but as a guide to start with, it may be mentioned that 9 inches will amply suffice to splice ordinary ploughreins of 1¼ inches circumference. Such *rope is the best to practise on*, and it should preferably be moderately new, as old worn rope unravels too easily and makes the work doubly hard.

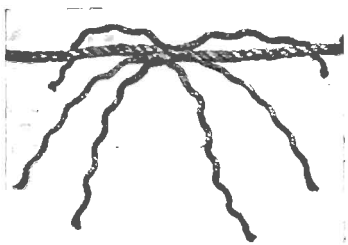


Fig. 2.—Short Splice. The two ropes laid back and brought end to end, ready for splicing.

The ropes are then brought end to end, as hard up as possible, with each strand of No. 1 rope between two strands of the opposite rope, No. 2 (Fig. 2). No. 1 rope and the strands of No. 2 rope are held very firmly in the left hand, and to commence with may be temporarily lashed in position. The strands of rope 1 are then interwoven with *those* of rope 2, by taking each one separately, jumping over *the strand immediately* the other side of it, and under the next one farther on (Fig. 3).

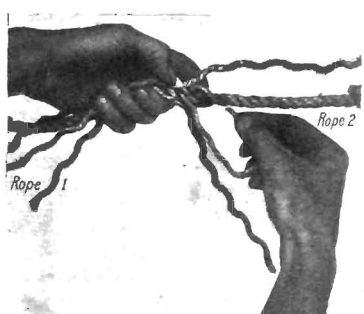


Fig. 3.—Short Splice. The position of the hands, placing the first strand of Rope 1 under Rope 2.

To do this without loosening the strands held tightly in the left hand, it is necessary to twist rope 2 with the *right hand, and place* the first finger of the left hand underneath the strand to keep it open. The strand that is to be interwoven is then pushed through with the thumb of the left hand. Twisting thus to make room for the strands loosens the rope, and it should be twisted back again every time to its original position before starting with the next strand. Continuing, the other two strands of rope 1 follow suit, going over the strand immediately the other side, and under the next. To make it

convenient, the rope is gradually turned over, taking the greatest care not to loosen the grip in the left hand. When one side is completed, the rope is turned so that the strands of rope 2 can be woven into

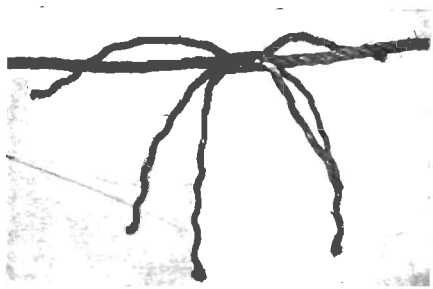


Fig. 4.—Short Splice. Each of the six strands woven once and hauled taut.

rope 1 with the right hand. The six strands are then hauled taut (Fig. 4), the durability of the splice largely depending on whether this is done thoroughly. The weaving continues in the same way, working at each end alternately, hauling the strands taut, and twisting the rope back into its original position to prevent its getting slack.

Fig. 5.—Short Splice finished. For comparison, one end has been tapered, and the other ended abruptly.

For thick rope, especially when new, a sharpened piece of iron or hardwood called a marlinspike has to be used for levering up the strands, as the rope is too stiff and rough for the fingers.

To taper a short splice at each end, and thus enable it to pass over obstacles with less likelihood of jamming, one or more yarns, according to the size of the rope, are cut off the strands every time the latter are interwoven, till, at the end of the splice, only one or two strands are passed under, and thus the thickness increases gradually to the centre (Fig. 5).

It is always a good plan, before cutting off the ends, to roll the spliced portion under foot: the ends can then be cut off close, but if this is done before rolling, they soon work their way from under the last strand where they were placed. In old rope the fibres are broken to such an extent that this method of tapering will not succeed, and the best way is to flay out the strands with a knife. The resulting splice is never so neat, nor perhaps quite so durable, but it is the best that can be done under the circumstances

The Long Splice.

Where the thickness of a short splice will interfere with the convenient handling of a rope, or where any rope above 2 inches in circumference is to be spliced, the best method is to use what is termed the "long splice." It entails the use of more rope, and is harder to make, but the resulting splice is much neater, and its advantages will usually justify the extra trouble.

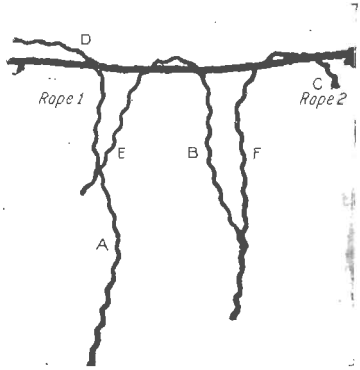


Fig. 8.—Long Splice. The strands laid up into position, ready for finishing off.
(Strands A, B, and C belong to Rope 1.
Strands D, E, and F belong to Rope 2.

Somewhere about three times the amount of rope used in the short splice (*i.e.*, about 2 feet in a 1¼-inch rope) is laid back, and the ropes are brought together in the same way. One of the strands of rope 2 is then further laid back, and its place taken by the corresponding opposite strand of rope 1. A strand of rope 2 then takes the place of the opposite and corresponding strand of rope 1 They should be laid up so far that there remains sufficient length to weave into the main rope in finishing off. Each pair of strands should now be equidistant from the pair that remain in the centre, though the ends, except in the centre, will naturally be of unequal length (*Fig.* 6).

There are a number of ways of finishing off. The most general is to take half or three-quarters of each strand, and tie with each pair an overhand knot, being careful that when finished each end still lies in the direction it did before. These six ends are then interwoven several times with the main

rope, tapering them gradually off. The quarter or half strand that remains may also be interwoven with the rope, or else cut off, and the ends just tucked away. (Fig. 7.)

The splice must be very carefully made when it is to be used for rope hoisting, and every care taken to prevent the slightest "belly."

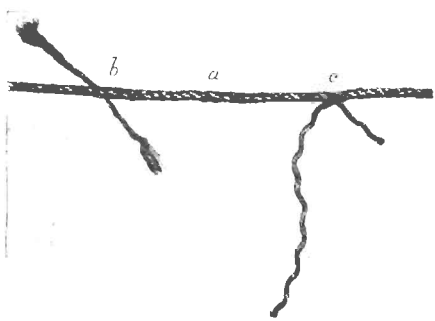


Fig. 7.—Finishing off Long Splice.

a. Two centre strands, woven and finished off. *b*. The overhand knot tied, ready for weaving. *c*. The two strands not yet touched, after laying up.

The Eye Splice.

The eye splice is easy to make, once the short splice has been mastered, and is very useful for leg-ropes, or wherever a running noose is used. It may be also made around a post or some similar object, but requires very careful manipulation to make it tight.

The strands are laid back as in the short splice, and the rope doubled to make the necessary sized loop. This loop is held in the left hand, while the strands, commencing with the middle one, are interwoven with the right. (Figs. 8 and 9.)

Two precautions must be taken in weaving—first, that the middle strand of the three comes over from the top of the doubled back portion; and secondly, that each of the strands is woven across and not with the twist of the rope. Special care must be taken of the latter when weaving the strand that is nearest the operator, as there is every likelihood of making a mistake at this point.

The Turk's Cap and Crown.

The ends of ropes will unravel very quickly if not prevented by some means. A common method is to lash the end with twine. This takes time, and necessitates the wherewithal to lash it. For certain work it may be an

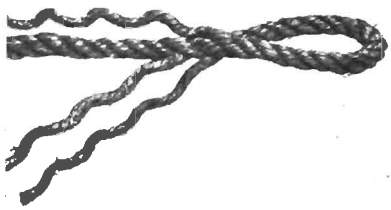


Fig. 8.—Commencing the Eye Splice. The middle strand turned under.

Fig. 9.—The Eye Splice finished. Not tapered.

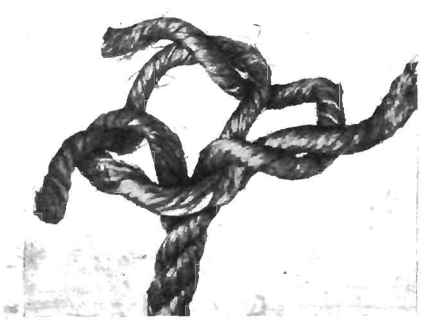


Fig. 10.—The Wall Knot, showing the position of the three strands before hauling taut.

advantage to have a knob on the end of the rope, when a Turk's cap or wall knot is the most satisfactory. If, on the other hand, only a moderate thickness is wanted, the "crown" is made, and the strands spliced back two or three times, tapering if necessary.

The Turk's cap or wall knot is shown in Fig. 10. The strands are laid back, and each takes a turn around its neighbour. The third strand, after taking a turn around the second, is inserted upwards through the loop made by the first strand, and all three are pulled taut. The ends can be cut off, but half an inch or more should always be left to flay out, and thus materially assist in preventing the knot from becoming undone.

Fig. 11.—The Wall Knot below and the crown above, showing position of the three strands before hauling taut.

For general purposes this is sufficient, but to make it more secure a crown is placed on the top by crossing the strands one over another as in Fig. 11, and hauling taut. The three strands are now all pointing downwards, and to make one of the most efficacious ends to a rope, these can be spliced back, The result is a large knob on the end, and to avoid this an excellent plan is to make only the crown, as shown in Fig. 11.

Fig. 12.—The crown made by itself, and the strands spliced back a short distance down the rope (not tapered).

By itself, the crown will not last, and the strands must be spliced back. (Fig. 12.) For convenience they should be tapered while being spliced, as this precaution will be found of very material assistance when drawing the end out of tight loops in undoing knots. All plough reins and halters should either be lashed, or finished off in this way.

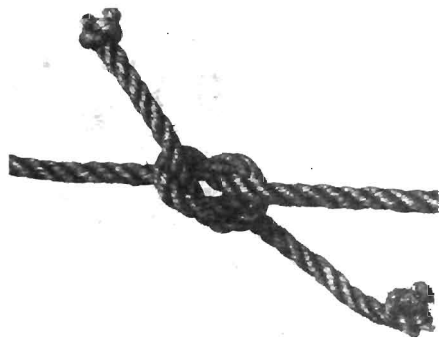


Fig. 13.—The Granny. The worst knot to use when joining ropes.

Fig. 14.—The Reef Knot.

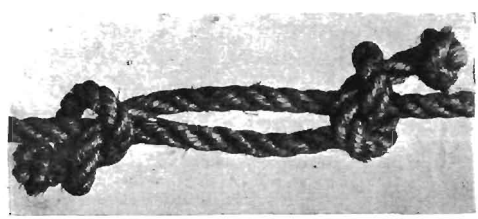


Fig. 15.—The Fisherman's Knot.

Fig. 16.—The Fisherman's Knot hauled taut.

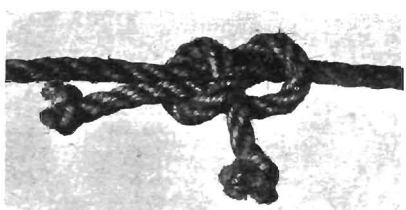


Fig. 17 (a).—The Sheet Bend.

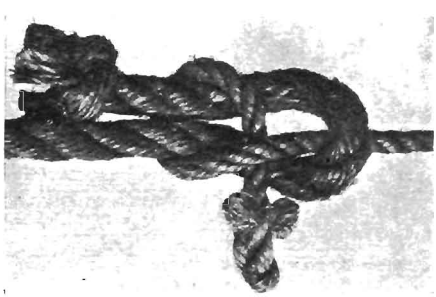


Fig. 17 (b).—Joining two ropes of uneven size with the Sheet Bend.

Knots.

There is such an array of knots that it is a difficult task to select just those that the farmer will find most useful. A few stand out prominently by virtue of their utility, but for the rest an endeavour will be made to describe types, and there should be little difficulty experienced in modifying or elaborating them according to requirements.

First and foremost are the methods of joining of two ropes together. The commonest and most inefficient knot to use is undoubtedly the "Granny" (Fig. 13). If not tied tightly it will slip; and when once it catches it jams so tightly, and is so difficult to undo, that it is often a cause of grave danger. The "Reef" knot (Fig. 14), which should always be made in its place, is very similar, and may be confused with it. The first tie is the same in both cases, the difference in the knots being that, in the "Reef" knot, the end that comes over from on top, remains on top when crossed for the *second tie, while in the "Granny" it is crossed below for the second tie.*

It may be worth noting here that a "Reef" knot is easily undone, by taking either end and giving it a sharp pull over in the opposite direction to which it is pointing. This will straighten it out if the material is pliable, and the end can then be easily drawn out. This is a good method to adopt with bandages or string, and when there is no knob on the end, but if there is a knob, or the material is fairly stiff, the easiest plan is to push one end back.

The "Reef" is easy to undo, and under ordinary conditions should never slip; but where a thin rope is to be tied to a thick one, the "Reef" will slip, and it is best then to use the "Sheet Bend" (Figs. 17 (*a*) and (*b*)). The latter can be used when a small rope is heaved, say, over a limb of a tree, and a thicker rope pulled up after it. The "Sheet Bend" is not permanent, and will soon come undone if the rope gets slack or the strain is intermittent.

The safest way of tying two ropes together, whether of the same thickness or not, is by what is termed the "Fisherman's" knot (Fig. 15). It will take some practice to make this successfully, and the overhand knots should be made in such a way that they fit over one another when drawn tight as shown in Fig. 16. So sure is this knot, that the Alpine Club have recommended its exclusive use where ropes are to be tied together in mountain climbing.

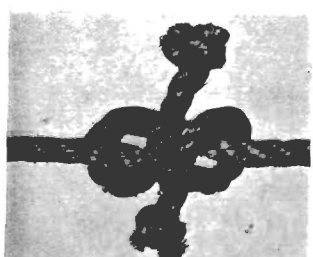


Fig. 18.—The Figure-of-eight Knot.

The "Figure-of-eight" knot (Fig. 18) is hardly suitable for working in rope, but it is so readily made with wire, and holds so strongly, that it is very widely used for tying fencing wire. Its disadvantage lies in the two ends, which stand out at right-angles and prevent its passing through auger holes when straining up

the wires. Probably two or three trials will be necessary before this knot can be tied correctly. The illustration should be examined and carefully followed.

Both on sea and land, the "Bowline" (Fig. 19) is probably more in requisition by those who know it than any other knot. The heavier the strain the tighter the knot holds, while its most marked characteristic is the ease with which it is undone. This knot should invariably be made

Fig. 19.—The Bowline.

when horses are tied up. If they pull back, it will not jam, a fault to which many knots are liable, frequently necessitating the rope being cut. Plough reins *should be attached by the "Bowline," since once learnt, it is easily* and rapidly made, and as easily undone. To make it, first place the rope around the post, holding the short end in the left hand. Make a loop with the right, taking care *that the long portion* of the rope forms the bottom portion of the loop.

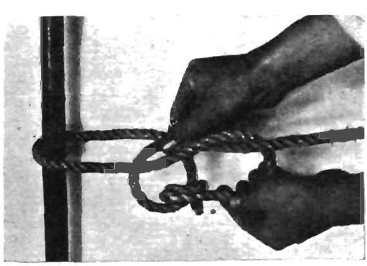


Fig. 20.—Making the Bowline.

The short end in the left hand is then passed up through this loop, over and around the main rope, and back again downwards through the loop (Fig. 20), so that the two ropes passing through will lie parallel. The rope in the right hand is then pulled tight to finish the knot.

Fig. 21.—Overhand Knot ready to be made into a Bowline on a Bight.

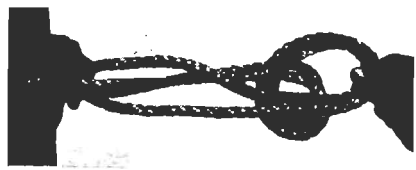


Fig. 22.—Showing the position of the loop in making the Bowline on a Bight, while it is being held down with the left hand.

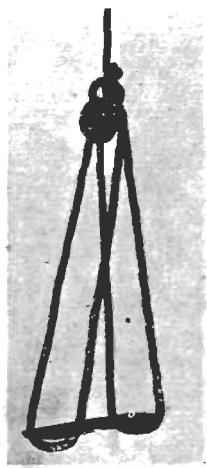


Fig. 23.—The Bosun's Chair.

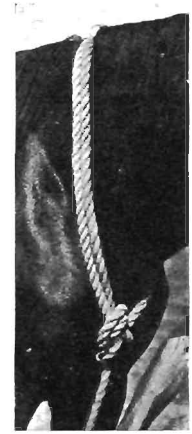


Fig. 24.—The Bowline on a Bight used for throwing a horse.

A variation of the "Bowline," the "Bowline on a Bight," is best made by first tying an overhand knot in the doubled rope (Fig. 21). The loop is then placed above and held there with the left hand, while the right draws it down into postion as shown in Fig. 22.

It makes an excellent cradle to sit in when drawing oneself up any height. As such it is called the "Bosun's Chair" (Fig. 23), and is useful in painting and other work when a ladder is not procurable or is inconvenient. The same knot is advocated by many for making the collar when throwing horses (Fig. 24). It makes a flat knot against the horses's chest, is doubled around the neck, and can readily be undone when a change in size is desired.

The "Timber Hitch" and the "Clove Hitch" are both well known (Figs. 25 and 26). The former is the safer, while the latter is quicker and easier to make. A slight alteration made in the "Clove Hitch," as shown in the lower part of Fig. 27, makes it less liable to slip.

Fig. 25.—The Hitch.

Fig. 26.—The Clove Hitch.

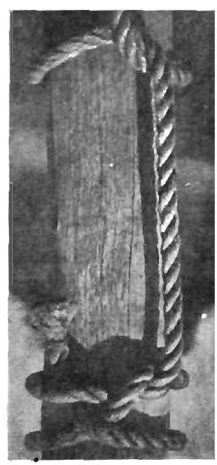


Fig. 27.—A Hitch adapted for lifting timber.

One of the safest of hitches is that shown in Fig. 28. The construction of such a hitch, or any other like it, prevents it from slipping sideways, making it extremely useful in tying horses to picket ropes, and in lifting and lowering round timber. One rope can also be attached to another by this means—as, for example, the guide rope of tackle used in lifting material for stacking.

To draw the lashing ropes of a load down tight, use is often made of the mechanical advantage derived from such a knot as that illustrated in Fig. 29. Make a loop in the rope as high as can conveniently be reached. Double up a portion of the loose end in the right hand and pass a few inches of it through the loop (Fig. 30). To draw the knot tight, pull evenly on the lower loop and the loose end. This loose end is then passed round the

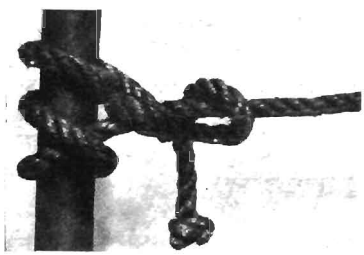


Fig. 28.—The Rolling Hitch. The safest hitch which will not slip in either direction.

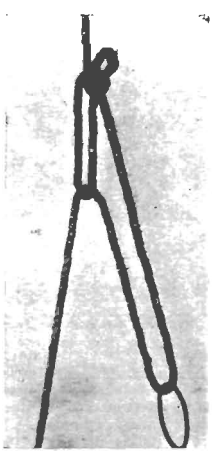


Fig. 29.—The Hay Knot.

Fig. 30.—Making the Hay Knot.

guard irons of the dray and up through the lower of the two loops. Where the "Hay" knot, as it is often called, is to be made more or less permanent, as in the case of railway trucks, &c., the top loop should take a half-hitch around the taut rope (Fig. 31). If this precaution is not observed, anyone stepping on the upper loop will cause it to slip. The knot will, of course, only hold while the rope is taut.

Fig. 31.—The Hay Knot made so as to prevent any chance of slipping.

Fig. 32.—*The Sheep-shank.*

Fig. 33.—Making the Military Tie.

It is often necessary to temporarily shorten a rope, and for this purpose nothing is more satisfactory than the "Sheep-shank" (Fig. 32). If the strain slackens off, or becomes intermittent, there is danger of the knot slipping, especially if the rope is thin. The top of the "Sheep-shank" is the same as the "Hay" knot, and is therefore liable to the same danger of becoming undone. There are several ways of making it more permanent, one of the handiest being the same as is adopted in the "Hay" knot, but in this case taking a half-hitch with the loops both top and bottom.

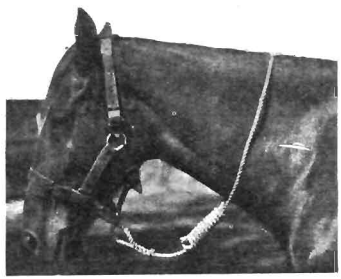
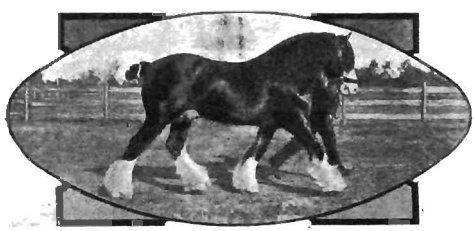


Fig. 34.—The Military Tie Unished.

The "Military Tie" (Figs. 33 and 34) is a handy and neat way of doing up a leading rope. The rope is placed around the horse's neck, with the loose end on the near side where the operator is standing. This loose end is doubled up, and the three ropes held in the left hand. The right hand then winds the loose end around the three held in the left hand, working downwards, till, when it is all used up, the end is passed through the small loop remaining, which is drawn tight to hold it in position. To facilitate undoing the knot, the end is best lashed, as its great disadvantage is the difficulty of drawing out the end, especially after it has become wet.



BLACKSMITHING FOR FARMERS.

The farmer is perhaps called upon more than anyone else to exercise his ingenuity and to meet emergencies, and in the present time of keen competition he must be in a position to help himself. He is called upon in turn to be carpenter, saddler, blacksmith, &c., and it must be admitted that farmers generally have well adapted themselves to circumstances. At the same time, it is noticeable that blacksmithing work is not taken up in the same way as, for instance, carpentry, although in the matter of time, and also of money, it would mean a great saving. When the ironwork of some machine

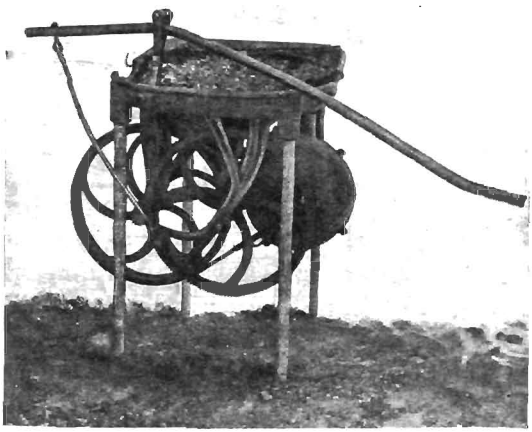


Fig. 1.—A Portable Fan-blast Forge.

breaks, it often means a long journey to the blacksmith, and in many cases if a forge were on the farm this work could be done by the farmer himself.

Another aspect of the question is worthy of consideration. The forge has a peculiar fascination for boys, and placing the facilities at their disposal provides them with a source of amusement, and with an occupation that, with a little skill, can be turned to profitable account, and at the same time will tend to make farm life more interesting.

Forges.

These can be roughly divided into two classes—fan-blast, and the bellows forges. Fan-blast forges are either self-contained—the hearth and blast being in the one forge—or the forge merely consists of a hearth, and the

blast is taken from a pipe connected with a blower. The blower may deliver air to several forges, each being equipped with a valve to regulate the flow. Such forges are only used in the large machine shops.

The portable fan-blast forges, an illustration of which is seen in Fig. 1, are very suitable for farm work. They are made in different sizes, but as the farmer does not usually have to take in hand very heavy work, a medium size will be satisfactory. At the same time a larger forge gives more room for working, and metal can be heated more rapidly. It is doubtful whether it is economy to purchase one of small size, when the outlay of a little more money results in a much superior forge being obtained.

Bellows forges are the kind generally used by blacksmiths. Like the blast forges, they are made in different sizes.

Probably the portable fan-blast forge is the most suitable for farmers' purposes. The fan action produces a very even blast, and the forge has the additional advantage that, being made of iron throughout, it can be exposed to the weather without danger of serious deterioration. When bellows are used the forge must always be housed in a proper shed, or the leather soon perishes.

It is a convenience, especially to those who work on large areas, to have a forge which can be moved easily from place to place. For instance, when tanks are being excavated, or distant paddocks ploughed, it is an advantage to have the forge on the spot. Unless it is portable it cannot easily be moved about.

The prices of fan-blast forges vary considerably. One with a hearth of about 22 or 24 inches square is a good size for most purposes, and costs about £11.*

Smithy.

A good building is required to house the tools and protect the workman from inclement weather. If the tools are not kept together in a definite place they soon become scattered, especially when only occasionally used, and are not at hand when required. Many odd jobs for the smithy accumulate on the farm, and not being matters of urgency are, in the rush of work, left over till a more convenient season. Wet days can be profitably filled in doing work of this class, and necessarily some shelter must be provided as a protection from the rain. Such a building should be located in a high and dry spot, as dampness causes rusting of the tools.

A suitable size is about 12 feet square and 8 or 9 feet high. The roof may be of iron or any other waterproof covering, and the sides of slabs. An opening must be made in the roof to allow fumes to escape readily.

Large numbers of tools of various descriptions accumulate in a shop after a time, and racks should be made for these so that they can be kept in a place where they can be found without difficulty.

The Tools.

The Anvil.—A solid anvil is required. A light one, or a heavy piece of iron, such as is sometimes used, lacks solidity and gives too freely under the hammer. An anvil weighing at least 2 cwt. is required, and this will cost between £8 and £9.* A second-hand anvil, quite suitable for amateurs, can often be obtained cheaply from a local blacksmith.

Vices.—A good strong vice is a necessity. Small vices are very well for light work, but they are practically useless for much of the work a farmer has to do. The ordinary blacksmith's vice, known as a "tail" vice, is

* These prices are subject to variation.

very good. These are generally sold by weight. One with a 5-inch jaw, and weighing between 65 and 80 lb., is a good workable size. Parallel vices cost slightly more than tail vices, but they possess the advantage that a full-faced grip is obtained, regardless of the extent to which the jaws are opened.

Hammers.—Different sizes and shapes are used by smiths, but for farmers' work, a hammer weighing about 2 lb., with a ball end, is all that is required. (Fig. 2). The ball end, or "pene," as it is called, is used in riveting, scarfing, and other work. In some hammers straight or cross penes take the place of the ball end. A straight pene is tapered, somewhat like a blunt chisel, and runs longitudinally with the handle, while a cross pene is at right-angles.

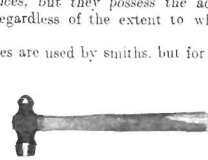


Fig. 2.—A Smith's Hammer.

Sledges are not urgently required by an amateur, but nevertheless a sledge-hammer is very useful on a farm for many purposes. A 10 or 12 lb. sledge is a good size.

The hammers, sledges, and other tools must be firmly attached to their handles. Well-seasoned wood should be used; it is an advantage to have the wood in the shop for some time before making the handles, so that it will be well dried out. Unless it is well-seasoned the heat of the forge shrinks the wood, and the hammer head becomes loose.

The Flatter.—This tool has a broad, flat face, and is used, as its name implies, to flatten or smoothen surfaces after the hammer. The hammer leaves the surface somewhat rough, and a better finish can be obtained with the flatter. Farmers, however, scarcely require this tool, as for all practical purposes sufficient finish can be obtained with the hammer.

Swages are small tools with the faces grooved in different sizes to fit over bars. Some have semicircular grooves, while others have angular ones. What are called top and bottom swages are used. They are ranged in pairs,

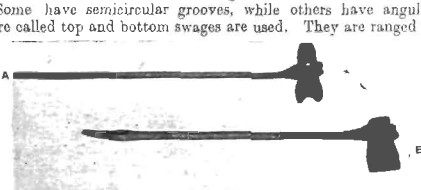


Fig. 3.—A—Top Swage. B—Fuller

one for the top and the other for the bottom. The top swage is fitted with a handle (Fig. 3A), while the bottom one has a stem for fitting into the hole in the anvil. These tools, like the flatter, are generally used for giving a finish, and can well be dispensed with.

Instead of the single swages a *swage block* is occasionally used. This is a large iron block, bearing on its outside surface a series of grooves of varying kinds and sizes, and having its centre pierced with holes. A swage block is of little use on the farm.

Fuller.—This tool has a convex face. It is chiefly used for forming semi-circular grooves or depressions in bars, and sometimes for finishing up corners where a hammer cannot be used. The rounded face does not cut the fibres of iron, but merely alters their direction. The fuller, therefore, when used to make a groove, does not lessen the strength of the iron.

They are made in different sizes. The face forms half of a circle, and the size is taken at the base of the semicircle, or what would be the diameter of a complete circle. Fullers are spoken of as ½-inch, ¾-inch, &c. (Fig. 3B.)

The *Hardie* is a tool with a sharp edge, adapted for cutting hot or cold iron or mild steel. It is fitted with a stem, so that it can be held in the anvil. When a bar of iron is to be cut, it is laid on the sharp edge of the hardie, a smart blow is struck with the hammer, and the bar is then moved round a little for the next blow, and so on until the bar is nicked all round. It is then easily broken by striking a sharp blow on the end, after laying the bar on the anvil with the nicked place just over the edge.

Hot and *cold sets* or *chisels* are steel tools used for cutting either hot or cold metal. They are fitted with handles and are forced into the metal with the hammer or sledge. Hot sets are kept *thinner* in the blade than

Fig. 4.—Cold Set.

Fig. 5.—Set Hammer.

cold sets. Cold sets must be kept thicker on account of the risk of breakage. These are tempered, but it is little use tempering the hot sets, as the heat of the metal cut by them soon withdraws the temper. (Fig. 4.)

Set Hammer.—This is somewhat similar to the flatter, but is made smaller in the face. (Fig. 5.) It is chiefly used for reaching those places where ordinary hammering cannot be done, as in angles. It is placed on the spot which requires working and struck with the sledge.

Punches are made circular, oval, oblong, and square in different sizes, and are fitted with handles for use.

Mandrels are slightly tapered tools used for finishing up holes after punching, shaping rings, &c. They are made in different sizes.

Bolster.—This is a steel or iron bar or block, containing holes or cavities for forming up different classes of work. The holes are round, square, and slotted, according to the class of work for which they are intended. If a

head is required on a bar or bolt it is upset a little to thicken the end so that it will not slip right through the bolster; the bar is then heated and dropped as far as it will go through the selected hole, and driven with the hammer. The effect of the hammer is to form a head on the bar from the upset metal.

The *tongs* vary in size and construction according to the nature of the work, and each blacksmith makes them to his own liking. The illustrations show some forms which have been found very handy where the work consists chiefly of repairs to farm tools or implements.

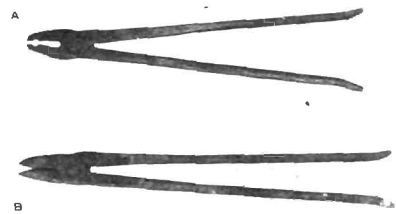


Fig. 6.—A—Tongs for holding Links. B General purpose Tongs.

Fig. 6A shows a pair of tongs adapted for holding small links whilst welding. The jaws should only be about ½ inch wide, and have a small groove near the points to enable a firm grip of the link to be obtained.

Fig. 6B shows a pair suitable for general purposes.

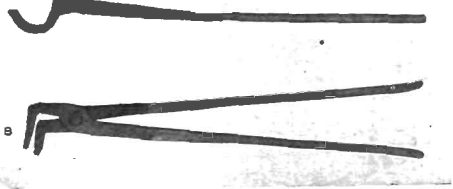


Fig. 7.—A—Tongs for holding Bolts. B—Tongs for holding Round Stocks.

Fig. 7A illustrates tongs for holding bolts. The rounded jaws leave room for the head, and enable the points to take a firm hold of the bolt.

The tongs in Fig. 7B are designed for holding hoops and flat rings, such as the round stocks of dray wheels, &c. This form gives such a grip that, when hammering, the work can be brought into the required position by merely turning the wrist. This is an important point, as iron cools quickly, and everything must be arranged so that no time whatever is wasted.

Fig. 8A shows a pair of tongs for holding a ploughshare. The lower two-pointed curved jaw is obtained by making an ordinary flat jaw about 1½ inches longer than the upper one. This jaw is split down the centre, and each section curved as shown, and the tips turned in at right-angles to prevent the share from moving from side to side. Similar tongs, smaller in size, are used for holding coulters.

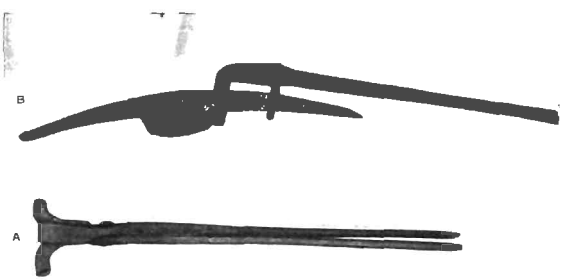


Fig. 8.—A—Tongs for holding Ploughshares. B—Tongs for holding a Pick.

Fig. 8B is an illustration of tongs for holding a pick. The jaws are curved round as shown, and are helped by a ring, an end of which holds the two parts of the tongs together instead of the usual rivet.

The Fire.

The best coal must be selected. Coal which crumbles up when firmly pressed in the hand, and has a bright glassy face on the fractures, as a rule gives the best fire. Hard dull-coloured coal, or bright splintery coal, does not make a good fire. Some of the dull hard coal is very unsuitable. It often contains a good deal of gas, burns away rapidly to white ash, does not bind when heated, and instead of forming a close-textured coke, falls to pieces. In a fire of this class a high heat cannot be obtained, and the fire does not last long.

Coal is generally used by smiths for firing, but in some of the bigger shops coke is used. As a matter of fact, it is coke which produces the heat in the small smith's fire also, the only difference being that the coke is produced from the coal by the smith on his own hearth.

Where coal is not obtainable, charcoal is a good substitute. In the pioneering days of the State, when transportation was difficult, charcoal was much used, but during recent years coal has almost altogether taken its place.

The place for the fire is immediately in front of the tue pipe, or, in those forges where the tue opening is in the centre, immediately above it. The tue pipe is the pipe which leads the blast to the fire.

The cinders, ashes, &c., of the last fire should be scraped away to leave a depression exposing the mouth of the tue pipe. All the coal, cinders, &c., on the top of the forge must not be removed, as these are required to keep the heat in the fire. The actual space on the hearth occupied by the fire is comparatively small, and the remainder of the surface, with its coal, &c., *acts, so to speak, as an insulator.*

Shavings, small chips, &c., are placed in the bed of the depression and lighted. When they are well ablaze, coke from the previous fire is put on, and the fire forced with the blast. Green coal, *i.e.*, fresh coal moistened with water, is finally added.

The actual heating material in the fire is coke, which is produced on the hearth by the action of the fire. In its formation from coal the volatile components, such as gases, &c., are driven off, and practically little left but carbon and ash. The special value of coke lies in its difficulty of combustion, which enables it to be brought to a high temperature under blast, and its freedom from flame and smoke.

In practice, green coal is backed up behind the fire. The heat converts it into coke gradually, and when the fire begins to get low, some of this coke is drawn down. *At the same time the coal forces the fire forward and prevents* it coming in contact with the tue pipe.

The coke, in addition to acting as fuel, serves as a coat to keep the heat in the centre of the fire. If the fire breaks through this coat, the heat passes out into the air, and it is difficult to secure a good welding heat.

The fire is not ready for use until a good supply of coke has formed. It must be cleaned regularly, as the coke burns away, by throwing out the clinkers, and fresh coke drawn in from the back or sides. The character of the fire has a most important influence upon the nature of the work turned out. It is, in fact, practically impossible to produce good work with a bad fire. This applies particularly to welds.

Effect of Heat upon Iron.

To appreciate the importance of the fire, *its effect upon iron and steel* must be understood. These metals, when cold, are hard, and cannot be changed in form without in some way injuring their strength. When, however, they are properly heated they can be worked at will without in any way impairing the strength. Heat causes marked changes in the metal. It becomes easily flexible, and if heated still further, plastic, and finally passes into a molten condition. A homely illustration of the behaviour of iron is seen in the change which takes place in wax when heated. It gradually passes from a hard state into a pliable, then into a plastic, and finally into a molten condition. The changes in iron are not quite the same, but are near enough for illustration.

It is owing to the properties of iron when in the heated condition that it is so valuable. Thick bars can be made thinner, thin bars can be thickened, it can be twisted into all conceivable shapes without impairing its strength, and, finally, separate pieces can be welded into one so firmly that where the joint is made the iron is as strong as in any other part.

When iron is being heated, it must be borne in mind that the right heated condition can only be obtained in a fire where there is little or no excess of air. A certain amount of air must be forced into the fire. If insufficient is forced in, heating takes place slowly, whilst on the other hand, if the blast is made too strong, burning takes place rapidly, but still the fire cannot use up all the air. The iron becomes very hot on the surface while the inner part is still comparatively cool. Now when its temperature becomes very high in the presence of air, iron "burns." It is probably difficult to realise that practically the same burning that takes place in wood can occur in iron. It is, however, the case, that when iron is heated to a very high temperature and air is present burning does occur.

This can be proved by placing a piece of iron in a fire and forcing in a heavy blast. In a short time brilliant sparks begin to fly off, and in a little while the iron is all burnt away. When such burning iron is removed from the fire, shooting sparks continue to fly off until it cools.

If the substance composing the sparks is collected and examined after cooling, it will be found very different from iron. It has a dull, slaty or bluish appearance, and is very brittle. It is iron changed into oxide of iron; that is, the iron has combined with oxygen and formed a material which has not the properties of the original metal. This oxide is seen in the scale found on and around the blacksmith's anvil.

The burning of iron is one of the first difficulties with which the amateur has to contend. So long as the fire cannot be so controlled that burning is prevented, good work is almost impossible.

From what has been said it will be seen that burning is due to iron at an intense heat coming in contact with air. The burning, therefore, can be largely prevented by blowing in only just as much air as can be used by the fire. If much over this is blown in, the iron commences to burn. The degrees of burning vary considerably; in the hands of a raw beginner a considerable portion of the iron may be burnt away, and even experienced workmen cannot altogether prevent the formation of some scale. This is objectionable in any class of work; proper welding is interfered with, and in ordinary forging the iron is pitted and roughened.

Fluxes are used to aid in preventing the formation of scale. Those generally used are sand or borax, either singly or mixed in the proportion of 3 of sand to 1 of borax. The flux should be sprinkled on the iron when it has reached a yellow heat, using sufficient to cover the whole of the surface, especially the parts to be welded. It melts under the heat, flows over the surface of the iron, and forms a protective covering or coat. This covering prevents the air coming in contact with the iron, and burning does not take place, or at least not nearly so easily. Besides this, the molten flux causes any scale which has already formed to melt, and when a weld is being made this fluid scale is forced from between the parts. The objectionable features of scale are its hardness and brittleness, and that when it covers the surface of iron, and an attempt is made to weld, it prevents perfect union.

Welding.

This is often looked upon as a most difficult operation, and one which can only be satisfactorily performed by an experienced smith. Whilst most men are ready to do many of the rougher kinds of forge work, few care to attempt welding. In many cases this is due to failure in attempts made when the underlying principles have not been understood. If the why and wherefore are not known, attempts at welding are gropings in the dark, and the rare successes due merely to chance.

To obtain a good weld, the first requirement is to secure the right heat in both pieces. Where iron is to be welded to iron or mild steel, this is comparatively easy. Other kinds of metal are more difficult to weld and require some skill. If the pieces of iron are of unequal size, care must be taken that the smaller is not overheated. This can be done by starting one before the other, or, if one shows greater heat than the other, by taking the hotter out to cool a little.

When iron and mild steel are heated they gradually change from a hard condition into a softer state. When a certain temperature is reached they become pasty, and if two pieces in a like condition are brought into contact a certain stickiness is noticeable. This is the right welding heat. It is only *metals like iron and steel, which become slowly softer before passing into* a molten condition, that can be welded. Some cannot be. Lead, as an example, passes suddenly from a hard condition into a molten state without any *perceptible intermediate stage.*

A further essential to a good weld is that the iron is thoroughly heated right through, and not merely superficially. A comparatively slow fire is required to obtain this. If heating is done too rapidly, only the outer surface is heated, and when the iron is taken from the fire it rapidly cools, so that the time required to form the weld is not available. Perhaps the best rule to follow is to heat slowly and notice when the metal comes into the sticky condition shown when the two pieces touch each other. If the iron is too cold welding of course cannot be done, while if the temperature is taken too *high, burning will occur and the iron become crumbly.*

A clean fire is required. In a dirty fire pieces of clinker, cinder, &c., *adhere to the metal and, getting in between the two pieces, cause flaws in* the weld. As mentioned before, the fire must also consist of compact burning coke, fed with the right amount of air.

Everything must be in readiness to proceed at once when the iron is sufficiently heated. When it is taken from the fire it cools rapidly, and no time must be lost. The anvil should be clean, and all tools at hand, so that they can be picked up without even looking for them.

Different forms of welds are used according to the nature of the work. *Each differs in some respect, and different methods of preparing for* the weld are adopted. The main preparation consists of upsetting and scarfing. The hammering when welding tends to reduce the thickness of the iron at that particular point, and to compensate for this both pieces of the weld must be upset as described a few pages further on.

Scarfing is the thinning down, with the hammer, of the tips of the parts to *be welded, so that they will fit together and weld without much hammering.* A more perfect weld is obtained, and less drawing down will be required to finish up the work after welding.

Scarfing is done usually with the pene of the hammer. Generally it can be done by the smith, but, to secure exactitude, it is necessary in some cases for the smith to hold the pene in position while the helper strikes with the sledge. It is done whilst the iron is just at a yellow heat, and before the pieces are returned to the fire for the final welding heat, they should be carefully fitted so that they are in close contact with each other. If this is not done, welding cannot be proceeded with at once, and the lost time results in defective work.

Different Kinds of Welds.

Fig. 9 shows one of the best methods of scarfing when simple straight bars are to be welded. A weld scarfed thus, is made by hammering directly downwards as shown by the arrows, and there is no danger of the two

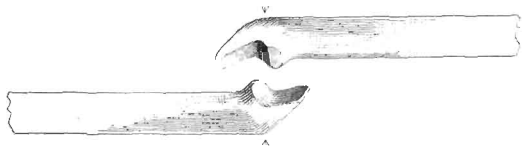


Fig. 9.—Lap Weld.

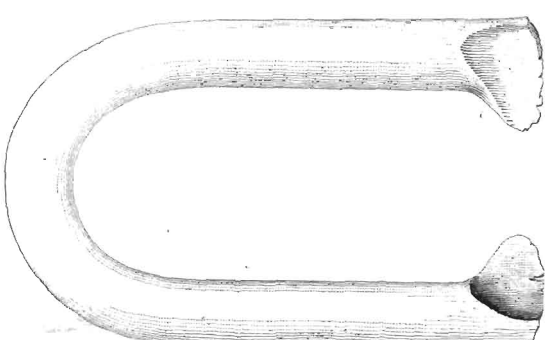


Fig. 10.—Link or Ring Weld.

parts being forced away from each other by the pressure of the blows. Other kinds of welds are recommended for this class of work, but in most of them the blows cannot be directed at right angles to the work and the anvil, and consequently it is more difficult to obtain a satisfactory weld.

Fig. 10 shows the scarfing for a link or ring. It is a simple form, and requires little explanation. As shown in the illustration, not much scarfing is required. After scarfing, the two ends are brought round and overlapped.

In welding, and indeed in any work, it is most important that a firm hold be obtained with the tongs. Those shown in Fig. 6A, which have slight grooves in the jaw, are very good for holding links and rings.

Fig. 11.—Angle Weld.

A method of scarfing for angle welding is illustrated in Fig. 11. By using this scarf, any required angle on the inner or outer side can be obtained. As in other welds, the ends must be slightly upset before scarfing.

Scarfing for either round or rectangular iron is shown in Fig. 12. The upper bar, A, is upset at the point of scarfing by heating and cooling off in water except where the

Fig. 12.—T Weld.

upsetting is done, to localise the heat. The bar is then held vertically on the anvil and hammered on the end. After every two or three blows it bends, and this must be corrected on the face of the anvil, and the upsetting proceeded with until a sufficient thickness is obtained. The scarfing of B is done by the smith holding the bar with the pene in position on it while the striker uses the sledge.

Fig. 13 illustrates a good method of welding for certain classes of work. The bar A is heated, and with a pene and sledge a cavity is made as shown.

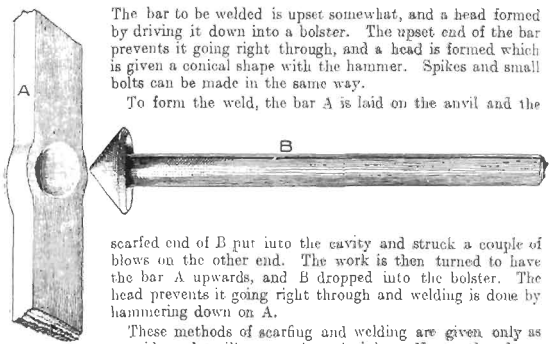


Fig. 13.
Butt Weld.

The bar to be welded is upset somewhat, and a head formed by driving it down into a bolster. The upset end of the bar prevents it going right through, and a head is formed which is given a conical shape with the hammer. Spikes and small bolts can be made in the same way.

To form the weld, the bar A is laid on the anvil and the scarfed end of B put into the cavity and struck a couple of blows on the other end. The work is then turned to have the bar A upwards, and B dropped into the bolster. The head prevents it going right through and welding is done by hammering down on A.

These methods of scarfing and welding are given only as a guide and to illustrate the principles. Many other forms are used, but the smith who grasps the idea of what is required can adapt himself readily to circumstances and devise methods for himself.

In welding, the length of the material decreases somewhat. A rough rule followed by many practical smiths is to allow a length equal to the thickness of the bars for shrinkage.

In the actual process of welding the scarfed points must be stuck together as soon as possible, as these, being thin, cool out quickly.

Drawing Down.

This means the reduction of the size of a bar of iron by hammering whilst it is at a high temperature. By proper direction of the blows the iron can be drawn down into any shape without injuring the strength. This can only be done at a high temperature and even then, the process is a slow one, and only advisable when it means a saving of labour in other ways, or better work being turned out. Where an article varies considerably in size at different points, as, for instance, a pair of tongs, less labour will be involved if a bar large enough to form the jaws is taken, and (after the jaws have have been formed) is drawn down, than if a thinner bar is taken and upset to give size for the thick section. In the case of tong-making, the necessity of drawing down a thick bar sufficiently to form the handle is avoided by drawing down a little and welding on a sufficient length of a thinner bar.

A blacksmith at work may draw down, upset, or weld his iron as it suits his purpose. As his whole object is to turn out work with the least amount of labour, it is difficult to set definite limits to the place of each.

The manner in which drawing down is done is determined by the kind of work. If it is merely a matter of tapering off to form a point, as when making a hook, the procedure is different from that followed when the size is suddenly reduced as in Fig. 14.

The first essential is a good heat. What is called a good welding heat gives the best results. If not heated sufficiently the bar will almost certainly split during the process.

When it is required to reduce the thickness of a bar from A to the thickness B, the first step is to fuller the bar, as in Fig. 14A. The fullering reduces the thickness abruptly at the right point, and it is an easy matter to get the thickness in 14B.

When the rounded fuller is used, no injury is done to the iron. A bar if broken shows a fibrous structure like the grain in wood, and it is this property which enables it to be bent at the will of the smith. It is absolutely essential

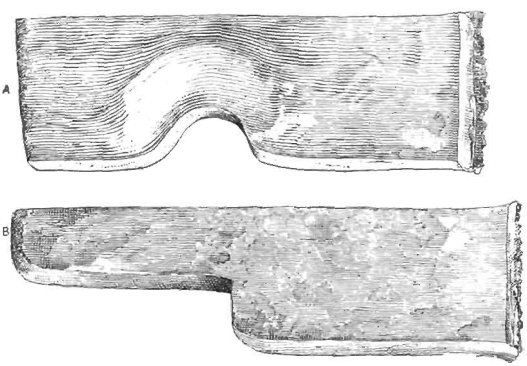


Fig. 14.—Drawing Down. A—Bar fullered. B—Bar drawn down.

that the fibre of the iron should be maintained. If iron is nicked with a sharp tool the fibre is destroyed, and it can easily be broken. A peculiarity of iron is that if a bar is cut round with a chisel it can be snapped off readily, and the fractured structure shows a crystalline nature instead of the fibrous condition seen when it is broken without nicking. When the fuller is used to make a depression, it merely changes the direction of the fibre without causing any break.

To draw the bar down after fullering, it is taken up to welding heat, laid upon the anvil and hammering commenced about 1½ inches from the end farthest from the smith. The bar must be worked down in square section without regard to its ultimate shape. For instance, if a ¾ inch round bar is to be reduced to ½ inch round, it must be worked down to about ½ inch square before commencing to round it. If an attempt is made to draw it down in a round form, splitting is sure to occur. When the bar is laid on the anvil and struck with the hammer, the effect is to make it spread sideways as well as to increase in length. The side-spread must be prevented by turning the bar a quarter round quickly so that it is hammered on every side.

The cooling of the bar prevents it being drawn down very much after each heating. The thickness of the bar, the quality of the metal, and the skill of the smith determine the amount. As a rule, with ordinary sized work, about $1\frac{1}{2}$ to 2 inches are all that can be drawn down at each heating with safety.

When the size has been reduced sufficiently in square form, finishing off is commenced. The corners of each side are hammered flat, forming an eight-sided section. The corners are again flattened, until finally the round form is obtained. This procedure must be carefully followed, otherwise the iron will split.

When a bar is to be merely drawn down to a point, fullering is not done, but the procedure is otherwise the same.

Upsetting, or Jumping Up.

This is a process followed by smiths to increase the bulk of metal at a certain point, and is the reverse of drawing down. It takes more time and care than the latter. A high temperature is required, and the heat must be localised—that is, confined to the spot where the upsetting is to be done. It follows therefore that a bar can be upset either at the ends or at any point along its length.

Different methods are followed. The bar may be taken in the hands and jumped down vertically on the anvil; it may be laid on the anvil and upset with the sledge; it may be held in the vice and upset with the hammer; or it may be held vertically on the anvil and upset in the same way.

When upsetting, it is necessary to see that the spread of the metal is in the right direction. If the blows are not carefully delivered, and the work straightened as required, the thickening may be in the wrong direction. During upsetting the fibres in the iron are forced apart, and hammering must be done after upsetting to restore the close texture.

Punching.

Different methods of punching are followed. Where it is not desired to expand the size of the section, a punch only a little smaller than the hole required is used. The metal is held over a bolster, or the hole in the anvil, and punched half-way through, then turned over and punched from the opposite side. A piece of the iron is punched out, leaving a hole nearly the right size. It is finished up to the correct dimensions by tapping in a mandrel and working on this. By this method a good deal of the metal is taken out, but the size of the section is not increased.

Another method is to punch out a small hole and gradually expand this hole with tapered tools until it is sufficiently large. When the holes are thus punched, very little metal is cut out, but the iron is swelled outwards a good deal. The eyes in hooks are often made in this way.

Tempering.

The temper of steel means the degree of hardness and the condition of the grain. Temper in rough tools is generally obtained by heating the steel and then cooling in cold water. If the temperature is too low the steel will be left soft, with a coarse grain, while if it is heated too much the steel will be brittle, and will probably have a coarse grain. The cooling also plays an important part. If it is too rapid the steel will be very hard, while if it is too

slow it will be soft. To get a good temper, therefore, the temperature must be right, and the cooling must be done properly. This is a matter of some difficulty, and a little practice is required. It is better not to cool off too rapidly, because if the temper does happen to be a bit soft, it is a simple matter to temper again, but if the tool is made too hard and used, it will probably break at once.

The following method is generally adopted in tempering picks, mattocks, cold chisels, &c.:—A dull red heat is obtained, and the tool is chilled by immersing about ½ to 1 inch of the point in cold water for three or four seconds. *It should be kept moving in the water.* It is then withdrawn, and in a moment a pale straw colour should come into the point. After this a dark blue comes, and finally this turns into a pale blue. This pale blue colour must be waited for. Each colour is quite distinct. If the pale blue does not come the tool will be too hard, while if it passes off quickly the tool will be too soft. After the pale blue comes the tool is dipped in water and cooled right out. After tempering in this way the tool should be so hard that the file just grips it.

Examples.

A description of the methods followed in actual practice will indicate in the best way the different operations. In a short article of this kind it is impossible to deal with the more complicated work; and indeed it is not necessary, as the amateur can only expect to do simple work.

Laying a pick is a class of work that farmers sometimes require to do. Blister steel is used for the work. A convenient sized bar to take is 1 in. x ½ in., about 2 inches long. It is drawn down in wedge form to about 3 inches, and left slightly wider than the blade of the pick. After drawing down, the lay and the pick are put into the fire and brought to a welding heat. Then with a few sharp blows the steel lay is stuck to the point of the pick, keeping the thick end of the lay at the point (Fig. 15). It is sufficient if the two are stuck together at the first heat; the welding is completed at the next.

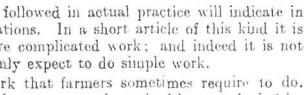


Fig. 15.—Laying a Pick.
The steel lay is shown stuck on to the pick.

If the pick has worn back into a very stumpy state, the steel point is stuck on as above but not completely welded, and a piece of tapered iron is stuck to the upper side of the lay, extending back with the thin end almost at the eye of the pick. The work is then returned to the fire, a fresh welding heat obtained, and the iron and steel lays welded to the pick together. About 3 inches can be welded at each heat, and about three heats will be required to complete the welding. The object of laying with the iron is to increase the length of the pick blade. The steel lay is inserted between the iron and pick, but the subsequent hammering, when drawing the pick into shape, brings it out to form the hard cutting point.

In some cases the laying is done by splitting the point of the pick and inserting the lay. Welding then proceeds as usual.

After the welding has been done, the pick is drawn down into shape and tempered.

Laying a Ploughshare.

The laying consists of welding a piece of iron on the point and wing to replace the loss by wear. The size and length of iron used for the lay is determined by the size of the share. For a large share, 1 in. x ⅝ in. iron, long enough to extend from about 2 inches in front of the worn point to the rear point of the wing, with a little over, is used. This is prepared in the form shown in Fig. 16A, and bevelled on the lower side, leaving the upper side nearly level. Bevelling increases the width of the lay.

The share is prepared for laying as shown in Fig. 16B. The curving is done by heating the share and hammering it down while held in the vice. The object of the curving is to allow for the bending backwards that takes place

Fig. 16.—A—Lay for a Ploughshare. B—Share prepared for laying.

when welding. The result is that when welding is finished, the share is practically straight, while if the bending were not done the hammering during welding would leave the share bent back, and some difficulty would be experienced in getting it straight again.

The share is scarfed for welding by heating the wing and hammering it down, so that when the lay is put on, the two fit together well. When both are ready they are brought to a welding heat, and the share is held bottom up on the anvil by the smith with one hand, while with the other the point of the lay is laid on the point of the share and struck with the sledge by the striker. The point is finished up by the smith with the hammer. With the two attached in this way it is a simple matter to bring the lay down to the shape of the wing. It should project about ¼ inch out along the side of the wing.

Fig. 17.—The lay ready for welding.

Fig. 17 shows the lay attached to the point and hammered into shape ready for welding. It is got into place by first knocking the lay into the right position on the rear point of the wing and it is then grasped there with the tongs and held while it is hammered in the centre and along the wing until it projects the same distance right along.

So prepared, the share is ready for the welding, which is done from the point backwards. The depression forming the frog of the share makes welding somewhat difficult at that point. This difficulty can be overcome by using the set hammer shown in Fig. 5. This is placed on the lay in the frog and struck with the sledge.

Fig. 18.—The finished Share.

About four or five heats are usually required in welding a share such as that shown. The welding of 3 or 4 inches at a time is fairly good work. Fig. 18 shows the share after laying has been finished.

Laying the Point of a Share.

This consists of welding a piece of iron to the point of the share. Bar iron 1½ in. x ⅝ in. and 3 inches long is taken and scarfed as shown in Fig. 19. The lay is welded to the underside of the point, and when scarfing the lay, the hammering should be done on the opposite side from that which is to *be in contact with the share, so that the projection shown in the lay will fit* down well on to the share. The welding is similar to that adopted when laying a pick.

It will be noticed that iron is used in laying both the point and wing of a share. This is so soft that in its natural state it wears away rapidly. The wearing can be prevented by what is called "casting." After the share is laid, it is brought up to a welding heat, and at the same time a thin piece of cast-iron is heated to a dull red. While the welding heat is on the share, the *red hot* cast-iron is rubbed over it in the fire. The heat of the iron melts the cast-iron, and a liquid coat is obtained. When sufficient of the cast-iron has been melted, the share is taken from the fire, and with an old file or rasp *the molten coating is* spread evenly over the point of the share. The effect is to give a coating of intense hardness, which makes *the share last very much longer.* Any cast-iron, such as a broken saucepan, kettle, &c., can be used. The thinner it is the better, as it melts more easily.

Fig. 19.—Laying the point of a Ploughshare.

TANK-MAKING.

In the construction of corrugated galvanised iron tanks 24-gauge iron is generally used, and it can be procured already curved to the sizes required. For a tank of 200 gallons capacity, two sheets 10 feet long would be necessary, curved to a full circle and joined by a 4 inch lap (*see* Fig 1)

The method most often adopted in rivetting the seams, is to clamp a small hand-vice at the top and bottom, then put in a couple of rivets at each end, after which the hand-vices may be removed. Small galvanised roof bolts can also be used to hold the iron in position.

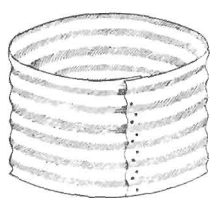


Fig. 1.

The holes for the rivets are punched from the outside, a piece of hardwood being held on the inside as a "dolly"; the rivets are distributed about 2 inches apart, or one to each corrugation. The rivets are put in the holes from the outside, an iron dolly being held to the heads, the washers placed in position and the rivets hammered down and snapped on the inside.

The second cylinder of the tank is fastened at the top, and then placed over the first cylinder (*see* Fig. 2), and lowered until the required lap is reached; one or one-and-a-half corrugations should be sufficient in a small tank. A rope is then passed round

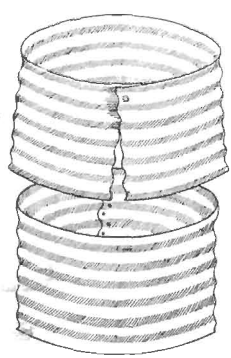


Fig. 2.

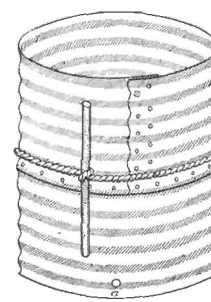


Fig. 3.

the body of the tank, with a short piece of pipe to form a tourniquet or twitch, and this is tightened until the seam is in position (*see* Fig. 3). Punching and riveting is then proceeded with.

A tank that consists of two sections only should have the vertical seams on opposite sides. Taking the line of the corrugations as a guide, the joint round the centre of the tank is easily adjusted, and should have a single line of rivets about 8 inches apart.

The next operation is to turn a flange on the body of the tank in preparation for the fitting of the bottom. This is done as shown in Figs. 4 and 5. As the tank now stands, the top or outside cylinder will be that to which the bottom is fitted. A line is drawn half an inch from the top edge, and the flange beaten over on a "hand-stake." Where this tool is not available, an ordinary laundry flat iron makes a very good substitute. For the bottom, one sheet of 24 gauge galvanised flat iron, 72 x 36 inches, will be required.

Fig. 4.

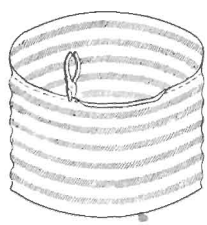


Fig. 5.

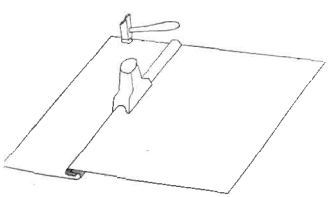


Fig. 6.

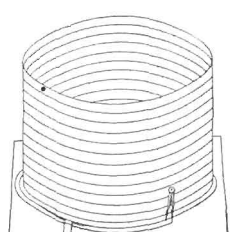


Fig. 7.

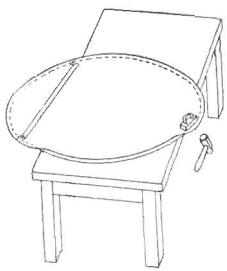


Fig. 8.

As this sheet will not be wide enough for the full diameter of the tank, it will need to be cut and joined together by a grooved seam (*see* Fig. 6). To form the seam a $\frac{5}{16}$-inch seaming tool or groover is used, the raised side of the seam being kept on top to go inside the tank. To insure a neat fold round the bottom it is necessary that the grooved seam be thinned down at each end (*see* Fig. 8).

The tank is then turned over, and the flanged end laid on the sheet of iron, and scribed round with a small pair of compasses (Fig. 7), a margin of $\frac{3}{4}$-inch being allowed for the turn-up. This method of striking out a tank bottom is usually adopted when compasses sufficiently large are not available. Care should be taken in the operation, as if the measurements are not fairly accurate, buckling and distortion may occur later.

The bottom being cut out, it is now placed on a bench, and flanged to the line previously marked. This is done by placing the flat iron on the line and beating the marked margin up to nearly a right angle, as shown in Fig. 8. Then the body is fitted to the bottom as in Fig. 9, and the flange closed down as in Fig. 10. A hole should be punched for the tap near the bottom of the tank (*see* Fig. 17), large enough to allow a $\frac{3}{4}$-inch water pipe socket to enter. A 2-inch hole is also cut close to the top for an overflow outlet (Fig. 17). The top edge of the tank may now be flanged over, as was previously done for the bottom.

Fig. 9.

Fig. 10.

For the lid, one sheet of 26-gauge galvanised plain iron 72 x 36 inches will be needed, and this should be cut and joined with a grooved seam as with the bottom (Fig. 6), or riveted as in Fig. 11.

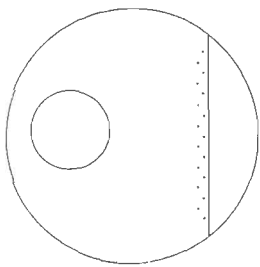


Fig. 11.

The lid is marked out as in Fig. 7 and a 15-inch circle struck for the *mouth or manhole; this can be placed* in the centre or near the side as required. The flange is then beaten up as in Fig. 8.

Around the mouth a strengthening collar is usually placed, this is made by taking a strip of plain galvanised iron about 2 inches wide, and of a *length sufficient to circle the opening* and allow of a 1-inch overlap, and cut as in Fig. 12. It is now turned up as in Fig. 13, and a rod of ¼-inch round iron of similar length is enclosed (Fig. 14), three quarters of an inch of the round iron being left protruding at the lap end to strengthen the joint. Next, round the collar up as shown in Fig. 15, and secure with a small rivet. Insert the collar in the mouth, and beat the flange over, as in Fig. 16.

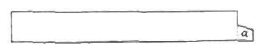


Fig. 12.

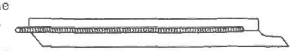


Fig. 13.

Fig. 14.

In fitting the lid to the tank, the same procedure is followed as with the bottom. Fig. 17 shows the lid in position. A movable strainer is usually let into the mouth of the tank (*see* Fig. 20).

A brass ¾-inch low pressure or range tap will be required. The ¾-inch socket is now inserted about a quarter of its length in the hole already made, and soldered firmly in position. The socket is supported by a boss (*see* Fig. 18) which is easily made from a piece of plain galvanised iron, 9 inches x 4 inches; cut a hole 1¼ inches diameter, and then shape as shown in Fig. 19, by bending along the dotted lines. The boss will then have a rough resemblance to a funnel, the small end being made to fit tightly around the

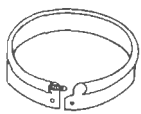


Fig. 15.

Fig. 16.

end of the socket, and the other end trimmed to the contour of the tank (*see* Fig. 17). Then solder the boss securely to the tank, also along the joint, and round the socket.

There remains now only the soldering to complete the tank. For this a fairly heavy soldering iron, weighing not less than 2 lb. should be used. All rivet heads and seams on the outside of the tank must be carefully soldered, extra care being taken with the bottom. Finally the tap may be screwed into place.

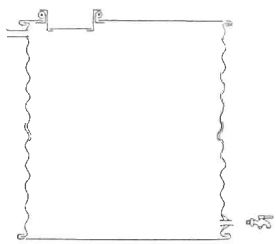


Fig. 17.

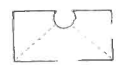


Fig. 18.

About 4 lb. of solder will be required for the above tank, and 4 lb. of rivets and washers. The rivets used are the ordinary galvanised tank rivets with round heads, and they are usually sold with the washers.

Fig. 21 shows the tools required. A riveting hammer and a 2-lb. soldering iron will also be necessary.

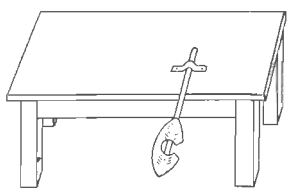


Fig. 19.

Fig. 20.

The foregoing details can be applied in constructing tanks of all capacities.

When building tanks of more than 4 feet high, the vertical seam on the third cylinder should be over that of the first cylinder (*see* Fig. 22).

Tanks of 800 gallons and upwards should have a lap of two corrugations around the body, and a double ring of rivets (*see* Fig. 22).

The following is a description of the materials necessary in the making of tanks up to 1,000 gallons.

The 200-gallon tank has already been dealt with.

400 GALLONS: SIZE, 3 FEET 9 INCHES DIAMETER × 6 FEET HIGH.

6 sheets galvanised corrugated iron 6 feet × 24 gauge, each curved to half a circle.
1 ,, ,, plain iron 6 feet × 3 feet × 24 gauge.
1 ,, ,, ,, ,, 6 feet × 3 feet × 26 gauge.
About 6 lb. solder, 6 lb. rivets and washers.

600 GALLONS: SIZE, 4 FEET 4 INCHES DIAMETER, × 6 FEET HIGH.

6 sheets galvanised corrugated iron 7 feet × 24 gauge, each curved to half a circle.
2 ,, ,, plain iron 6 feet × 2 feet × 24 gauge.
2 ,, ,, ,, ,, 6 feet × 2 feet × 26 gauge.
6 lb. solder, 6 lb. rivets and washers.

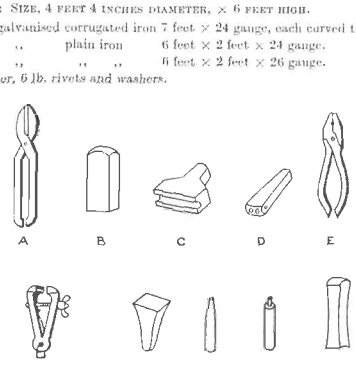


Fig. 21.

800 GALLONS: SIZE 5 FEET 3 INCHES DIAMETER × 6 FEET HIGH.

3 sheets galvanised corrugated iron 8 feet × 24 gauge, each curved to half a circle.
3 ,, ,, ,, ,, 9 feet × 24 gauge, each curved to half a circle.
Note.—Join one 8 feet sheet and one 9 feet to form a circle.
1 sheet galvanised plain iron 6 feet × 2 ft. 6 in. × 24 gauge.
1 ,, ,, 6 feet × 3 feet × 24 gauge.
1 ,, ,, 6 feet × 2 ft. 6 in. × 26 gauge.
1 ,, ,, 6 feet × 3 feet × 26 gauge.
7 lb. solder, 7 lb. rivets and washers.

1,000 GALLONS: SIZE 6 FEET DIAMETER × 6 FEET HIGH.

3 sheets galvanised corrugated iron 9 feet × 24 gauge each curved to half a circle.
3 ,, ,, ,, 10 feet × 24 gauge each curved to half a circle.
Note.—Join one 9 feet sheet and one 10 feet to form a circle.
2 sheets galvanised plain iron 6 feet × 3 feet × 24 gauge.
2 ,, ,, 6 feet × 3 feet × 26 gauge.

For each tank a ¾-inch tap and socket will be required. If a quick delivery is desired in the larger tanks a 1-inch tap and socket could be fitted.

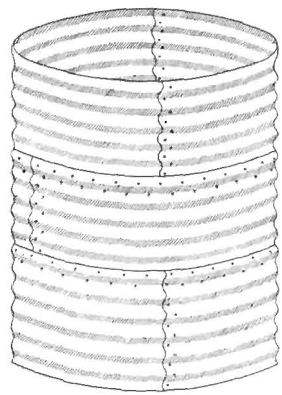


Fig. 22.

A Few Hints on Soldering.

Solder is the name given to several different alloys used for the purpose of making joints between different metals, which, if properly done, does not consist merely of sticking the metals together, but forms a real weld or a fresh alloy.

The composition varies a good deal. Every solder should, and must, be more *fusible than the metal to be united or joined together; therefore, hard* solders can only be used on metals that will stand a high temperature without melting. Soft solders melt at a low temperature, and may be more generally used. A suitable solder for galvanised-iron work is one containing equal parts of tin and lead. For tin-plate work a solder richer in tin is generally used.

The materials and tools necessary for soldering work are hydrochloric acid (also known as muriatic acid and spirits of salts), solder, and a soldering iron. Where much work is to be done, it is as well to have two irons, so that one is heating up while the other is in use.

Preparatory to soldering, the surfaces to be united must be made perfectly clean, and they should fit closely together. Protect the cleaned surfaces from the air by coating them with a suitable flux. The usual flux for iron and

tin is spirits of salts. For galvanised-iron work the acid is generally used in the raw state, although some workmen prefer it partially "killed," because the raw acid is likely to stain the work if allowed to run off the parts intended to be soldered. On the other hand, a soldered joint in galvanised-iron work is much stronger if raw acid is used. For tin-plate work "killed" acid is best. To "kill" the acid, procure some clean sheet zinc cuttings. Place the acid in an old china cup or stone jar and add a few pieces of the zinc cuttings. After the first violent frothing ceases, add more zinc cuttings until some of the zinc is still undissolved after the chemical action stops, but remove such portions before use. It is also advisable to strain the liquid. No water should be added. The flux is now ready for use, and as it is a very corrosive poison it should be kept well out of the reach of children.

Almost any fire will do to heat the soldering iron, although for outdoor work a portable firepot will be found most convenient. One can be readily made from a petrol tin or oil drum by punching a few holes in the bottom for draught, and one in the side near the bottom large enough to receive the soldering iron.

Before the soldering iron can be used it must be tinned. This is done by filing the end bright, then heating it and rubbing it on a piece of tin plate that has been previously covered with a small quantity of "killed" acid and solder. If the iron is at the right temperature, the part that has been filed bright will be evenly coated with solder. Should the tinning be burnt off at any time—this will occur if the iron is left in the fire until red hot—it must be re-tinned, otherwise the work performed with it will be unsatisfactory.

To proceed with the actual soldering work, apply the acid to the joint by means of a small brush; take the iron from the fire and clean it by wiping it on a piece of bagging and then dipping it into a vessel containing water to which a little "killed" acid has been added; manipulate the iron with one hand and the stick of solder with the other. Commence at one end of the joint, supply solder as required by placing the end of the solder stick against the iron near the point. When the solder ceases to run freely, it is a sure sign that the iron needs re-heating. When soldering a loose patch, it will be found convenient to run a drop of solder on to the joint first, then hold the patch in place with the aid of the solder stick while the iron is operated to make the patch firm.

In the case of repair work where it is desired to use up old material, see that the joints are free from rust before attempting to solder. These may be cleaned with a file or emery cloth.

After completion of the soldering see that all acid is washed off the work, otherwise it will corrode the metal surfaces. Water to which a little washing soda has been added will be found useful for this purpose, as the soda neutralises the acid.

CARPENTRY.

For a man acquainted with the art of carpentry, or even slightly gifted in that direction, it is not a difficult matter to pick up a saw, hammer, chisel, or plane, and to set about the making of a gate or a wheelbarrow; but when one who knows little if anything about the business finds that his chisel, plane, and saw are blunt, and that things are otherwise "cranky," it is a *different problem altogether, and it is then, perhaps, that the truth comes* home to him that what he requires is not only the tools, but the knowledge of how to handle them and to put them and keep them in good order.

Elementary as it may appear, it is nevertheless necessary to know both how to hold and how to adjust a tool, and before the beginner can turn out a satisfactory job these things must be mastered. In the hope that the information will be useful to farmers, it is proposed to offer a few pages about the tools that may usefully be found in a farmer's kit.

PLANES.

Plane irons differ slightly—not in angle, but in shape. They may be briefly described thus:—

Name.	Width of iron.	How edge is ground.	Use of tool.
German jack ..	1½ inches ...	Convex (see Fig. 1) ...	For very rough work.
Jack	2¼ ,, ...	Slightly convex (Fig. 2)	For rough work and straightening slightly.
Try	2½ ,, ...	Straight across. Tips of of each corner rounded off on oilstone (Fig. 3)	For making surface perfectly straight.
Smoother ...	2¾ ,, ...	Do (Fig. 4)	For finishing off job smooth.

It is evident that, while all planes must receive careful handling, the two last-mentioned require to be ground and sharpened with special attention, in order that they may do the fine finishing work satisfactorily. But this is not all. The planes themselves require proper care and handling if the best work is to be got out of them. In my opinion and experience, wooden planes are the best to work with, the easiest to keep in order, and the least likely to be broken, and it is with these that I am dealing. A beginner will be well advised to procure second-hand planes (provided they are still in fairly good order), as new tools may be seriously damaged in the process of learning their use.

Wooden planes, old and new, should be regularly oiled all over with raw linseed oil. Great care should be taken of the sole—that is, the bottom—especially of the "try" and "smoother" planes.

The smoother, try, and jack planes all have double irons—the cutting iron and the back iron. The cutting iron is, of course, the only one that requires sharpening, and during that operation the back iron should be put aside, but otherwise the two irons are handled as one. The back iron acts as a spring, and keeps the cutting iron rigid. The back iron of the smoother and try should be kept not more than one-sixteenth of an inch from the cutting edge; that of the jack should be not more than one-eighth of an inch from the *cutting edge, being brought correspondingly closer for finer work.*

Fig. 1.
German Jack.

Fig. 2.
Jack.

Fig. 3.
Try.

Fig. 4.
Smoother.

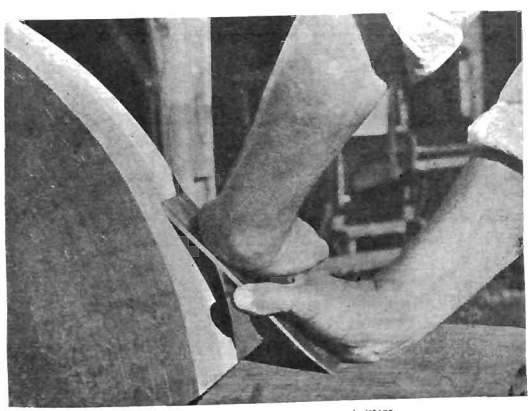


Fig. 5.—Grinding a Plane Iron on the Grindstone.

Sharpening the Planes.

The sharpening of plane irons and chisels is very similar, and if the former is mastered, the latter will not be found difficult. Two angles have to be kept in mind—the grindstone angle, which is the angle at which the iron is held on the grindstone (about 30 degrees) and the oilstone angle, which is the angle at which the iron is held on the oilstone to get a fine cutting edge.

To grind a plane iron or a chisel, rest the handle or end of the iron on the frame of the stone with the iron against the stone (see Fig. 5). Plenty of water must be played on the stone while the stone is turned on to the iron. Care must be taken to keep on the outside edge of the stone, or the stone will be worn hollow, which will make it very hard to grind the irons true—a most important point.

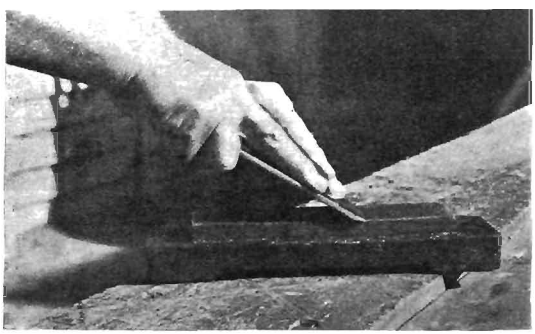


Fig. 6.—Sharpening a Plane Iron on the Oilstone.
The method of treating a chisel is the same.

On the oilstone, the angle should be about 36 degrees. The stone should be placed firmly on the bench, lying straight away from the body (Fig. 6). Keep plenty of oil on the stone, and work the iron as near as possible the full length of the stone, keeping the iron square on it, and at the same time moving from side to side, so that the stone shall be worn evenly. A light burr will often form on the edge as the sharpening on the oilstone finishes, and this must be removed by laying the iron upside down on the stone and giving it a few sharp rubs. For this operation the iron must be quite flat on the stone, or another angle may be formed, which will spoil the cutting edge. Even a slight angle when the "burr" is being removed will have the effect of spoiling the edge. The tool must be sharpened in such a way as to have no bevel on the face side.

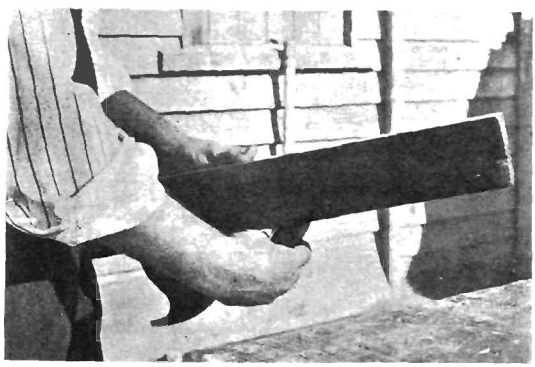


Fig. 7.—Taking the Iron and Wedge out of the Try and Jack Planes.

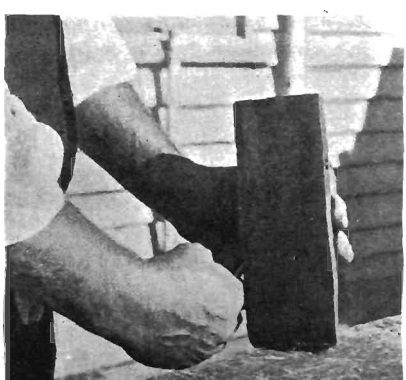


Fig. 8.—Taking the Iron and Wedge out of the Smoother and German Jack Planes.

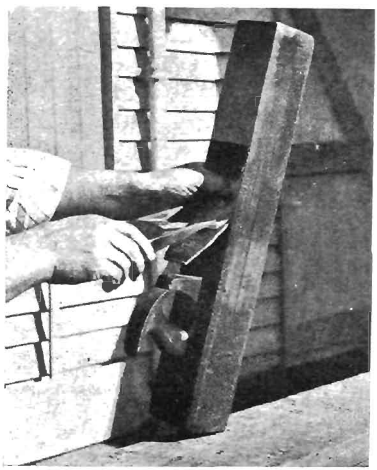


Fig. 9.—Inserting the Iron and Wedge in the Try and Jack Planes.

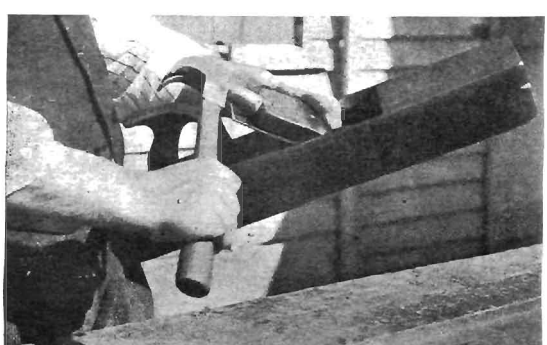


Fig. 10.—Tightening the Wedge and Iron.
The method is the same in the case of all four planes—Smoother, Try, Jack, and German Jack.

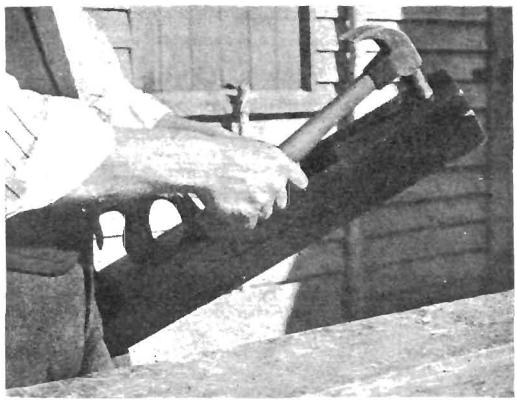


Fig. 11.—Drawing the Iron back a shade.
This method applies to Try and Jack Planes.

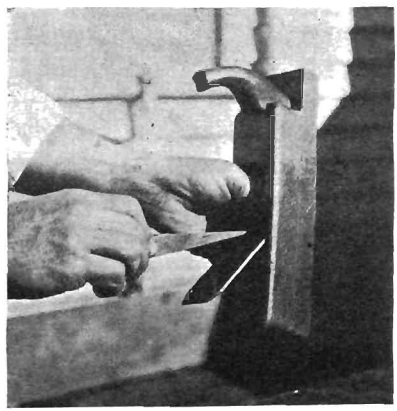


Fig. 12.—Inserting the Iron and Wedge in the German Jack.

It is essential that the hands shall not be rocked up and down. The angle of 36 degress must be maintained on every portion of the stone, or a round edge will be made which will not remain sharp, but will soon necessitate more grinding and more sharpening. Nothing is more disheartening to a beginner than continually to be grinding and sharpening. What should be aimed at is a good, clean, square edge.

Chisels of all sizes are ground and sharpened the same way.

Adjusting the Irons.

The planes are not all handled and adjusted the same way. The two largest—the try and the jack—being adjusted in the same way, may be dealt with first.

To withdraw the wedge and iron of the jack, grip the plane in the left hand, and then with the right hand grip the wedge and iron, and strike the front top side of the plane on the solid portion of the bench (see Fig. 7). This will release the wedge and iron.

Fig. 13.—Inserting the Iron and Wedge in the Smoother.

Though the extremes in the classes of work they are intended for, the German jack and the smoother are the two smallest planes, and they are handled and adjusted alike. To withdraw the wedge and iron, grip the plane in the left hand, then with the right hand grip the wedge and iron (Fig. 8) and strike the back end of the plane on the solid portion of the bench. This will release the wedge and iron.

The releasing of the wedge and iron of all four planes can be effected by striking with the hammer on the same part of the plane as was struck on the bench, but the hammer tends to spoil the plane, and tradesmen who take a pride in their tools are particular how they strike their planes with the hammer on account of the danger of disfiguring them.

The setting up of the planes next occupies us, and again we take the two larger planes first. Grip the plane (try or jack) with the left hand, and resting the plane end on the bench, with the thumb in the throat (see Fig. 9),

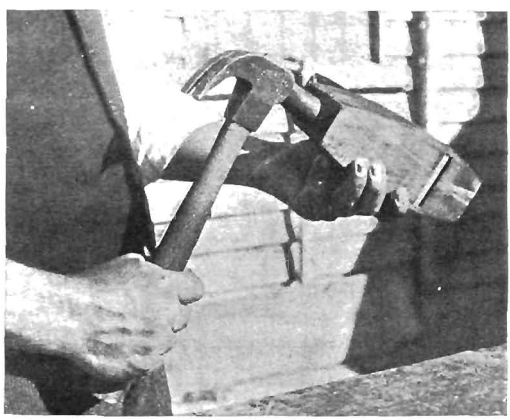


Fig. 14.—Drawing the iron back a shade.

The method is the same for Smoother and German Jack Planes.

take the irons and slip them into position, holding them with the thumb; now slip the wedge into position, still keeping the thumb of the left hand on the irons, but so that the points of the wedge slip up on either side of the thumb. Then with the hammer give the wedge a light tap—just enough to hold the irons in place (Fig. 10). Now turn the plane over and sight it along the sole to see how the iron is. It will be observed by the tyro how easily the plane is handled when gripped in the manner suggested. If the iron is too far out, give the plane (still held in the left hand, the thumb in the throat, and resting on the wedge and iron) a light, sharp tap with the hammer on the front top side. The plane must be struck quite square with the face of the hammer, so that it will not be marked (Fig. 11). The effect of the blow is to draw the iron back a shade. After each tap on the front of the plane give the wedge a light tap (Fig. 10), to make sure that the iron does not fall out and get "gapped."

Turning now to the two smaller planes, the method of gripping them with the left hand is the same as with the larger planes. Slip the iron and wedge into position, as described, then give the wedge a sharp tap with the hammer, and inspect the sole of the plane as before (Figs. 10, 12, and 13). If the iron is too far out, still holding the plane with the left hand, as before, give the plane a light, sharp tap with the hammer on the back end of the plane (Fig. 14); this will draw the iron back a shade. If one corner of the iron projects more than the other, give the top of the iron a tap the opposite way, and again tighten the wedge. Finally, when the irons are set to satisfaction, give the wedge a couple of sharp taps, making the iron and wedge secure.

The Use of the Planes.

The correct handling of tools is one important factor in obtaining success with them. In using the planes, the correct position in which to stand at the bench is with the feet about 2 feet 6 inches apart, the left foot parallel with the bench and the right foot at right angles to the bench. This position gives a firm foothold. The two large planes are held alike. The handle is gripped with the right hand and the front top of the plane with the left hand, the elbow pointing directly ahead (see Figs. 15 and 16).

In the case of the smoother, which has no handle, grip the back of the plane with the right hand, at the same time holding the wedge and iron with the thumb and first finger, and with the left hand grip the front of the plane (see Fig. 17). The German jack is gripped at the back with the right hand, just as in the use of the smoother, and the left hand takes hold of the *horn in front (see Fig.* 18).

A brief description of how to square a rough piece of sawn timber may be of interest, as the initial part of any job. It is necessary first to know what amount of reduction is required. If the rough timber is only to be reduced one-eighth of an inch, for instance, the whole of that reduction must not be taken off the first side, or the discovery will be made that the other side has yet to be planed off and that there is no margin on which to do it without spoiling the job. The first thing to do is to get one side absolutely true. This involves getting the timber true as to length and breadth, and also as to anything in the nature of a twist. It might be thought that provided timber is true as to length and breadth it is absolutely true, but not necessarily so. There may be a twist (or "wind") in it, and this must be carefully worked out in getting the first side true.

The German jack will be used to take the rough or "dirt" off, the jack *will partly straighten the piece of timber, and the trying-plane should make* it perfectly true.

To ensure that it is free from a twist, two "winding sticks" are required. These are two pieces of timber, each 12 inches long by 2½ or 3 inches wide and ½ to ¾ inch thick. They are bevelled on one edge, and one has side straight edge painted white while the other has the straight *edge* painted black (see Fig. 19). To test a piece of timber, the two sticks are placed on the timber and sighted to see that they are perfectly level. In the case of a long piece of timber the winding sticks should be tried in several places to make sure that the face is perfectly level and uniform. If the winding sticks discover a twist it must be planed out before the other sides of the timber are attempted.

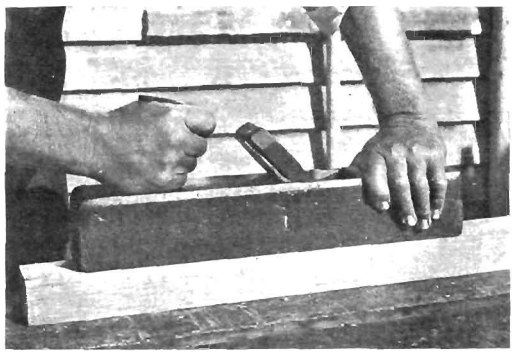


Fig. 15.—The Correct method of holding the Jack Plane while planing a surface.

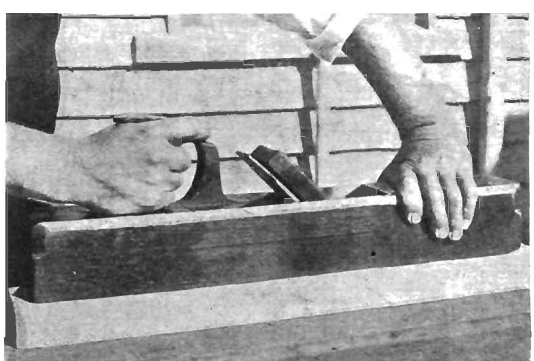


Fig. 16.—The Correct method of holding the Try Plane.

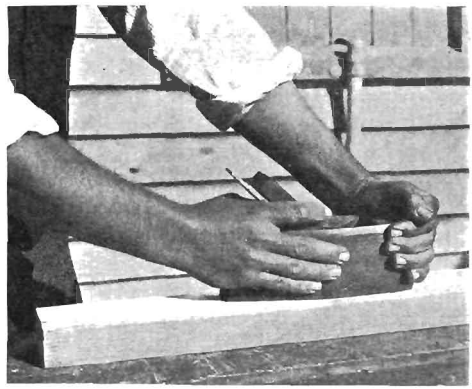


Fig. 17.—The Correct method of holding the Smoother.

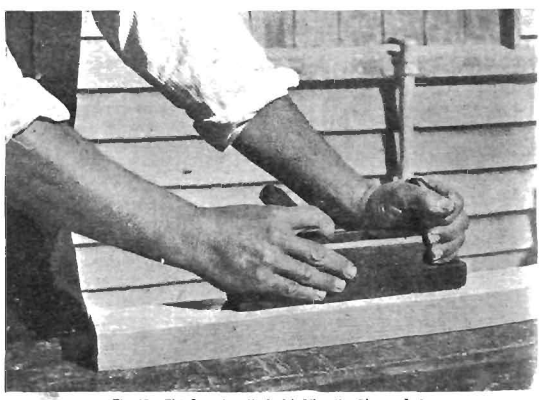


Fig. 18.—The Correct method of holding the German Jack.

Many beginners have a bad habit of continually planing away where the plane will bite, but it has to be learned that the plane may be biting where further planing is only spoiling the job. It is an illusion to imagine that because shavings are coming off that that is the spot for further planing. Sometimes a hollow exists where the plane is not biting, and it is necessary to work the hollow out. To do this the high portions of the timber must be planed off until the plane takes an even shaving off the full length. Sometimes the failure of the plane to bite is due to the condition of the tool.

The face side of the timber, which is the most important, must be made quite true. From it the "face-edge" is next worked straight and square. This is done with the same set of planes and also with the square. The brass plate of the square must be kept up against the face side, bringing the steel plate down on the edge, and drawing it from end to end to ensure that no

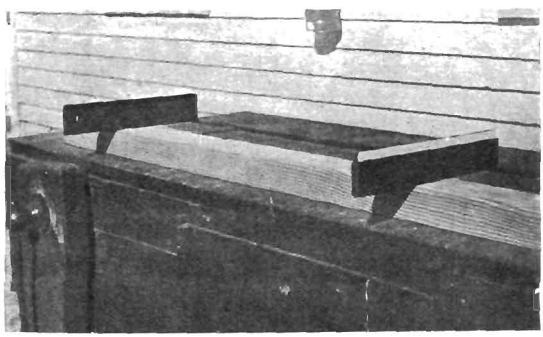


Fig. 19.—The Winding Sticks.

daylight can be seen under the steel edge. The face-edge must be tested with the square until it is right, and at the same time watch must be kept along the edge to see that it is true. Having two sides thus trued and planed up, take the single-tooth marking gauge, set it to the finished thickness, and run the gauge round on the untouched sides, one at a time, gauging off the face side. The thickness of the timber has to be reduced to the gauge-line with the same set of planes. Both winding sticks and square are done with now, and there is only the gauge-line to watch.

The width of the final side of the timber is gauged in the same way and planed down. If any smoothing has to be done it should be done now with the smoother, but only very lightly, or the timber will be put out of shape again.

SAWS.

The saws commonly in use number four, namely, (1) the rip-saw, for cutting down the grain, No. 4 (four points to the inch); (2) the hand or panel saw, for cutting across the grain, Nos. 7 or 8 (seven or eight points to the inch); (3) the tenon-saw, for cutting tenons and shoulders and for fine work (14 inches long); and (4) the turning saw, for cutting circles, &c.

As everyone who uses tools knows, there are such things as saws that are too stiff and those that are too limp, and to choose what one wants in these respects is not hard. A saw can be tested by taking the handle in one hand

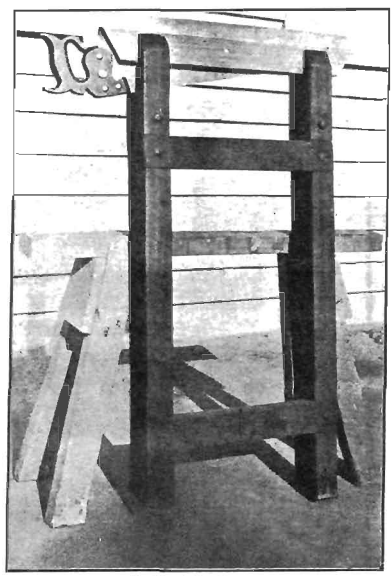


Fig. 20.—A Saw Clamp.

and the tip in the other and bending the tip around to the handle; if it is hard to get them to meet the saw is too stiff, but if it is too easy to bend in this way and if a buckle appears in the saw it is too limp. A saw that comes round fairly stiffly and springs back straight without leaving a buckle is the one to pick. The quality of the steel is indicated by the ring. On the whole, however, it must be admitted that there is a good deal of luck in buying tools and especially in buying saws.

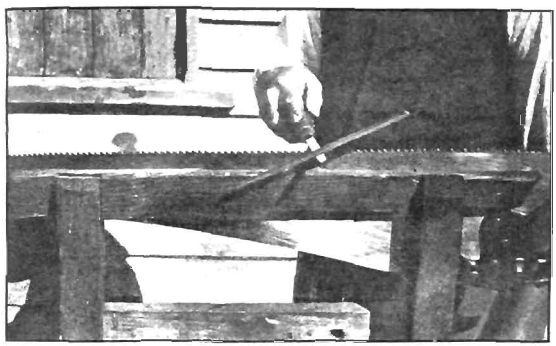


Fig. 21.—The most important angle to watch while sharpening a saw.
The angle is indicated by a flat file laid on the top side of the triangular file with which the actual sharpening is done.

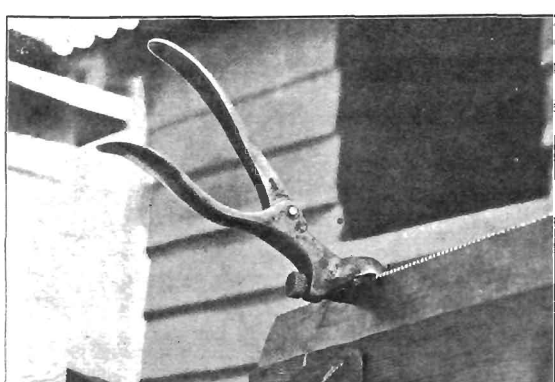


Fig. 22.—An adjustable saw-set.

Sharpening the Saw.

Before being sharpened, all saws should be run over from the handle to tip with a flat file, an old mill-saw file being the best for the purpose. This is done by holding the saw by the handle, laying the file along the tips of the teeth, and running it down the tips. The effect is to bring all the teeth to a uniform height and remove any unevenness such as may have been caused by several teeth striking a nail and having the tips taken off. The rip, hand, or panel saws should have a slight belly in the centre, but a tenon-saw should be straight.

Fig. 23.—The Correct Use of the Saw.
Starting the stroke.

The teeth now being all of one height, we shall start to sharpen with a triangular file. This, be it admitted, is a most difficult matter for a beginner, who, if not very careful, will reduce the teeth to all shapes and sizes and leave the saw worse than it was before he touched it. The saw must be held in an upright position in a vice of some kind. The best hold

of all is obtained with a pair of saw chocks or clamps (see Fig. 20), but if these are not available, an ordinary vice may be used. If the vice is an iron one, then the saw should not be gripped between the metal jaws, but between pieces of wood on either side, by which it will be found that a much better hold will be obtained without damage to the saw

Fig. 24.—The Correct Use of the Saw.
Finishing the stroke.

Start filing at the tip of the saw, filing the back of every tooth that is leaning away from you, and the front of every tooth that is leaning towards you. As the teeth lean alternately to you and from you, this means that you use the file on each alternate tooth, leaving the other tooth to be dealt with afterwards from the other side. Most attention must be given to the filing of the tooth that is leaning away from you; it will be found in a little while that the front of the tooth leaning towards you is at the same time receiving attention, but the thing to watch is the back of each tooth that leans away.

The operation is, needless to say, a delicate one and three things are essential in handling the file:—

1. The top side of the file itself must be held at exactly the same angle on *every tooth*. By merely *altering* the angle at which the triangular file is leaning a very uneven job will result. If, for instance, the top side of the file leans first at the angle shown in Fig. 21 and then at another angle, it is impossible for the job to be a satisfactory one. It is this angle that determines the amount of "hook" on each tooth, and it is most important that it be uniform. The angle indicated in Fig. 21 (the top side of the file not quite flat, but leaning slightly to the tip of the saw) will give a satisfactory "hook." This hook should be greater in the case of the rip-saw than in other types.

2. The hand must be held at a uniform height throughout; it should not be held first high and then low, or an uneven set of teeth must result. Some men drop the hand and file upwards, but this is not satisfactory. The file should cross the saw at right angles to the side of the saw—in other words the point of the file should neither be elevated nor depressed, and it should be so throughout the job.

3. The direction at which the file is worked across the saw must also be uniform. Swinging the hand from one side to the other will be as unsatisfactory as swinging up and down. In the case of a rip-saw, the file must go straight to and fro at right angles to the length of the saw. With other saws, the handle of the file should be slightly inclined towards the tip of the saw. The effect is to form a sort of diamond point.

If the teeth are in good order and regular it is only necessary in sharpening to see that the file is pressed firmly into the angle between the teeth, but if the teeth are uneven the file must be used with a *little* weight on it, one way or the other, to put the teeth in order again. Where a saw is in very bad order indeed, it is sometimes necessary to run the teeth down and retooth the saw, cutting out new teeth.

The alternate teeth having been treated in the way described, the remaining teeth are treated in the same way and with the same care from the other side.

Setting the Saw.

The "set" of the saw is a term employed to suggest the amount of spread that the teeth have sideways, the teeth being pointed alternately one way and then the other. Only one-third of the tooth should be bent outwards—the whole of the tooth should not have an outward lean.

With the rip-saw, very little spread is needed—sometimes none at all, but with the hand-saw (used for cutting across the grain) there should be more set, especially for green timber. When the teeth are set, there should be a distinct V or *slight* depression down the centre if the saw is held so that you look along the tips. The teeth must be evenly set, one side having no more spread than the other. A special "saw-set" can be obtained, which can be simply adjusted to the size of tooth and amount of spread desired (Fig. 22)

Saws must be kept away from all dampness, and may be smeared with oil at times to protect them from rust. The fumes of muriatic acid (spirits of salts) are also very destructive to them.

Handling the Saw.

Everyone can handle a saw, or thinks he can, but those who do it to the best advantage are not so numerous. In starting a cut, it is a common mistake to allow the weight of the end of the saw to rest on the timber, with the result that the teeth catch and fail to run free, the work being poorly

Fig. 25.—The Correct Use of the Saw.
Keep the arm-pit plumb over the saw-cut.

begun. It is in the effort to avoid the catching that results from this error that so many people begin a cut by drawing the saw up to them. The right way is to start the cut with the tip of the saw (Fig. 23), striking the timber very lightly at first, and then, as the saw runs down the edge, allowing an

increasing weight to come on the timber. In this way the cut is properly started in the first movement of the saw (Fig. 23). The novice, watching a cut started in this way, will remark on the ease, balance, and surety with which the tool is handled, and no doubt the secret of the successful use of all tools lies just there; but one way to acquire this command over the implement under discussion is to learn to strike correctly—to allow no weight of the saw, or hardly any, to rest on the timber at first, and to increase it slightly as the saw comes down the first time.

The position in which the operator stands is also of importance. He should stand with the saw in the right hand, leaning over his work, with the arm-pit in line with the cut that is to be made, so that as the saw is brought up, the handle is brought up into the arm-pit (Fig. 25). This brings the saw up straight in the cut. The tendency with the beginner is to draw the saw-handle *towards himself as he brings his hand up*, the result being that the blade not being straight, the cut is a rough one, the work is hard, and the result unsatisfactory. A long steady stroke, with a free movement, is what is required.

"Let the saw run itself," says the tradesman, and so, too, the man with a little practical experience.

TOOLS SUITABLE FOR USE ON A FARM.

The following list of tools has been prepared as an indication of the equipment likely to be most useful on a farm. The prices shown are those quoted in Sydney price lists, 1929. Fluctuations in market values must, of course, be expected:—

	£	s.	d.
1 Smoothing-plane, 2¾" ..	0	10	6
1 Trying-plane, 2½"	0	15	0
1 Jack-plane, 2¼"	0	13	6
1 German Jack-plane, 1¾"	0	8	6
1 Rebate-plane, 1½"	0	7	6
1 Rip-saw, best quality, 28"	0	14	0
1 Hand-saw, best quality	0	13	0
1 Tenon-saw, best quality, 14"	0	12	0
1 Nest of saws, best quality	0	7	6
1 Saw-set	0	6	9
1 Oilstone	0	5	0
1 Rule 2 ft.	0	2	2
1 Claw-hammer, No. 5 ...	0	6	3
1 Square, 12"	0	5	0
1 Square, 6"	0	3	0
1 Bevel, Sliding, 10"	0	3	0
1 Draw-knife, 10"	0	5	0
1 Marking-gauge, Single.	0	1	3
1 Mortise-gauge	0	5	0
1 Carriage Clamp	0	5	6
4 Chisels, Socket, ½", ⅝", ¾", 1"	0	12	0
6 Chisels, Firmer Socket, ⅜", ½", ⅝", ¾", 1", 1¼"	0	16	3
1 Brace, all iron, 10" ...	0	8	0
6 Bits, double twist, ¼", ⅜", ½", ⅝", ¾", 1" ..	0	16	3
11 Bits, Nail, Nos. 2 to 12, at 6d. each	0	5	6
1 Screwdriver, 10"	0	2	6
1 Mallet	0	4	0
5 Augers, ½", ⅝", ¾", 1", 1¼"	1	9	
1 Spokeshave	0	2	
1 Adze, No. 2	0	6	
6 Bradawls	0	3	
1 Hatchet	0	5	
1 pair Compasses, 8" ...	0	2	
1 Wood Rasp, 12"	0	2	
1 Oil-can	0	2	
1 Spirit-level, 24"	0	6	
1 pair Pliers, 7"	0	2	
1 pair Pincers, 7"	0	2	
1 Metallic Tape, 66' ..	0	12	

PAINTING ON THE FARM.

It is important that at least certain fundamentals pertaining to painting be thoroughly understood if satisfactory results are to be obtained even in comparatively simple cases. It is often noticeable that where successive coats of paint have been applied by amateurs, the surface is in such condition that to bring it back to a satisfactory state often costs more than the actual painting. It is not sufficient merely to stir up a tin of ready-mixed paint and spread it on the walls or whatever is being painted.

Painting is a comprehensive subject which calls for much study in order to gain a thorough knowledge of all its branches. It is possible, however, for the average person to do creditable work by giving a little consideration to the subject. It is with this object, and also with the idea of assisting the man on the land, who, by reason of his comparative isolation, can only secure skilled labour at exceedingly high rates, that this article is written.

It is, in the first place, necessary to consider the class of material it is proposed to paint—whether wood, iron, cement, plaster, brick, &c. Consideration has also to be given to the condition of the surface it is intended to paint—whether it has been painted previously, and if so, whether it has a good smooth unbroken surface, or whether it is cracked, blistered, or peeling. It may be that the old paint is tacky, and has considerable dust hanging to it. Consideration of these conditions determine the preparatory work essential for satisfactory results, and the composition of the paint to be used, which, in a general way, may include linseed-oil paint, cold-water paint, kalsomine, varnish, &c. By linseed-oil paint is meant a paint in which linseed oil, together with a thinner, forms the distributing agent for a base of finely divided pigment, such as white lead, red lead, zinc oxide, or titanium zinc, and to which may or may not be added colour pigments called stainers.

Linseed Oil.

Linseed oil is, for many reasons, the oil mostly used for house painting, its function being to hold the pigment in suspension and enable it to be evenly distributed over the surface. Subject to certain conditions, it dries in an insoluble film, thus binding the particles of pigment together. Linseed oil varies somewhat in quality, and, although possessing valuable properties, it has one great defect in that special preparations have to be added to it to give it the drying properties it seldom in itself possesses.

Good fresh oil should be clear and pale and emit very little odour. There are two kinds of linseed oil, viz., raw and boiled. Boiled oil is now not used to the same extent as formerly. It is suitable for some purposes, but for painting generally raw linseed oil is the correct material to use.

Thinners.

These are added to make the paint more mobile, *i.e.*, they thin the paint according to the quantity added, thus making it work more freely. For this purpose, genuine turpentine is of proven worth, but as its cost has of late years increased considerably, petroleum or white spirit is sometimes used as a substitute. These thinners ultimately evaporate and, therefore, take no part in the final composition of the paint.

The addition of turpentine tends to cause the paint to dry with less gloss; thus, if the pigment were mixed with turpentine to the exclusion of linseed oil, the paint would be quite flat, i.e., without gloss. If, on the other hand, linseed oil only were used, the paint would dry with a glossy surface which, in most cases, causes subsequent coats to run together in blobs or patches, which action is called cissing. It will be seen, then, that the purpose of adding turpentine to the paint may be a threefold one, viz., to thin it down so that the paint will sink in and thus provide a good foundation, to produce a flat finish, and also to prevent cissing. It is for this reason that in tables which give the proportions of ingredients for mixing paint for three-coat work, the second coat contains the greatest quantity of turpentine and the final coat considerably less.

Driers.

Linseed oil does not possess sufficient drying properties in itself, and, therefore, driers are added to make up this deficiency. These must be used with caution, however, as in addition to carrying oxygen to the oil, they also tend to burn it up. As will be readily understood, paint requires less driers in warm weather than in cold damp weather, which fact applies equally to external and internal painting.

Two driers in common use are patent driers and terebene. The latter is very powerful as may be judged from the fact that one ounce will cause one pound of paint to dry in about half an hour. This is a danger to the durability of the work. Not less than forty-eight hours should elapse between each coat, and provided that only sufficient driers are added to cause the paint to dry hard within this period, good work will result.

The Base.

White Lead.—Until recently, white lead ground in oil was the standard material for general painting. Its poisonous properties have given rise to world-wide complaint and dissatisfaction by operative painters. Another great defect is that when used by itself, that is, without stainers, it tends to become chalky upon exposure, particularly along the coast, and it is not an uncommon thing to find work that has been done by painters little better than whitewash. The addition of pigment (or stainers) corrects this defect, while for surfaces which are to be finished white, the addition of one part zinc white to three parts of white lead will produce satisfactory results. This is the composition of some of the better brands of ready-mixed white paint.

Zinc White.—This is a zinc oxide and similar in appearance to white lead. Compared with this latter material it lacks opacity, in that ordinarily three coats of white lead are equal in covering power to four or more of zinc white. Zinc white dries very hard and for this reason should not be used by itself on external work as it will crack badly, and cracked paint is costly in that it must be burnt off if further painting is to be done satisfactorily.

Titanium Zinc.—This is a comparatively new material which is gradually gaining in favour. Titanium is an inert, and, therefore, non-poisonous material, but because of its inertness it will not dry if used by itself. By mixing it with zinc oxide, however, the inertness of the one is corrected by the hard-drying properties of the other, and because of the extraordinary opacity of titanium, the resultant mixture possesses covering properties far greater than that of white lead. It is a consideration, also, that because of the number of gallons of paint that can be made from a hundredweight of titanium zinc paste, the cost per gallon of such paint is no more than if made with other pastes, notwithstanding that the cost per hundredweight of titanium zinc may be greater.

For painting, the foregoing pastes should be bought in paste form, i.e., ground in oil. As these pastes deteriorate if exposed, they should be kept covered with oil or water once the container is opened.

Red Lead.—Unlike the other bases, red lead is bought in powder form. It has many uses, but for general painting is chiefly used as a primer or first coat. Mixed with titanium zinc, it works well and provides a splendid foundation for further coats.

How to Mix Paints.

The skilled painter regards as indispensable an adequate supply of paint pots of convenient size and shape. The amateur will soon appreciate the benefit of following his example. He should also see that they are perfectly clean before putting paint into any of them. The easiest way to clean old paint pots is to set fire to them.

It is advisable to mix first the white paint (that is, the base), linseed oil, thinners, and driers. Then mix the stainers together on a flat slab, and afterwards add these to the white paint, stirring the whole until the required tint is obtained. It is better to add only a little of the stainers at a time; thoroughly stir and brush-out on a piece of timber to ascertain if the desired tint has been obtained. If a lot of colour is added to start with, the paint when stirred up and brushed-out may prove to be so dark as to require a considerable addition of white paint, with the result that the batch is far in excess of the quantity required. If, for any reason, there does happen to be an excess, do not try to change its colour by adding a lot of other stainers, because if too many stainers are used the result is likely to be a monotonous drab rather than a pleasing tint. After the batch has been well stirred, it should be strained through a clean piece of singlet

or stocking spread across the pot and tied in position. For house painting the amateur should never be in such a hurry as to neglect the little extra time involved in straining.

It is assumed that the mixing of the paint would not be commenced until it was actually needed, for, unless kept in an air-tight container, mixed paint tends, upon exposure for any length of time, to become fatty, and this causes cissing when being brushed-out.

Pigments.

The following pigments or stainers are used for the common colours in house painting:—

Stone Colour.—Burnt Turkey umber, raw Turkey umber, yellow ochre.
Drabs.—Burnt umber and yellow ochre.
Buffs.—Yellow ochre and Venetian red.
Greys.—Lamp black, Indian red, ultramarine blue, vermilion.
Browns.—Burnt sienna, Prussian blue, yellow ochre.
Greens.—Brunswick green (dark and light), with blue and chrome yellow.

These should always be ordered "ground in oil."

White Lead Paint.

To make 1 gallon of white paint with white lead pastes:—

Priming Coat.—Mix 21 lb. white lead paste, 1 lb. dry red lead, 3½ pints raw linseed oil, 1 pint turpentine, and 12 oz. patent driers.
Second Coat.—Mix 23 lb. white lead paste, ¾ gallon raw linseed oil, ¾ gallon turpentine, and 1 lb. patent driers.
Finishing Coat.—Mix 23 lb. white lead paste, 3 pints raw linseed oil, ½ pint turpentine, and 1 lb. patent driers.

White Titanium Zinc Paint.

To make 1 gallon of white paint with titanium zinc paste:—

Priming Coat.—Mix 9 to 10 lb. titanium zinc paste, 1 lb. of dry red lead, 4½ to 5 pints of raw linseed oil, 1 pint of turpentine, ½ to 1 oz. of terebene driers.
Second Coat.—Mix 10 lb. of paste, 1 to 1½ pints raw linseed oil, 2 to 3 pints turpentine, ½ to ¾ oz. terebene driers.
Finishing Coat.—Mix 10 lb. titanium zinc paste, 5 pints raw linseed oil, ½ pint turpentine, ½ oz. terebene driers.

It is important to note that patent driers should not be used with titanium zinc paint, or, for that matter, with any zinc oxide paint. Terebene, if used in the proportions given above, is suitable. If desired, a reliable brand of zinc driers may be used.

Whilst the quantities given above will suit most cases, they will not meet every known condition; for instance, if the wood is very hard, a little less thinners (turpentine) will be required for the first coat, while if it is unusually absorbent, a little more may be added with advantage.

A gallon of paint mixed according to the foregoing instructions, and in the proportions given above, will cover from 650 to 850 square feet, depending on the condition of the surface. To determine the quantities of materials for any job, it is, therefore, only necessary to divide the total square feet of surface to be painted by the average spreading power of the paint, say, 750, and multiply this by 2 or 3 according to the number of coats to be applied. This will give the total number of gallons of paint, from which the quantities of the ingredients can be computed.

Paint Brushes and Gear.

Painting broad surfaces with a small brush is slow and tiring, while to attempt cutting in window sashes, small mouldings, &c., with a large brush is slovenly. For broad surfaces, a 3½ or 4 inch flat wall brush is recommended, and for mouldings, &c., a 1½-inch flat varnish brush. A flat soft brush for dusting is almost indispensable.

Brushes of quality will, of course, cost more than the inferior article, but their cost is more than compensated for by the speed, the appearance of the work, and the general satisfaction which they afford.

It is advisable first, to soak a new brush in water for a few hours to tighten up the bristles in their binding. Care should be taken, however, to see that they are quite dry before painting. They should not, when out of use for lengthy periods, be left in water or even in pure turpentine, as this robs the bristles of their elasticity. A good method is to bore a hole through the handle, and by means of a piece of wire suspend the brush in a mixture of equal parts of linseed oil and turps. After use a brush should be washed in turpentine, soap and water, or even a patent varnish remover.

Painting broad surfaces, such as walls, from a ladder is tedious, and does not tend to good work. An effort should always be made to work comfortably, and for ordinary buildings, such as cottages and sheds, a couple of planks supported by trestles constructed with 3-inch by 1-inch battens will make possible the painting of the walls, guttering, eaves, ceilings, &c., with a minimum of effort, proper control of the brush, and a proper perspective of the brushing-out.

Preparing Surfaces for Painting.

To prepare the surfaces for painting is more important than is generally supposed. Generally, the surface should be smooth and clean. This latter word is comprehensive in its application, as any surface with a film of dust, moisture, smoke stain, or any matter foreign to the paint or the material to be painted is not clean. To make surfaces smooth calls for either the removal of excrescences or the filling of voids, and each of the following will have its special use:—Sandpaper (fine and middle 2), steel wool No. 2, patent pumice stone, and also a putty knife. An artisan's equipment would include a blow-lamp for the removal of cracked or peeling paint, etc. The risk of fire, however, might make this dangerous in the hands of an amateur if used on a weatherboard structure. For this reason it will probably be

better to use a patent liquid paint solvent for the removal of cracked paint. It is essential that the solvent be entirely cleaned off with benzine or methylated spirits before applying new paint.

Knots and veins that exude gum should be smoothed off and given a coat of shellac or patent knotting. Holes should be stopped with putty (this consists of whiting and linseed oil), but not until the priming coat has been applied.

Moisture is one of the greatest destroyers of paint. It may be in the timber (unseasoned timber) or on the surface in the form of condensation, in which case, particularly in kitchens where gas fumes from the stove condense upon cold surfaces, it may contain sulphur, which is a great destroyer of white-lead paint.

Tacky paint can be successfully prepared for painting by coating it with lime-water (not limewash). The water in which lime has been slaked will, if allowed to stand for some time, become quite clear. It is this clear water that should be used.

Smoky ceilings and walls should, if extremely dirty, be first washed with water and soda. If in fair condition a coat of lime-water will suffice. Rub down between each coat of paint to remove excrescences. Remove dirt from corners, quirks of mouldings, etc., with putty knife, and always use the dusting brush well in advance of the painting.

The Painting of Various Materials.

Timber.—Previous references to painting and how to mix paints apply principally to the painting of timber; it is therefore not necessary to deal with this material further.

Cement.—It would be quite wrong to apply the paint previously referred to, or any paint ordinarily used for house painting, to new cement, for new cement contains an alkali which will cause the paint to lie on the surface in a treacle-like form, i.e., it will not dry, but always remains in a wet, sticky condition.

Untreated cement work should not be painted until it is about two years old except with cold water paint, limewash, or one of the proprietary lines of paint specially manufactured for the purpose. If desired it can be prepared for ordinary paint by applying two coats of sulphate of zinc. When dry the surface should be brushed down to remove all crystals, it may then be painted in the ordinary way. A very satisfactory priming coat for weathered cement work may be had by mixing one part of red lead with two parts titanium zinc paste.

Asbestos Cement Sheets.—The foregoing references to cement apply more or less to asbestos cement sheets, for they are principally of cement, and although containing considerably less free lime, it is inadvisable to paint them when new with ordinary paint without special treatment. It is advisable to allow the sheets to weather for about twelve months and then apply

a coat of equal parts of genuine turpentine and hard oak varnish. If to this a coat of paint is applied consisting of one part of red lead to three parts of titanium zinc, a first-class foundation will be provided for further painting.

For internal surfaces a coat of preparatory liquid can be followed with one or two coats of cold water paint, or the even more pleasing flat oil paint, so many beautiful shades of which are now available. Cold water paint may be applied externally in lieu of oil paint if desired. For this purpose it will be necessary to add about one quarter of a pint of raw linseed oil to the gallon of water paint.

For ceilings kalsomine is recommended in lieu of cold water paint. It often happen that repeated applications of this latter material will cause it to crack and peel off in a most unsatisfactory manner. This cracking does not occur on the walls to anything like the same extent.

Galvanised Iron.—Under the heading of iron may be included roof iron, guttering, downpipes, tanks, and water pipes. In all these instances the iron is galvanised to prevent it rusting, so that to some extent painting is only necessary after the galvanising shows signs of wear. Guttering, downpipes, etc., are usually painted for appearance immediately the building is completed, being given one good coat only, but it is preferable not to paint roof iron until it has been exposed to the weather for a few years. Because of the continual contraction and expansion, the extremes of heat and cold, and the absence of a good grip or key, ordinary house paint is not suitable, and it is always advisable to use a high-grade paint specially manufactured for the purpose. The writer has not yet found a so-called cheap roof paint that is satisfactory.

Whitewash.

The question is often asked how to make a suitable whitewash, so that probably a few remarks here will not be out of place.

Obtain, if possible, large pieces of fresh lump lime, place them in a very large bucket or other suitable container, and into this pour hot water. Cold water will do, but hot water is better as it hastens the slaking. The lime will start to boil and break up. Keep it covered all the time with about half an inch of water. This is important, for if whilst the lime is slaking it is allowed to rise up above the water in a dry powder it will "curdle," a condition tolerated only by inexperienced and indifferent workmen. Before the lime commences to boil fiercely, add tallow or common fat in the proportion of about 1 or 2 lb. to 7 lb. of lump lime. This makes a good binder which will prevent the wash from rubbing off. If desired, a little yellow ochre may also be added, which will give a cream or buff tint according to the quantity used. When the lime is thoroughly slaked it should be stirred and sufficient water added to make it a little heavier than, say, milk, after which it should be strained and, if desired, may be applied whilst hot.

SECTION XV.

Farm Measurements and Useful Tables.

FARM MEASUREMENTS.

THE common problems of farm measurements can be dealt with by simple rules of mensuration. There is usually no need to aim at exact measurements, since only a reasonable approximation is generally desired, especially in valuation work, where many factors besides measurement must be considered, the final result being at best only an estimate, depending on the skill and experience of the valuer.

Estimation of Areas.

In finding areas we must know how to—

(1) Run straight lines,

(2) Measure distances,

(3) Set out a line at right angles to another line.

There are important points to be noted in doing these simple jobs.

In sighting a straight line the poles must be straight, and must stand straight up out of the ground. Any third pole may be placed in line with two others by sighting over the tops or along the sides of the first two.

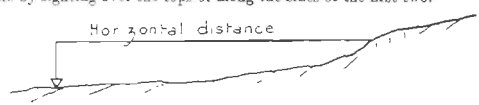


Fig. 1.

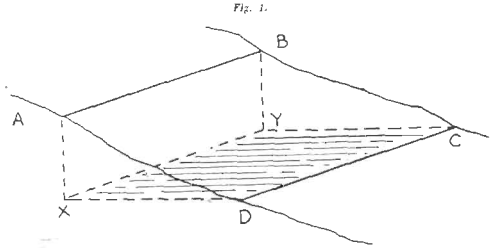


Fig. 2.

All distances must be measured horizontally, that is, on the level. When ground is sloping or bumpy, one end or, if necessary, both ends of the tape must be held off the ground. The point on the ground which coincides with

the raised end of the tape is easily found by dropping a small plumb-bob—a small stone or an old nut on the end of a piece of string is accurate enough for most practical purposes. (*See* Fig. 1.)

The reason why horizontal measurements are always taken in finding land areas becomes obvious when we realise that in general no more trees or blades of grass will grow on the side of a hill than on the horizontal area of the same piece of ground. If ABCD (Fig. 2) is a paddock on the side of a hill, we calculate actually the area XYDC, which is the "effective area," obtained when horizontal measurements are used in the calculation.

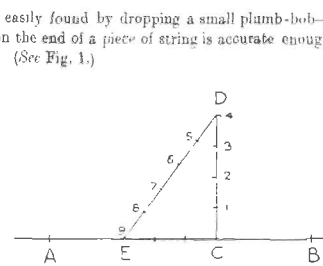


Fig. 3.

Where it is desired to mark a spot, it is advisable to drive a small peg flush with the ground, and to mark its position by means of a longer peg or pole projecting well up out of the ground.

To Set Out a Right Angle.

The common method of setting out a right angle is the "3-4-5 method," which depends upon the fact that any triangle of which the sides are in the ratio of 3–4–5, has a right angle at the junction of the two smallest sides.

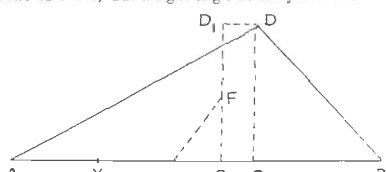


Fig. 4.

Suppose AB in Fig. 3 is a given line—a line of fence, for instance—and it is desired to lay out a line at right angles to it, from a point C. Measure 3 yards, from C to E. Hold or secure the end of the tape at C, and the 9-yards mark at E. Then, holding the 4-yards mark draw the tape taut throughout its whole length, and put n a peg at the 4-yards mark, *i.e.*, at the point D. By sighting over poles placed at C and D the desired line may be produced to any length.

Fig. 5.

A handy method of securing the tape on a peg when there is no one to hold it, is to drive a nail in the top of the peg, and then the link at the end of the tape may be thrown over this, or the tape may be wrapped round it.

A second method is to hold the end of the tape first on C, and with a sharp stick held at the 4-yards mark, draw an arc on the ground where the point D is expected to be. Next hold the end of the tape at E, and as before, but holding the sharp stick at the 5-yards mark, draw a second arc to cut the first arc. The point where these two arcs or lines cross, will give the required point D.

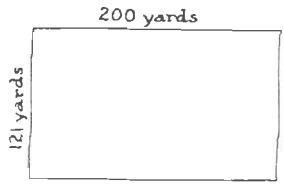


Fig. 6.

Any multiples of 3, 4 and 5 may be taken, *e.g.* 15, 20 and 25 or 30, 40 and 50. The longer the sides taken, the greater will be the accuracy.

A common problem in finding areas is to have to make the new line pass through a point (D in Fig. 4) some distance from a line, and at the same time make it at right angles to the line (AB in Fig. 4). If AB is not a fenced line, then sight from A to B, and place a pole at any point X in the line AB. By aligning with the poles at A and X, it is possible to keep on the line AB.

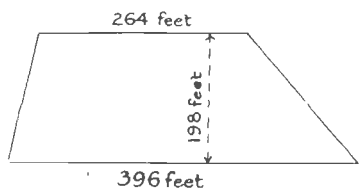


Fig. 7.

The point C might be guessed with the eye with sufficient accuracy for some jobs, but for greater accuracy, it should in addition be checked by erecting a line C_1F at right angles at C_1. By sighting over C_1F, the error DD_1 can be noted with the eye, and the point C_1 moved along this distance to C. Another checking may or may not be necessary.

A simple and useful little instrument for setting out right angles, can be made as follows:—Take a piece of well-seasoned board about 6 inches square and 1 inch thick, and saw two clean cuts across the surface, about $\frac{1}{2}$ inch deep, and exactly at right angles. Attach this board to a stake 3 to 4 feet long, pointed at one end. This is best done by means of a screw countersunk into the centre of the cross so that the line of sight will not be obstructed. The screw should be just firm enough to allow the cross staff to be turned into any line. If required, the cross-head may be taken off the stake and placed on a post in a line already fenced. (*See* Fig. 5.)

Applying this instrument to the problem illustrated in Fig. 4, we would place it at C_1 in the line AB, and turn it round until, by sighting through one of the cuts, it is seen to be in line with AB. Then, by sighting through the other cut, a line is got at right angles to the first. By moving the cross-staff one way or the other, the desired point C is quickly obtained.

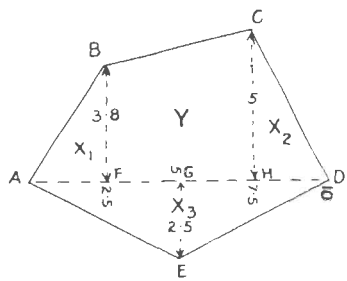


Fig. 8.

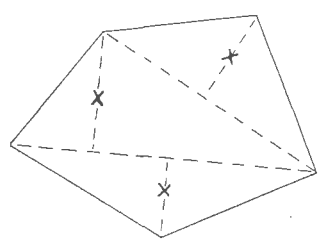


Fig. 9.

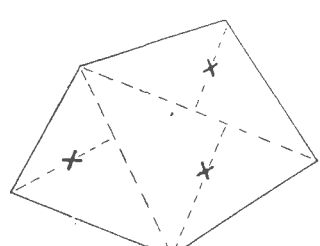


Fig. 10.

The Areas of Paddocks.

Measurements will usually be taken with the common linen tape, in feet. Measurements in chains and links offer easier working of these problems, because links may be so easily expressed as a decimal of a chain, *e.g.*, 10 chains 75 links=10·75 chains.

The area will be square feet, square yards, or square chains, according as the figures multiplied together represent feet, yards, or chains. There are :—

9 square feet in 1 square yard.
4840 square yards in 1 acre.
10 square chains in 1 acre.

To obtain acres :—

If the answer be in square chains, divide by 10.
" " yards, " 4840.
" " feet, " 4840 × 9.

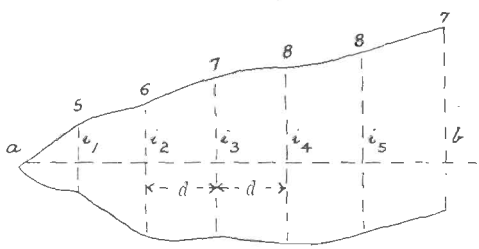


Fig 11.

In finding areas the shape of the paddock is a first consideration. Where the field is four-sided and all corners are right angles, the area is found by multiplying the length by the breadth. In this case the opposite sides are parallel and equal. For example, Fig. 6 represents such a field, 200 yards long by 121 yards wide. The area = 200 × 121 square yards = $\frac{200 \times 121}{4840}$ = 5 acres.

If a four-sided paddock has only two sides parallel (they may or may not be equal), it is called a trapezoid or trapezium. Its area is found by multiplying the sum of the parallel sides by the perpendicular distance between them, and dividing the result by 2. Fig. 7 is an example. Its area = $\frac{(396 + 264) \times 198}{2}$ square feet = $\frac{660 \times 198}{2 \times 9 \times 4840}$ acres = $1\frac{1}{2}$ acres.

In the case of paddocks having four sides, none of which is parallel or having more than four sides, it is necessary first to divide them into triangles or trapezoids. The area of each triangle or trapezoid is then

calculated, and the areas of all these sub-divisions added together to get the total area. Figs. 8, 9, and 10, show the same field divided up for purposes of determining the area. In Fig. 8 the areas X_1, X_2, X_3 are triangles, X_1 and X_2 being right-angled triangles, and Y is a trapezoid. In each of the figures 9 and 10, there are only three triangles marked X; but in order to complete the area in these cases, five measurements must be taken as against four in Fig 8. Since the field measurements take much longer than the actual calculations, the method of division illustrated in Fig. 8 is to be preferred.

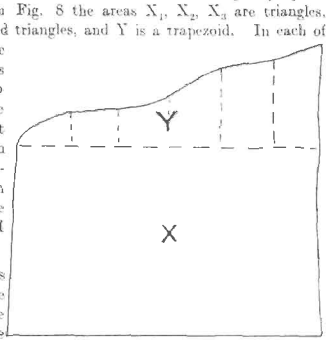


Fig. 12.

The area of any triangle is found by multiplying the base by the perpendicular distance *from the base to the opposite* angle, and dividing by 2.

The area of a right-angle triangle is found by multiplying together the two shorter sides (i.e., the base by the perpendicular height), and dividing by 2. In Fig. 8, let AD = 10 chains; AF = 2·5 chains; HD = 2·5 chains; BF = 3·8 chains; CH = 5 chains; and GE = 2·5 chains.

Then, area of triangle $X_1 = \frac{2{\cdot}5 \times 3{\cdot}8}{2} = 4{\cdot}75$ square chains = ·475 acre.

The area of triangle $X_2 = \frac{2{\cdot}5 \times 5}{2} = 6{\cdot}25$ square chains = ·625 acre.

The area of triangle $X_3 = \frac{10 \times 2{\cdot}5}{2} = 12{\cdot}5$ square chains = 1·25 acres.

The area of trapezoid $Y = \frac{(5 + 3{\cdot}8) \times 5}{2} = 22$ square chains = 2·2 acres.

The total area of the field ABCDE is thus :

·475 + ·625 + 1·25 + 2·2 = 4·55 acres = $4\frac{1}{2}$ acres approximately.

In the above examples, the perpendicular heights would be easily found with the aid of the cross-staff (Fig. 5), as illustrated in Fig. 4.

For areas bounded by curves, the trapezoidal formula may be used. This formula is, " Add together the intermediate offsets and half the end offsets, and multiply the sum by the constant interval." To apply this to Fig. 11, the field is actually divided into a number of trapezoids having the same perpendicular distance d between them. The formula assumes that "the

parts of the curve bounded by the offsets are straight lines. The end offsets are represented by a and b, the intermediate offsets by i, and the common interval between the offsets by d.

The area thus equals $d \left\{ \frac{(a + b)}{2} + i_1 + i_2 + i_3 \text{ etc.} \right\}$.

The offsets i, would be measured at constant intervals of 1 or 2 chains, at right angles to the main dotted line (base line) running through the paddock. In the above case, the end offsets, a and $b = 0$ and 7 respectively, d the common interval = 2 chains; intermediate offsets = 5, 6, 7, 8, and 8 chains.

The area $= 2 \left\{ \frac{(0 + 7)}{2} + 5 + 6 + 7 + 8 + 8 \right\}$ square chains;

$= 2(3\frac{1}{2} + 34)$ square chains; $= 75$ square chains; $= 7{\cdot}5$ acres.

This formula is readily applied to areas bounded by creeks or rivers (see Fig. 12). The dotted line shows method of division. The portion X forms a rectangle. The area of the irregular portion Y can be determined by the trapezoidal formula.

Fig. 13 illustrates a method that may be used in some cases for irregular areas. A regular figure—triangle, square, or rectangle, is constructed around the figure, and its area determined. The excess area is then obtained by calculating separately and adding together, the areas of the outside figures. The area of the irregular block illustrated in Fig. 13 would be the area of the main rectangle, ABCD, minus the sum of all the figures marked X.

The area of the main rectangle ABCD $= 14 \times 12 = 168{\cdot}00$ square chains.

The area of $X_1 = \frac{2 \times 7{\cdot}8}{2} = 7{\cdot}80$ square chains;

The area of $X_2 = \frac{5{\cdot}6 \times 1{\cdot}2}{2} = 3{\cdot}36$ square chains;

The area of $X_3 = \frac{(5{\cdot}6 + 5) \times 3}{2} = 15{\cdot}90$ square chains;

The area of $X_4 = \frac{(9 + {\cdot}6) \times 3}{2} = 14{\cdot}40$ square chains;

The area of $X_5 = \frac{{\cdot}6 \times 4}{2} = 1{\cdot}20$ square chains;

The area of $X_6 = \frac{5 \times 2{\cdot}5}{2} = 6{\cdot}25$ square chains.

The total area of the areas marked X = 48·91 square chains.

The area of irregular field thus = 168 — 48·91 = 119·09 square chains = 11 acres 3 roods 25·4 square poles.

It will be seen that two small areas, y and z, cancel each other. It saves much time in measurement and calculation to run straight lines along the irregular curves so as to arrange this "give and take" of small areas. Unless great precision is required, this procedure is quite permissible, any resulting error being generally negligible in practice.

A possible internal division of the area shown in Fig. 13 is given in Fig. 14. Generally it will be found easier to make internal divisons. Irregular areas call for the application of common sense rather than fixed rules in making subdivisions to get the least number of regular figures, from which the area required is easily found.

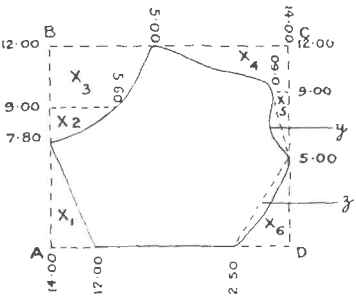


Fig. 13.

Some definite system should be followed in taking notes in the field. Perhaps the best way is to make a neat, rough sketch of the field, showing the actual field boundaries as full lines, and the imaginary lines of sub-division as dotted lines. Write in the figures always at right angles to the direction of measurement. This latter instruction is important and will prevent confusion, as experience will show. However, in some cases—long diagonals for instance—where confusion is not likely to result, the figures may be written on the line. (See Fig. 13.)

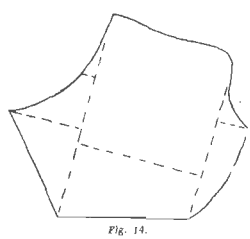


Fig. 14.

Estimation of Volumes.

In estimating volumes, it is best to consider all problems from first principles, and to find first the area of a uniform section of the solid under consideration, and then multiply this area by the length through which it extends.

Household Tanks.

Simple examples are household tanks. In the case of a square or rectangular tank, the area of the base extends uniformly from the bottom to the top of the tank, *i.e.*, through a distance equal to the height or depth of the tank. Hence to obtain the volume of such a tank, multiply the area of the base by the height of the tank.

The area of the base = length × breadth; thus the volume of the tank = (length × breadth) × height.

A ship's tank (Fig. 15) provides a simple illustration :—

The volume of the tank = $l \times b \times h = 5 \times 5 \times 5$ cubic feet = 125 cubic feet

There are $6\frac{1}{4}$ gallons in a cubic foot of water, so that to calculate the number of gallons of water in any tank it is necessary to multiply the volume in cubic feet by $6\frac{1}{4}$.

The number of gallons of water in the tank illustrated in Fig. 15 would thus be $125 \times 6\frac{1}{4} = 125 \times \frac{25}{4} = 781\frac{1}{4}$

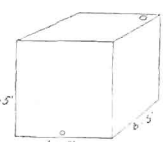


Fig. 15.—A Square Tank.

With round or cylindrical tanks the bottom area (circular in this case) is again a uniform section extending through a distance equal to the height of the tank. The area of the base = $\frac{\pi d^2}{4}$ where $\pi = \frac{22}{7} = 3{\cdot}1416$, and d = diameter of tank.

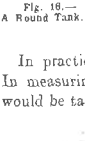


Fig. 16.—A Round Tank.

In the example given in Fig. 16

Volume = Area of base × height

$$= \frac{\pi d^2}{4} \times \text{height} = \frac{22}{7} \times \frac{6 \times 6}{4} \times \frac{6}{1} \text{ cubic feet.}$$

$$\text{Capacity in gallons} = \frac{22}{7} \times \frac{6 \times 6}{4} \times \frac{6}{1} \times \frac{25}{4} = \frac{7{,}425}{7}$$

$$= 1{,}060.$$

In practice the capacity of the tank would be stated as 1,060 gallons. In measuring the diameter of a round galvanised tank, the measurement would be taken to correspond with the centre of the corrugations.

Drains.

Where it is desired to know the amount of earth removed (in cubic yards) during the construction of an ordinary drain, say, 4 feet wide at the top,

2 feet wide at the bottom, 4 feet deep and 100 yards long (Fig. 17), the uniform section is the end of the drain, which is a trapezoid in shape, and runs throughout the whole length of the drain.

$$\text{The area of this end section} = \frac{\text{sum of parallel sides} \times \text{height}}{2}$$

$$= \frac{(4 + 2) \times 4}{2} = 12 \text{ square feet.}$$

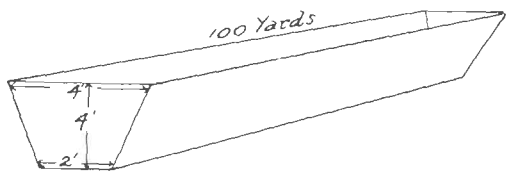


Fig. 17.—A Section of a Drain.

All measurements must be in the same unit, *i.e.*, all in feet or all in yards, &c., so that it is necessary to multiply the length (100 yards) by 3 to convert it into feet.

$$\text{The volume of the drain thus} = 12 \times 100 \times 3 \text{ cubic feet} = \frac{12 \times 100 \times 3}{27} \text{ cubic yards.}$$

$$= 133\tfrac{1}{3} \text{ cubic yards.}$$

Pit Silos.

Fig. 18 represents an ordinary silage pit having sloping ends and straight sides. The side (a trapezoid), in this case, is a uniform section, extending through a distance equal to the width of the pit.

$$\text{The area of the side} = \frac{(60 + 24)}{2} \times \frac{6}{1} \text{ square feet.}$$

$$\text{The volume of pit} = \frac{(60 + 24)}{2} \times \frac{6}{1} \times \frac{15}{1} \text{ cubic feet.}$$

$$= \frac{84}{2} \times \frac{6}{1} \times \frac{15}{27} \text{ cubic yards} = 140 \text{ cubic yards.}$$

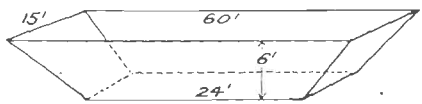


Fig. 18.—Diagram of a Pit Silo.

The volume in cubic yards would be required where the pit was dug by contract at so much per cubic yard, but a more important calculation is the number of tons of silage the pit will hold. It may be taken that 2 cubic yards of silage equal 1 ton, so that to work out the number of tons of silage in the pit, divide the number of cubic yards by 2.

The capacity of the pit represented by Fig. 18 $= \frac{140}{2} = 70$ tons.

Hay Sheds.

If the full capacity of a hay shed is required, the measurements taken will be those of a stack under the shed, and allowance made for settling of the hay. If the volume of a stack already under the shed is required, the measurements are readily taken.

In the case of hay sheds the end section is uniform throughout the length of the stack. The area of this end section is found by adding the rectangular area to the triangular area, and the volume of the shed or stack = end area × length.

Taking Fig. 19 as an example :—

Area of rectangular portion = 30 × 15 = 450 square feet.
Area of triangular portion = $\frac{30 \times 10}{2}$ = 150 ,,
Area of end = 600 square feet.
Volume of shed = 600 × 60 = 36,000 cubic feet.

The number of tons of hay in the stack will vary with a number of factors :—

(*a*) Size of stack—in large stacks compression will be greater, and the hay heavier for a given volume.

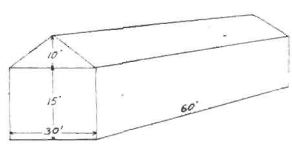


Fig. 19.—Diagram of a Hay Shed.

(*b*) Age of stack—settling, with resulting compression, increases with the age of the stack.

(*c*) Condition of hay—whether in sheaves or loose.

(*d*) Sort of hay—lucerne, wheaten, oaten, &c.

(*e*) Quality of hay—the ratio of grain or leaf to stalk.

The following table gives the number of cubic feet of hay of various kinds to the ton for various periods after completion of stacking, the figures being the result of actual experiments:—

CUBIC Feet of Hay to the Ton.

Period after Stacking.	Oaten.		Wheaten.		Lucerne.
	Sheaf.	Loose.	Sheaf.	Loose.	
Immediately on completion of stack.	350	400	400	500	Varies greatly from 400 to 300 cub. ft. to the ton.
One week after	325	375	375	450	
One month after	300	350	350	400	
Twelve months after ...	300	325	330	400	

At Bathurst Experiment Farm, wheaten hay averaged 297 cubic feet to the ton, and loose straw 892 cubic feet to the ton. Any figure taken can only be approximate. The figures in the above table will serve as a guide, and indicate that little or no settling takes place after the first month.

If it is assumed that the shed illustrated in Fig. 19, which has a volume of 36,000 cubic feet, contains sheaf wheaten hay, the number of tons of hay in shed $= \frac{36,000}{350} = 102{\cdot}8$. The capacity of this shed would be a little more than 100 tons.

The area of the end of the shed illustrated in Fig. 19 might be calculated in one step, instead of two as shown above, by considering the top triangular portion equal to a rectangular portion half its height. The end is then a rectangle 30 feet wide by $(15 + \frac{10}{2})$ feet high, and its area $= 30 \times 20$ square feet $= 600$ square feet.

It would be a good plan for farmers to work out the number of cubic feet of hay to the ton in their particular stacks. *This can be done as follows:—Cut out a truss of hay from about half-way up the stack, weigh it, measure* the space it occupied in the stack, and estimate the number of cubic feet to the ton. For example, if a truss is cut from a stack 1 yard square by 1 foot deep, and is found to weigh 57½ lb.,

Volume of truss $= 3 \times 3 \times 1 = 9$ cubic feet.

Therefore 9 cubic feet $= 57\frac{1}{2}$ lb.

Therefore 1 cubic foot $= \frac{57\frac{1}{2}}{9}$ lb.

Therefore 1 ton will contain $\frac{2,240}{1} \times \frac{9}{57\frac{1}{2}}$ cubic feet, $= \frac{2,240 \times 9 \times 2}{115}$ cubic feet

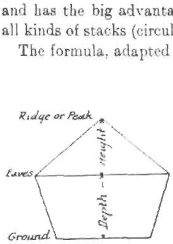
$= 350{\cdot}6$ cubic feet $= 351$ to nearest cubic foot.

Hay Stacks.

The capacity of all rectangular stacks may be calculated as for hay sheds. Where, however, the stacks are larger at the eaves than at the ground, and where the top ends slope inwards to the ridge, this method is not accurate and is therefore unsatisfactory. The better method is to apply the

prismoidal formula, which is only a little more difficult, is much more accurate, and has the big advantage that it can be applied to finding the capacity of all kinds of stacks (circular and rectangular), dams, tanks, and earth heaps.

The formula, adapted to haystack problems, may be thus stated :—



Product of measurements at top ...
Product of measurements at eaves ...
Product of sums of corresponding measurements at top and eaves ...
Product of measurements at eaves ...
Product of measurements at ground...
Product of sums of corresponding measurements at eaves and ground

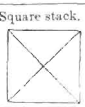
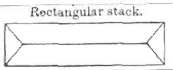
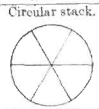
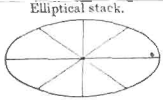
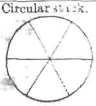
Sum of the three products × height above eaves.

Sum of the three products × depth below eaves.

Sum × $\frac{1}{6}$ × constant = cubic content.

The constants used depend upon the shape of the stack and what measurements are taken. They may be summarised thus :—

CONSTANTS for Prismoidal Formula.

Shape of Stack.	Measurements Used.	Constant Multiplier
Square stack. 	Length of side at ground, eaves, and top; vertical height above eaves, and depth below eaves.	1
Rectangular stack. 	Length and breadth at ground, eaves, and top; vertical height above eaves, and depth below eaves.	
Circular stack. 	Diameter at ground, eaves, and top; vertical height above and depth below eaves.	$\frac{\pi}{4} = \frac{11}{14} = .7854$
Elliptical stack. 	Long and short diameters at ground, eaves, and top; vertical height above eaves and depth below eaves.	
Circular stack. 	Length right round stack at ground, eaves, and top; vertical height above and depth below eaves.	$\frac{7}{88}$

Thus it is seen that for rectangular or square stacks, when the length and breadth are the figures taken, the constant is 1; for circular or elliptical stacks when the diameters are taken, it is $\frac{\pi}{4}$ or the shown equivalents $\frac{11}{14}$ or ·7854; for circular stacks when the circumference is taken, it is $\frac{1}{4\pi} = \frac{7}{88}$.

A few worked examples will make the method clear. Applying the formula to the rectangular stack represented by Fig. 20, the volume would be :—

Product of length and breadth at top = 35 × 0 = 0
Product of length and breadth at eaves = 45 × 25 = 1,125
Product of sums of lengths and breadths = 80 × 25 = 2,000

Sum × height above eaves = 3,125 × 10 = 31,250...

Sum × $\frac{1}{6}$ = $\frac{100,250}{6}$ = 16,708½ cub. ft.

Product of length and breadth at eaves = 45 × 25 = 1,125
Product of length and breadth at ground = 40 × 20 = 800
Product of sums of lengths and breadths = 85 × 45 = 3,825

Sum × depth below eaves = 5,750 × 12 = 69,000...

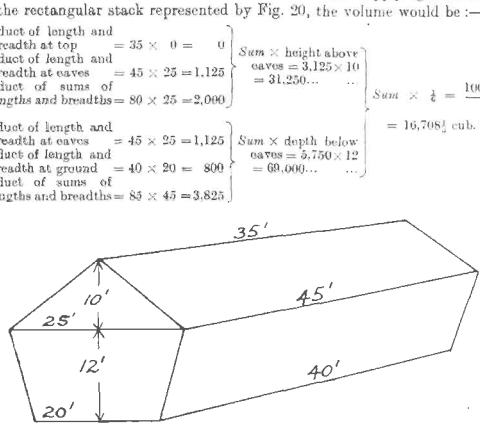


Fig. 20.—A Rectangular Haystack.

The rule is similarly applied to circular and elliptical stacks, bearing in mind the constant to be used. In the case of a circular stack where the diameter is the measurement taken, the constant $\frac{\pi}{4}$ must be used or the result would represent the volume of a square stack of which the side was equal to the diameter of the circular stack. Multiplying by $\frac{\pi}{4}$ reduces this volume to the correct amount for this shape of stack. Similarly if the constant $\frac{\pi}{4}$ were not used in the case of the elliptical stack the result obviously would be the volume of a rectangular stack having sides equal to the diameters of the elliptical stack. Again if the circumference of a circular stack be the measurement taken, the constant $\frac{1}{4\pi} = \frac{7}{88}$ must be used, or the result would represent the volume of a square stack with sides equal to the circumference of the round stack.

If the formula is applied to the circular stack represented by Fig. 21, using the circumference as the measurement, and the constant $\frac{7}{88}$, the volume would be :—

Product of measurements at top = 0 × 0 = 0
Product of measurements at eaves = 96 × 96 = 9,216
Product of sums of measurements = 96 × 96 = 9,216
Sum × height above eaves = 18.432 × 9 = 165,888 ...

Product of measurements at eaves = 96 × 96 = 9,216
Product of measurements at ground = 84 × 84 = 7,056
Product of sums of measurements = 180 × 180 = 32,400
Sum × depth below eaves = 48.672 × 10 = 486.720 ...

Sum × $\frac{1}{2}$ × $\frac{1}{3}$ = $\frac{652.608}{6}$ = 8,652 cub. ft.

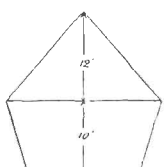


Fig. 21.—Diagram of a Round Haystack.

The volume of the conical top of a circular stack might easily be calculated by the ordinary rule for volume of a cone; but it is better to work as above, as this enables the one rule to be applied throughout.

The volume of an elliptical stack, having long and short diameters of 30 feet and 22 feet respectively at the eaves, and of 24 feet and 16 feet respectively at the ground, with height of 12 feet above the eaves and 10 feet from ground to eaves, would be :—

0 × 0 = 0
30 × 22 = 660
30 × 22 = 660
Sum × height above eaves = 1,320 × 12 = 15,840.

30 × 22 = 660
24 × 16 = 384
54 × 38 = 2,052
Sum × depth below eaves = 3,096 × 10 = 30,960.

Sum × $\frac{1}{2}$ × $\frac{\pi}{4}$ = $\frac{46,800}{6}$ × $\frac{11}{14}$ = 6,128 cubic feet.

The prismoidal formula may be used to find the volume of the lower or upper half of the stack alone, or to find the capacity of a stone heap (Fig. 22), or a tank (Fig. 24.)

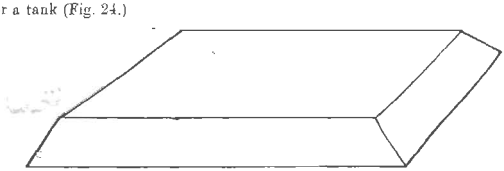


Fig. 22.—Diagram representing a Stone Heap.

Tanks and Dams.

In estimating the volume of water in a dam, care must be taken, where the dam is built on a slope, to take the top measurements along the line of water level. Generally, of course, this precaution is not necessary, for slopes are not usually so great as to appreciably affect the measurement. The question of dam capacity usually arises as soon as the construction of the dam is completed, and it is still dry, when the bottom measurements are readily taken, the capacity being required, not only for stock watering purposes, but for payment of the dam sinker. If the dam is full, and only the depth, and the slope of the sides are known, the bottom measurements can be calculated thus: "From the top measurements deduct the figure got by multiplying twice the depth by the horizontal component of the slope."

As an example, let the length and breadth at top of a dam be 120 feet and 90 feet respectively, the slope = 1 in 3, and the depth be 10 feet.

Then bottom length = $120 - (2 \times 10 \times 3) = 120 - 60 = 60$ feet;
Bottom breadth = $90 - (2 \times 10 \times 3) = 90 - 60 = 30$ feet.

It is seen from Figs. 23 (*a*) and 23 (*b*) that the sides will all "come in," a horizontal distance of 30 feet. Thus the bottom measurements are less at both ends, and both sides, than the top measurements by this amount, that is the distance to be subtracted from the top measurements is $(3 \times 10) \times 2 = 60$ feet.

Fig. 23 (*a*). Fig. 23 (*b*).

The capacity of the tank illustrated in Fig. 24 would be found thus:—

Product of length and breadth at top = $150 \times 100 = 15{,}000$
Product of length and breadth at bottom = $114 \times 64 = 7{,}296$
Product of sums = $264 \times 164 = 43{,}296$

Sum $\times \frac{\text{depth}}{6}$ = $65{,}592 \times \frac{12}{6}$ cubic ft. = $65{,}592 \times \frac{12}{6} \times \frac{1}{27}$ cubic yds. = 4,859 cubic yds.

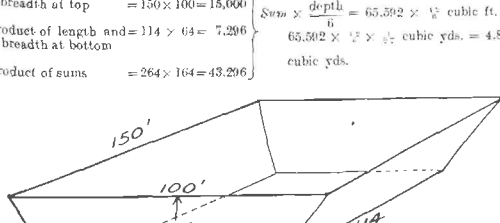


Fig. 24.—Diagram of a Tank or Dam.

The capacity of dams and tanks is always stated in cubic yards, and in the above example division by 27 converted cubic feet into cubic yards. The number of gallons of water can be found, because 1 cubic foot = $6\frac{1}{4}$ gallons. For example, in the above tank, 4,859 cubic yards = 4,859 × 27 cubic feet. *Therefore the capacity of the tank* = 4,859 × 27 × $6\frac{1}{4}$ gallons = 819,956 gallons.

The earth removed in the excavation of a tank will equal the water-holding capacity only when the surface is level. When the surface is very uneven, and the amount of earth removed is required with greater accuracy, the tank may be divided into a number of vertical strips by taking the measurements of several vertical and parallel cross sections, averaging the depths along and widths across the section. In old dams, the original shape may be lost and the top and bottom areas uneven and not parallel. They may be treated as suggested above, averaging depths and widths of a number of cross-sections. The number of points at which the depth or width is measured for purposes of averaging will depend upon the unevenness of the bottom, top, or sides. The average width will generally be got with sufficient accuracy by taking half the sum of the top and bottom widths (See Figs. 25 and 26).

The method of arrangement shown on the next page, where the figures representing "sums" are placed between the other two measurements, makes for neatness and reduces the number of rows of figures, but probably makes the matter a little more difficult to follow.

Calculating Size of a Dam.

An important problem confronting the dam-sinker is to find the length and breadth he shall make his dam to give him the desired capacity. He usually can decide upon the number of cubic yards and the depth desired, but is then in doubt as to what length and breadth the dam must be made. To arrive at these measurements, the slope of the sides must be known. For example, suppose the top measurements are required for a tank of 5,000 cubic yards capacity, 12 feet deep, with a slope of 1 in 3. The proceedure is as follows :—

(i) *Find the number of cubic yards in an average section of the dam* 1 yard deep. To do this divide the total capacity in cubic yards by the depth in yards. In this example—

Capacity of dam = 5,000 cubic yards.

$$\text{Capacity of average section} = \frac{5,000}{4} \text{ cubic yards} = 1,250 \text{ cubic yards.}$$

(ii) Take any two numbers which multiplied together, give this number—1,250 in the example. These two numbers (50 and 25) then represent the length and breadth in yards of the average section (50 × 25 = 1,250). In a dam with sloping sides, the average section is assumed to be half-way

Method of calculating quantities by means of cross-sections :—

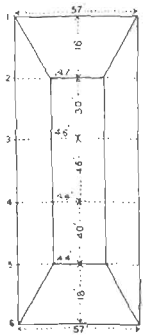


Fig. 25. Tank.
Sketch plan overall.

Breadth and depth of No. 1 Section are 57′ and 0′, then...	57	0	= 0	
Sums of breadths and depths of Nos. 1 and 2 Sections	= 104	× 5	= 520	*Sum* × distance between Sections Nos. 1 and 2 = 755 × 16 = 12,080 ..
Breadth and depth of No. 2 Section are 47′ and 5′, then	47	5	= 235	
Sums of breadths and depths of Nos. 2 and 3 Sections	= 93	9	= 837	*Sum* × distance between Sections Nos. 2 and 3 = 1256 × 30 = 37,680 ..
Breadth and depth of No. 3 Section are 46′ and 4′, then	46	4	= 184	
Sums of breadths and depths of Nos. 3 and 4 Sections	= 91	9·3	= 845	*Sum* × distance between Sections Nos. 3 and 4 = 1268 × 46 = 58,328..
Breadth and depth of No. 4 Section are 45′ and 5·3′, then	45	5·3	= 238	
Sums of breadths and depths of Nos. 4 and 5 Sections	= 89	14	= 1246	*Sum* × distance between Sections Nos. 4 and 5 = 1867 × 40 = 74,680..
Breadth and depth of No. 5 Section are 44′ and 8·7′, then	44	8·7	= 383	
Sums of breadths and depths of Nos. 5 and 6 Sections	101	8·7	= 879	*Sum* × distance between Sections Nos. 5 and 6 = 1,262 × 18 = 22,716
Breadth and depth of No. 6 Section are 57′ and 0′, then	57	0	= 0	

Sum × $\frac{1}{2}$ × $\frac{1}{27}$ = $\frac{205,484}{6 \times 27}$ = 1,208 cubic yards.

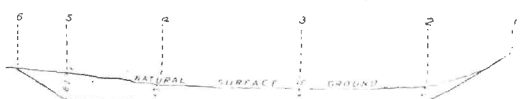


Fig. 26.—Average Longitudinal Section of Tank of Irregular Depth.

between the surface and the bottom of the dam. The measurements 50 × 25 would correspond to the length and breadth of this section, midway between the top and bottom of the dam (Fig. 27).

(iii) Add to the mid-measurements an amount equal to the depth multiplied by the "slope figure," *i.e.*, the horizontal component of the slope. A consideration of Fig. 28 shows that to get the top measurements in this case, add to the mid-measurements, 6 yards for each end. Thus—

Top length = 50 + (4 × 3) = 62 yards = 50 + (6 + 6) = 62 yards.
Top breadth = 25 − (4 × 3) = 37 yards.

Thus the top measurement = 62 yards long by 37 yards. These measurements would be checked as shown in the next example.

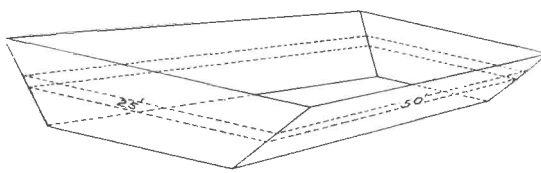


Fig. 27.—Diagram of Tank, showing Average Section.

The top measurements of a tank having a capacity of 6,000 cubic yards, a depth of 15 feet, and a slope of 1 in 2, would be ascertained as follows :—

$$\text{Average section} = \frac{6{,}000}{5} = 1{,}200 \text{ cubic yards.}$$

Mid-measurements, say, 40 × 30 (= 1,200 cubic yards).
Add to each end, depth × slope figure = depth × 2.
Then top measurements = 40 + (5 × 2) and 30 + (5 × 2)
= 50 yards × 40 yards.

It is possible to check these measurements by finding the bottom measurements and then calculating the capacity of the dam. To get bottom measurements :—

Mid-measurement = 50 × 40
Subtract depth × 2 in each case.
Then bottom measurements = 40 − (5 × 2) and 30 − (5 × 2) = 30 × 20

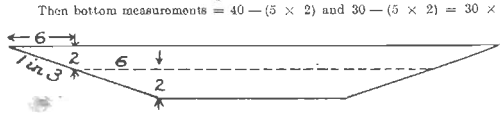


Fig. 28.—Longitudinal Section of a Tank.

From these measurements the capacity of the tank would be—

$$\left.\begin{array}{l} 50 \times 40 = 2{,}000 \\ 30 \times 20 = 600 \\ 80 \times 60 = 4{,}800 \end{array}\right\} Sum \times \frac{\text{depth}}{6} = \frac{7{,}400 \times 5}{6} = 6{,}166\tfrac{2}{3} \text{ cubic yards}$$

which is too much. There will always be a slight excess capacity given from measurements obtained as above.

By cutting down the length, say 1 yard, the volume would be :—

$$\left.\begin{array}{l} 49 \times 40 = 1{,}960 \\ 29 \times 20 = 580 \\ 78 \times 60 = 4{,}680 \end{array}\right\} Sum \times \frac{\text{depth}}{6} = \frac{7{,}220 \times 5}{6} = \frac{36{,}100}{6}$$

$$= 6{,}016\tfrac{2}{3} \text{ cubic yards.}$$

The top measurements, 49 yards by 40 yards, give a capacity of $6{,}016\frac{2}{3}$ cubic yards, which might be taken as near enough, considering the irregularities of surface, bottom, and sides.

USEFUL TABLES.

The most important of our tables of weights and measures are given below.

LENGTH (*Linear Measure*).

12 inches	=	1 foot.
3 feet	=	1 yard.
5½ yards	=	1 *rod*, pole, or perch.
40 poles or 220 yards	=	1 furlong.
8 furlongs or 1,760 yards	=	1 mile.

In measuring the height of horses the *hand* is used.

1 hand	=	4 inches.

Surveyors' Units.

100 links	=	1 chain = 4 poles.
10 chains	=	1 furlong.
8 furlongs or 80 chains	=	1 mile.

AREA (*Square Measure*).

144 square inches	=	1 square foot.
9 square feet	=	1 square yard.
30¼ square yards	=	1 square pole or perch.
40 square poles	=	1 rood.
4 roods or 4,840 square yards	=	1 acre.
10 square chains, or 100,000 square links	=	1 acre.
640 acres	=	1 *square mile*.

In measuring thatch and tiles the *square* is used.

1 square	=	100 square feet.

Surveyors' Units.

10 square chains or 100,000 square links	=	1 acre.
640 acres	=	1 square mile.

SOLIDS (*Cubic Measure*).

1,728 *cubic inches*	=	1 *cubic foot*.
27 cubic feet	=	1 cubic yard.
24¾ cubic feet	=	1 solid perch (mason's work).
12⅞ cubic feet	=	1 solid perch (brickwork).

Note that 1 cubic foot of water weighs 1,000 ounces avoirdupois, and that approximately 277¼ cubic inches=1 gallon.

LIQUID AND DRY MEASURE.

4 gills	=	1 pint } For liquids.
2 pints	=	1 quart } For liquids.
4 *quarts*	=	1 *gallon* } For liquids.
2 gallons	=	1 peck } For dry goods only.
4 pecks	=	1 bushel } For dry goods only.
8 bushels	=	1 quarter } For dry goods only.

AVOIRDUPOIS WEIGHT.

16 drams	=	1 ounce (oz.).
16 ounces	=	1 pound (lb.).
14 pounds	=	1 stone (st.).
28 pounds	=	1 quarter (qr.).
4 quarters or 8 stone	=	1 hundredweight (cwt.).
20 hundredweights	=	1 ton.

Avoirdupois weight is used for weighing all goods, *i.e.*, groceries, meat, bread, coal, &c., and all metals (except gold, silver, platinum, and jewels, which are bought and sold by troy weight).

Note that 1 cwt.=112 lb., but 1 cwt. of flour=100 lb.; 2240 lb.=1 ton, but 2,000 lb.=1 ton of flour. [N.B.—A cental=100 lb.]

TROY WEIGHT.

24 grains	=	1 pennyweight (dwt.).
20 *pennyweights*	=	1 *ounce* (*oz.*).
12 ounces	=	1 pound (lb.).

Troy weight is used in weighing gold, silver, platinum, pearls, gems, and some liquids. Pure gold is said to be 24 carats fine. The gold of a sovereign or half sovereign is 22 carats fine, *i.e.*, 22 parts out of 24 are pure gold, the other 2 parts being alloy.

APOTHECARIES' WEIGHT.

1 ounce	=	437½ grains.
1 pound (16 oz.)	=	7,000 grains.

(Same as avoirdupois weight.)

APOTHECARIES' FLUID MEASURE.

60 minims	=	1 fluid dram	1 minim	= 1 drop.
8 fluid drams	=	1 fluid ounce	1 dram	= 1 teaspoonful.
20 fluid ounces	=	1 pint	2 drams	= 1 dessertspoonful.
8 pints	=	1 gallon	4 drams = ½ oz.	= 1 tablespoonful.
			1 oz.	= 1 wineglassful.

Note that :—

1 fluid oz. of pure water	=	1 oz. avoirdupois.
1 pint of pure water	=	1¼ lb. avoirdupois.
1 gallon of pure water	=	10 lb. avoirdupois.
1 lb. avoirdupois	=	16 fluid ounces of pure water.
1 cubic foot	=	6¼ gallons.
1 ton	=	32 cubic feet of pure water.
1 lb. avoirdupois	=	27·727 cub. inches of pure water.
1 Imperial bushel	=	2,218·192 *cub. inches of pure water.*
1 bushel	=	80 lb. pure water.
1 cubic foot pure water	=	62½ lb. (1,000 oz.).
1 cubic foot seawater	=	64 lb.

BUSHEL WEIGHTS OF GRAIN AND PRODUCE.

Names.	lb. per bushel.	Names.	lb. per bushel.
Barley	50	Malt	50
Beans	60	Oats	40
Bran	20	Peas	60
Flour	56	Pollard	20
Maize	56	Wheat	60

Other Useful Information.

In addition to the foregoing standard tables of weights and measures, the following tables, notwithstanding that many of the figures are only approximations, contain much information that will be found very useful when planning or erecting farm buildings, wire and rabbit-proof netting fences, &c.

WIRE-NETTING.

There are three grades of wire-netting on the market :—

"A" grade is what is known as full weight.

"B" grade is about 8 per cent. lighter in weight than "A" grade.

The third grade will be 20 per cent. lighter than "A" grade. This grade reduces the size of wire by about two gauges, viz.,—18 gauge, and 20 per cent. light weight netting, will be about 20 gauge. It is not economy to buy it.

The following table shows sizes and approximate weights per mile in "A" grade, and when purchasing netting it is wise to specify what "weight per mile" netting you require. This is safer than merely ordering according to classified grade.

Size of Netting.	Approximate Weight per Mile.
	"A."
42 × 1½ × 17	32 cwt.
42 × 1½ × 17	27 "
42 × 1½ × 18	23½ "
42 × 1½ × 18	20½ "
36 × 1½ × 17	27½ "
36 × 1½ × 17	23¼ "
36 × 1½ × 18	20½ "
36 × 1½ × 18	17¾ "

Rabbit Netting.

Size of Mesh.	Gauge.	Approximate Weight per Mile.				
		24 inches wide.	30 inches wide.	36 inches wide.	42 inches wide.	48 inches wide.
inches.		c. q. lb.	c. q. lb.	c. q. lb.	c. q. lb.	c. q. lb.
2½	18	7 1 14	9 3 0	11 1 0	12 2 25	14 0 10
2½	17	10 0 14	13 0 0	14 3 0	16 2 0	17 3 10
2½	16	13 0 0	16 3 0	19 1 14	21 2 21	24 1 7
2½	15	15 2 14	19 3 14	22 3 7	26 0 14	28 1 0
3	18	6 0 7	6 3 14	8 1 14	9 2 5	10 2 [illegible]
3	17	8 0 0	9 0 14	11 0 0	12 2 25	13 3 15
3	16	9 2 0	11 0 14	13 2 10	15 3 17	17 2 15
3	15	13 0 0	15 0 0	18 1 0	21 0 0	24 2 0
3	14	15 1 0	18 1 1	21 2 7	24 3 21	28 2 14
4	18	4 2 0	5 2 0	5 3 14	6 2 0	7 1 21
4	17	6 2 14	7 3 0	8 2 20	9 2 5	10 2 14
4	16	8 2 21	9 2 0	11 0 0	12 0 20	13 1 7
4	15	11 0 0	12 2 14	14 0 8	15 3 20	17 2 14
4	14	14 0 14	15 3 14	17 3 19	19 2 26	21 2 21

Plain Fencing Wire.

No.	Weight per Mile.	Length per cwt.	Breaking Strain.	
			Annealed.	Bright.
	lb.	yards.	lb.	lb.
6	502	393	1,544	2,316
7	422	467	1,298	1,946
8	348	566	1,072	1,608
9	282	700	869	1,303
10	223	882	687	1,030
11	183	1,077	564	845
12	148	1,333	454	680

Barbed Wire.

Barbed wire is put up in 1 cwt. coils—20 to the ton. It can be put up in 10 cwt. coils if necessary.

Length per cwt. in Yards.

		Close Set. Barbs 3 in. apart.	Long Set. Barbs 5½ in. apart.
Ordinary "Iowa" Pattern ...	12 gauge	450 yds. cwt. cl.	520 yds. cwt. cl.
	14 ,,	725 ,, ,,	830 ,, ,,
Special Long Distance Pattern	12 ,,	650 ,, ,,	660 ,, ,,
	14 ,,	935 ,, ,,	1,000 ,, ,,

Special long distance is sometimes known as "Scrutch."

FENCE POSTS.

Distance apart.	Number of Posts Required.		Distance apart.	Number of Posts Required.	
	Per Chain.	Per Mile.		Per Chain.	Per Mile.
ft. in.			ft. in.		
6 0	11·0	880	15 0	4·4	352
8 0	8·25	660	16 0	4·125	330
8 3	8·0	640	16 6 (1 rod)	4·0	320
9 0	7·34	587	18 0	3·67	293
10 0	6·6	528	20 9	3·3	264
12 0	5·5	440	22 0	3·0	240
14 0	4·71	377			

CORRUGATED GALVANISED IRON.

The following table gives the approximate number of sheets of corrugated iron (ordinary corrugations) in a case, which weighs about 10 cwt.

Length of Sheet.	Gauge.					
	18.	20.	22.	24.	26.	28.
5 feet	42	53	66	83	116	132
6 ,, ...	35	44	55	69	98	111
7 ,, ...	30	38	47	59	84	95
8 ,, ...	26	33	41	51	73	83
9 ,, ...	23	29	36	45	65	74
10 ,, ...	21	26	33	41	58	66
11 ,, ...	19	24	30	38	54	62
12 ,, ...	17	22	28	35	49	56

Approximate weight per sheet (in lb.) is given in the following table:—

Length of Sheet.	Gauge.					
	18.	20.	22.	24.	26.	28.
	lb.	lb.	lb.	lb.	lb.	lb.
5 feet	26½	21	17	13½	9½	8¼
6 ,, ...	32	25¾	20¾	16¼	11½	10
7 ,, ...	37½	29¾	24	19	13¾	11¾
8 ,, ...	43	34	27¾	22	15½	13½
9 ,, ...	49	38½	31	25	17¾	15¼
10 ,, ...	53	43	34	27½	19¼	17
11 ,, ...	58½	46½	37½	29¾	20¾	18½
12 ,, ...	64	51	40½	32½	23	20

SPRING HEAD NAILS AND GALVANISED ROOFING SCREWS.

One packet of "spring heads," which are used for fixing iron, contains 100 nails, and is usually reckoned as sufficient for one square of roofing. A square is 10 ft. x 10 ft.

The approximate numbers of galvanised roofing screws to the lb. are :—

1¾ inch	×	12	gauge	...	...	...	...	...	56 screws.
2	,,	×	12	,,	..	...	...	...	48 ,,
2½	,,	×	14	,,	..	...	.	...	31 ..
3	,,	×	14	,,	..	...	...	..	27 ..

There are about 57 lead washers in a lb.

Plain Galvanised Iron.

The table below shows the approximate number of 6 feet sheets of plain galvanised iron in a case, which averages about 10 cwt. The approximate weight per sheet is also shown :—

Width of Sheet.	Gauge.								
	14.	16.	18.	20.	22.	24.	26.	28.	30
Approximate number of sheets in a case (about 10 cwt.)									
24 inches	30	36	47	57	74	86	120	140	160
30	23	29	37	45	59	69	97	112	130
36	19	24	31	38	49	57	80	92	112
Approximate weight per sheet.									
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
24 inches	37	31	24	19½	15	13	9½	8	7
30	48⅝	38⅝	30¼	25	19	16¼	11½	10	8¼
36	59	46⅝	36	29½	23	19⅝	14	12¼	10

Fibro Cement Sheets.

Width of Sheet.	Length of Sheets.
4 feet ($\frac{3}{16}$-in. and $\frac{1}{4}$-in. thick) ...	3, 4, 5, 6, 7, 8, 9, and 10 feet.
4 ,, ($\frac{3}{16}$-in. thick only) ...	11 feet and 12 feet.
3 ,, ($\frac{3}{16}$-in. and $\frac{1}{4}$-in. thick) ...	3, 4, 5, 6, 7, 8, 9, and 10 feet.
3 ,, ($\frac{3}{16}$-in. thick only) ...	11 feet and 12 feet.
2 ,, ($\frac{3}{16}$-in. and $\frac{1}{4}$-in. thick) ...	3, 4, 5, 6, 7, 8, 9, and 10 feet.
18 in. ($\frac{3}{16}$-in. and $\frac{1}{4}$-in. thick) ...	3, 4, 5, 6, 7, 8, 9, and 10 feet.

Fibro sheets $\frac{3}{16}$-in. thick = 125 square yards to the ton (108 sq. yds. if crated).
Fibro sheets $\frac{1}{4}$-in. thick = 160 square yards to the ton (140 sq. yds. if crated).

Approximate Weight of Timber.

	per ton weight.		per ton weight.
Hardwood	360 sup. ft.	5-ft. Sawn hardwood palings...	380 count.
Oregon	700 ,,	6-ft. ,, ,,	320 ,,
Kauri	750 ,,	Hardwood pickets	500 ,,
Redwood (wet) ...	550 ,,	Doors, average... ...	50 ,,
Redwood (dry) ...	1,000 ,,	Stock sashes, average ...	100 pairs ,,
Baltic	1,000 ,,	Bricks, ordinary	333 ,,

A superficial foot is 1 foot long by 1 foot wide by 1 inch thick, while a foot superface is 1 foot long by 1 foot wide, irrespective of thickness. Also note that it takes 4 bundles of redwood shingles or 700 oak shingles to cover one square (10 feet by 10 feet).

RATE OF DISCHARGE OF WATER PIPES.

Diameter of Water Pipe.	Gallons per Minute Discharged.	Diameter of Water Pipe.	Gallons per Minute Discharged.
½ inch	½	4 inches	60
¾	¾	5	100
1	1½	6	160
1¼	3	7	220
1½	5	8	300
2	10	9	400
2½	15	10	500
3	20	12	800
3½	40	14	1,000

Miscellaneous.

Bricks.—About 1,000 bricks, with 2 bags of lime and 1 load of sand are required to build an ordinary cottage chimney; and 2,000 bricks, 3½ bags of lime and 1½ loads of sand for a double chimney.

About 1,000 bricks, on the average, go to 3½ tons weight.

Lime.—From 15 to 16 bags go to the ton.

Cement.—A cask or barrel weighs about 3½ cwt.

Plaster of Paris.—A barrel weighs about 2¾ cwt.

Oil.—Oil weighs about 56 lb. per 5 gallon drum.

Paint.—One gallon of mixed lead paint weighs 18 to 20 lb., and will cover from 40 to 50 square yards with one coat, according to the surface.

Nails.—Allow 1 lb. 2-inch brads, or 1½ lb. 2½-inch, or 2 lb. 2½-inch to every 100 feet of flooring; and allow ½ lb. 1½-inch nails to every 100 feet of lining, and 1 lb. 2-inch nails to every 300 feet of weatherboards.

SECTION XVI.

Book-keeping for Farmers.

MANY farmers record simple details of their doings in "diaries," which are useful, but many advantages accrue from the keeping of a permanent record covering purchases and sales, profits and expenses, and other business transactions.

While farm accounts constitute only one branch of the records that may, with advantage, be kept by farmers, they furnish, in a simple form, the following information:—

(1) The total amount of a person's worth, *i.e.*, the amount that should be realised if possessions were sold and all debts paid.
(2) The amount of cash in the bank or the amount of overdraft.
(3) Purchases, sales, and value of, as well as profits or loss on, live-stock and produce such as chaff, grain, butter.
(4) The value of the farm, machinery, buildings, and other improvements.
(5) Expenses incurred on such items as seed and fertilisers, bags and twine, repairs to machinery, fences or buildings, rates, taxes and insurance, household expenses.

The reasons for keeping accounts may be summarised thus:

(1) The actual profit for the whole venture is obtained.
(2) It is possible to determine which crops, or what kinds of live-stock, are most profitable.
(3) Costs may be compared with a view to finding out the cause of high or low costs, and so remedying high costs.
(4) The information necessary to compile income-tax returns is readily obtainable.
(5) Reliable information is at hand if required to be produced for the information of commissions and other public bodies.

The bank pass-book gives no indication of the state of one's affairs. The overdraft might increase, and yet a good profit be made; while, on the other hand, an increase in the amount of cash in the bank might occur in a year when a loss is actually incurred in the business. Undoubtedly many farmers are securing larger profits than they themselves realise, owing to their private expenses being in excess of what they estimate.

Preliminary Considerations.

It is first necessary to lay down a few definite rules before going into details. Many systems premise a clear line of demarcation between the farm proper and the house, practically on the basis that to ascertain the actual profits of a farmer, as compared with those of a merchant or a professional man, the two must be kept very distinct. Though this is only the logical outcome of any correct system, the constant analysis of all accounts makes it undesirable for at least the first few years of a beginner's career in book-keeping.

Again, one of two aspects of the profit assessment may be chosen. The first is to charge the business with the owner's estimated salary and treat the total net return as a direct interest on the capital invested—*e.g.*, if, after paying all expenses (including salary of say £200), a profit of £160 is made on a capital of £1,600, 10 per cent. per annum has been earned.

The second method is to charge the ruling rate of interest on the capital invested (*i.e.*, treat the owner's interest in the farm in exactly the same way as if it were a loan) and take the balance as net income for the year. Using the same figures as before in this case, 5 per cent. per annum on £1,600 would be £80, and the net profit is, therefore, £360 less £80 interest, or £280, which is the farmer's payment for time, trouble, and experience. In each case the total income is the same; but inasmuch as he would have received the 5 per cent. on his capital as a mere investment without labour, and as any allocation for salary can only be assumption, the second of the two systems is perhaps the more desirable.

In the case of a partnership, where the two or more parties are of unequal experience, or where one is not taking an active part in the business, the question assumes a different aspect and must be decided on its merits.

A popular suggestion for treating farm accounts is to take each of the paddocks separately, debit its proportion of rent, labour, seed, manure, &c., and credit the net returns. This, though possible to a skilled accountant, and perhaps comparatively easy where the crop occupies the ground the greater part of the year, should rather be discouraged, especially when dealing with mixed farming, as it involves so many mere approximations and estimates. Probably the only instances where it is directly beneficial are either in conjunction with experiment plots, when accuracy in the seed and manure used and in the yield obtained is imperative, or where a farm of only three or four paddocks is confined to one crop and each is dealt with at one time.

Simplifying the Work.

The following suggestions may assist in simplifying the work at the outset:—

1. The house, farm, buildings, &c., may be treated as one property, whether rented or owned by the farmer, unless the house (as in a few cases) is detached from the farm and forms a separate property.
2. No salary is drawn by the owner or his family for services rendered. All farm products used by the household need not be charged, but all definite expenses incurred debited to a house account.
3. Interest charged at 5 per cent. per annum on capital invested, and any further profit is his net return.
4. Inasmuch as few farmers have many cash or bank transactions, the cash book may be dispensed with to reduce the number of books required. All entries may then be made through the journal.

The First Essential—an Inventory.

The man who starts a system of book-keeping with his capital in cash, and then purchases the farm, stock, &c., has a much simpler task than the one who for years perhaps has been engaged on the land. The latter must, as a preliminary, "take stock,"—*i.e.*, discover what he is worth at any particular time. The season of the year for inaugurating the system needs some

judgment. Other things being equal, January 1 or July 1 would be the best; but with certain classes of farming, this might be inconvenient. For instance the end of March might be most suitable for a wheat-grower, as in December he would have wheat unsold, or even unharvested. The end of September might be best adapted for a summer fruit and citrus orchardist, inasmuch as that would probably be the only time when there was no fruit for sale. A tenant-farmer would probably find it better to take his inventory on the anniversary of the day he entered into occupation, and the holders of conditional purchases and homestead selections on one of the dates on which their payments became due. Low stocks and slackness of work may govern other cases. In general, however, as income is calculated for taxation purposes for the year commencing July 1, this may be regarded as the most suitable date on which to commence the work.

In making this valuation, much judgment must be exercised, and this in turn will tend to develop the business faculty. The memory will be called upon, old receipts and pass books looked up, and current values considered, to ensure some amount of accuracy. Over-sanguine estimates may in some cases be made, but a wide-awake farmer usually gathers from the prices obtained at local auction sales, &c., a very fair idea of values.

Numberless instances might be given of the problems which confront the farmer at such a time. For instance, with the financial year closing on June 30, he has several tons of seed potatoes intended for his own planting next season. To buy them would cost £6 per ton; whereas if sold they would realise but £4 or £4 10s. per ton. At what should they be valued? As an enhancement of the value in the "growing" year means a lowering of profit in the "sowing" year, the middle course would be wisest, with a strong leaning towards a low estimate.

The list must then be classified under separate headings, of which the following are the most important:—

1. Land (either with or without house, buildings, &c., which, with fences, dams, clearing, &c., may be placed under the heading of "improvements"). If the place has been bought as a going concern with the house built and fences erected, the one account will suffice; but if unimproved land is obtained, and the additions made subsequently, two or even more divisions would be preferable.
2. Live-stock, including horses, cattle, sheep, pigs, and fowls, placed in separate accounts or together, according to importance. It is easy as well as desirable to keep separate accounts for the several kinds of live-stock.
3. Plant, fixed and movable. Where much heavy fixed plant is in use, the two classes may be kept distinct, as differing allowances for depreciation have to be made.
4. Farm products on hand (ready for sale or use).
5. Farm products growing.—If the inventory is made at the slackest period of the year, these may not be very extensive, and may even be neglected. To prevent an over-estimate, any such crops should only be priced at the cost of labour, seed, and manure, the benefit of any profit being carried to the year in which the harvesting is done.
6. Furniture and domestic effects.

This must be supplemented by a statement showing the cash in hand or in bank, debts owing to or by the farmer, promissory notes, mortgages, &c.

Possibly the most difficult task is the assigning of a value to the farm and buildings, and the tendency would be to overestimate it. Due consideration must be given to the original cost, and to the subsequent improvements, whether made by the farmer in the ordinary course, or carried out by tradesmen for a definite amount. In the case of a tenancy, an estimate must be made of the present worth of any additions or improvements, based upon the fact that the value of such must be spread over the term of the lease and will be considered as of no value at the end.

A Balance-sheet.

This will constitute his balance-sheet, showing his assets, or what he owns, on the one side, and his liabilities, or what he owes, on the other side, and the difference between these two will be his capital—provided, of course, that the assets exceed the liabilities.

Capital account in the books corresponds to the owner's personal account, and is always credited with the owner's net worth. Just in what manner this amount is involved or made up is shown by the other items in the balance-sheet, each of which will be represented by an account in the ledger.

All such balance-sheets inevitably include approximations to value and not actual values (which can only be ascertained when a sale is effected), and, therefore, the merit of any system of book-keeping must depend, first and foremost, on the nearness to accuracy of the various valuations.

SPECIMEN BALANCE-SHEET.

Liabilities.	£	s.	d.	*Assets.*	£	s.	d.
Storekeeper	25	0	0	Land, Buildings, &c. ...	850	0	0
Interest unpaid ...	20	0	0	Stock	320	0	0
Loan from Bank ...	400	0	0	Plant	96	0	0
Capital	1,010	0	0	Crops	84	0	0
				Sundry Debtors ...	105	0	0
	£1,455	0	0		£1,455	0	0

It will be seen from this example that four out of the five divisions into which the assets are divided must of necessity be valuations on the part of the owner, and if in any way inflated will, when realisation takes place, reduce the stated capital to its correct figure.

The Next Essential—A Diary.

The inventory, especially if taken on January 1, might well be copied on the opening pages of a diary. These are cheap enough, and the foolscap sizes, with two or three days to a page, and sufficient space at the end for a financial summary, are eminently suitable. (If preferred, a well-bound book may be used, and columns ruled for the insertion of values for several years. An example of this is given later.)

All the transactions should be recorded in the diary as they occur; and in addition, it is wise to note the doings of every labourer (in a special book, if necessary), the date of service of the farm breeding stock, the plantings

and harvestings, the rainfall, frosts, unusual winds, &c. Many an otherwise unaccountable variation in the yield of two similar crops sown at almost the same time may be understood by reference to some such record, and many of the innumerable problems which incessantly confront the agriculturist may by this means be solved.

At the end of each month a summary should be made of the receipts and expenditure, and in this some discrimination is needed. It is not enough to pay the storekeeper's bill of, say, 100s. Of this, 52s. may be for groceries, 20s. for seed, 10s. for plough-lines, harness oil, &c., 15s. for a new plough-share, and 3s. for an odd ball of binder twine. Similarly, the blacksmith's bill may include shoeing, repairs to ploughs, new gate hinges, &c. Groceries should be charged to house expenses; seed, to a crops account; plough lines, harness oil, to a farm expenses account; shoeing, to a horse account; plough-share, repairs to plough, gate hinges, to a repairs or maintenance account. In just the same way, the receipts must be classified, and credited to crops, cattle, sheep, pigs, fruit, &c.

From this summary of the month's transactions, the Journal (to be afterwards explained) may be made up. All receipts should be kept and numbered, and all account sales of produce, stock, &c., carefully preserved for future reference. The safest method for any farmer to adopt is the banking of all moneys received, and the payment of accounts by cheque as far as possible. His pass-book then becomes a very valuable aid in book-keeping. Small accounts may be paid from Petty Cash, a cheque for £5 or £10 being drawn for this purpose as required, and payments recorded on a special page of the diary. When the amount provided is exhausted, or nearly so, a cheque is drawn for the amount expended and the payments classified for entry in the Journal. The Journal entries will appear as under:—

Petty Cash—Dr.	...	...	...	£5 0 0		
To Bank	...	...	...		£5	0 0
House Expenses	...	...	...	2 15 0		
Horse (shoeing)	...	...	...	1 2 6		
Repairs—Dr.	...	...	...	0 17 6		
To Petty Cash			...		£4	15 0

It may not be out of place to suggest here that a page of the diary might well be used for a few particulars regarding the fire and life policies (giving No., amount and due date of premium, and where the policy is kept), details of any mortgages on the farm, and rough details (if actual copies are not on hand) of any agreements with labourers, clearers, &c. Another page should be set aside for names and addresses. Such information may be required at a moment's notice, and may be of paramount importance when the owner is, through sickness or other cause, absent at the time when payments are due.

There are good grounds for the opinion that an accurately made inventory and a regularly kept diary conduce as much to a thorough knowledge of one's affairs as a journal or a ledger.

The Principles of Double-entry Book-keeping.

Having thus laid down the broad outlines upon which any system of book-keeping must be carried into effect, it is now necessary to briefly describe "Double Entry" as the most suitable for the farmer. It may

entail a few more figures, but the ease with which its correctness may be proved and the balance-sheet compiled, makes it the system least open to criticism.

It is based upon the general principle that every transaction, whatever its nature, concerns two accounts, or has two aspects—that of a receiver and that of a giver. If money is paid into the bank as the result of a sale of stock, the bank account *receives*, while the stock account *gives*. If 100 corn bags are bought at 10d. each, and these are used to market the crops, the crop account *receives*, and the bank (or cash) account *gives*.

If, then, this principle is carried out in its entirety, and the same figures appear on both sides (though in different accounts) of whatever books are kept, a failure of the totals to correspond would certainly indicate an error, which must at once be looked for.

The two books which are needed to supplement the diary, or whatever means are used to make a rough record of daily happenings and transactions, are the Journal and the Ledger. The former is written up in order of date, and the latter according to the account to which the entry belongs.

Simple Rules.

The *fundamental principles of correct book-keeping* are:—

1. Debit the receiver, or that which is received; credit the giver, or that which is given.
2. Debit losses; credit gains.
3. Every debit must have a corresponding credit.
4. The sum of the debits must equal the sum of the credits.

If the first two rules are clearly grasped, the others may be neglected, as they are merely the logical outcome.

Custom has led to the placing of the debits on the left-hand side of the page and the credits on the right.

Classification of Accounts.

Some classification of the various accounts simplifies matters, and though two sections are occasionally advised, viz., real and personal, a more extended division into four classes has the merit of indicating the actual accounts that would be kept. These classses are:—

Personal, or accounts with persons.
Property, or dealings in goods, live stock, &c.
Money, or records of receipts and expenditure.
Convenience, or nominal, such as expenses, interest, discount, wages, &c.

The Journal.

The *Journal is ruled with the following* columns:—"Date," "Account debited and account credited," "Ledger folio" (or page on which the corresponding entry is posted in the Ledger), "Amount of cash (or value) debited," "Amount of cash (or value) credited."

The method of writing up the Journal may be thus illustrated:—

Diary entries:—Jan. 1, 1927—Bought 700 corn bags at 10d. each, from *T. Brown. Jan. 17, 1927—Paid for bags by cheque.*

Bags may be charged to a crops account or to a farm expenses account.

Date.	Dr. / Cr.	Ledger Folio.	Dr. £ s. d.	Cr. £ s. d.
1927.				
Jan. 1	Crops, Dr.		29 3 4	
	To T. Brown		...	29 3 4
„ 17	T. Brown, Dr.		29 3 4	
	To Bank		...	29 3 4

In actual practice, as payment is made before the end of the month, the transaction can be treated as a cash one, and the entry would then be stated as "Crops, Dr. to Bank," without involving the use of Brown's name.

Additional value may be given to the Journal by briefly describing the transaction:—

	£ s. d.	£ s. d.
Crops, Dr.	29 3 4	
To T. Brown		29 3 4
700 corn bags at 10d.		

Where the journal is compiled from rough memoranda, and not from a regularly-kept diary, this is distinctly advantageous.

Reference has already been made (see page 964) to the necessity for analysing the various receipts and expenses, to ascertain the accounts to which the amounts should be charged. The storekeeper's bill, if paid as soon as due, could be journalised thus:—

	Dr. £ s. d.	Cr. £ s. d.
Household (groceries)	2 12 0	
Crops (seed and twine)...	1 10 0	
Repairs (shares, &c.), Dr.	0 18 0	
To Bank		5 0 0

The Ledger.

This is the most important of the books of reference, as it contains an abstract of every transaction recorded in business. It is ruled with columns for "Date," "Particulars of corresponding Cr. entry," "Journal folio" and "Amount" on the Dr. side, and a similar number of columns on the Cr. side.

Dr.					Cr.				
Date.	Particulars of corresponding Cr. entry.	Journal folio.	£	s.	d.	Date	Particulars of corresponding Dr. entry.	Journal folio.	£	s.	d.

Every account mentioned in the Journal requires a Ledger account under its own heading. In actual practice, these would appear on various pages, allotting say ten to the bank, twenty to stock, two to horse, and so on, according to the number of likely transactions. An index is required, and it is desirable to classify them as already stated.

THE FIRST YEAR'S OPERATIONS.

An elementary example of a year's business dealings is here given to explain the foregoing principles. The transactions are really a summary of a diary, and thus no dates are mentioned.

J. Bull starts in 1927 with a capital of £1,000, which is banked. He buys horses for £150, and stock for £400 cash, together with implements from the Sydney Plough Co., for £50 (not paid). He sells stock to James for £300 (not paid), crops for £100 cash, and butter for £10 cash. £120 is paid as wages, and £80 as rent. Valuations at the end of the year are:—Stock, £300; crops, £60; plant, £40; and horses, £140. Interest charged on capital at 5 per cent. per annum. These transactions would be journalised as follows:—

Date	Dr.	Cr	Ledger Folio	Dr			Cr		
				£	s.	d.	£	s.	d.
1927.	Bank, Dr.		2	1,000	0	0			
	To Capital		1				1,000	0	0
	Horse, Dr.		3	150	0	0			
	To Bank		2				150	0	0
	Stock, Dr.		4	400	0	0			
	To Bank		2				400	0	0
	Plant, Dr.		5	50	0	0			
	To Sydney Plough Co. ..		9				50	0	0
	James, Dr.		8	300	0	0			
	To Stock		4				300	0	0
	Bank, Dr.		2	100	0	0			
	To Crops		6				100	0	0
	Bank, Dr.		2	10	0	0			
	To Dairy		7				10	0	0
	Wages, Dr.		10	120	0	0			
	To Bank		2				120	0	0
	Rent, Dr.		11	80	0	0			
	To Bank		2				80	0	0
	Interest, Dr.		12	50	0	0			
	To Capital		1				50	0	0
				£2,260	0	0	£2,260	0	0

Entries need not be made of the valuations.

The manner of posting from the Journal to the Ledger may be explained from a consideration of the first transaction Bank Dr.: To Capital. "Bank Dr." means that an entry must be made on the debit side of Bank Account, the actual entry being the corresponding credit entry—in this case "To Capital." Similarly "To Capital" means that an entry must be made on the credit side of the Capital Account, the actual entry in this case being "By Bank." The posting of the other entries should be done similarly.

In the following Ledger entries the accounts only are numbered, and date and Journal folio columns are omitted to facilitate working. The entries in *italics* will be explained later.

1. CAPITAL.

		£	s.	d.			£	s.	d.
To Balance	*1,150*	*0*	*0*	By Bank	1,000	0	0		
				,, Interest	50	0	0		
				,, *Profit & Loss a/c* ...	*100*	*0*	*0*		
	£1,150	*0*	*0*		*£1,150*	*0*	*0*		

2. BANK.

To Capital	...	...	1,000	0	0	By Horse	...	...	150	0	0
„ Crops	...	...	100	0	0	„ Stock	...	...	400	0	0
„ Dairy	...	...	10	0	0	„ Wages	...	...	120	0	0
						„ Rent	...	...	80	0	0
						„ *Balance*	...	...	*360*	*0*	*0*
			£1,110	*0*	*0*				*£1,110*	*0*	*0*

3. HORSE.

To Bank	...	...	150	0	0	*By Balance (Valuation)*			*140*	*0*	*0*
						„ *Profit & Loss a/c*	...		*10*	*0*	*0*
			£150	*0*	*0*				*£150*	*0*	*0*

4. STOCK.

To Bank	...	...	400	0	0	By James	...	...	300	0	0
„ *Profit & Loss a/c*	...		*200*	*0*	*0*	„ *Balance (Valuation)*			*300*	*0*	*0*
			£600	*0*	*0*				*£600*	*0*	*0*

5. PLANT.

To Sydney Plough Co.			50	0	0	*By Balance (Valuation)*			*40*	*0*	*0*
						„ *Profit & Loss a/c*	...		*10*	*0*	*0*
			£50	*0*	*0*				*£50*	*0*	*0*

6. CROPS.

	£	s.	d.				£	s.	d.
To Profit & Loss a/c ...	*160*	*0*	*0*	By Bank	...	...	100	0	0
				„ *Balance (Valuation)*			*60*	*0*	*0*
	£160	*0*	*0*				*£160*	*0*	*0*

7. DAIRY.

To Profit & Loss a/c ...	*10*	*0*	*0*	By Bank	...	...	10	0	0
	£10	*0*	*0*				*£10*	*0*	*0*

8. JAMES.

To Stock	...	300	0	0	*By Balance*	...	...	*300*	*0*	*0*
		£300	*0*	*0*				*£300*	*0*	*0*

9. SYDNEY PLOUGH CO.

		£	s.	d.				£	s.	d.
To Balance	...	*50*	*0*	*0*	By Plant	...	...	50	0	0
		£50	*0*	*0*				*£50*	*0*	*0*

10. WAGES.

To Bank	...	120	0	0	*By Profit & Loss a/c*	...	...	*120*	*0*	*0*
		£120	*0*	*0*				*£120*	*0*	*0*

11. RENT.

To Bank	80	0	0	*By Profit & Loss a/c* ...	80	0	0
	£80	0	0		£80	0	0

12. INTEREST.

To Capital	50	0	0	*By Profit & Loss a/c* ...	50	0	0
	£50	0	0		£50	0	0

Trial Balance.

Neglecting the entries in *italics*, it is now possible to verify the correctness of the posting (*i.e.*, entering into the Ledger) by means of a trial balance. The totals of each side of every account are added, and the results should be equal to the totals of the Journal, and of course, to one another.

TRIAL BALANCE.

Dr. £	s.	d.	*Name of Account.*	*Cr.* £	s.	d.
.....			Capital	1,050	0	0
1,110	0	0	Bank	750	0	0
150	0	0	Horse	.....		
400	0	0	Stock	300	0	0
50	0	0	Plant	.....		
.....			Crops	100	0	0
.....			Dairy	10	0	0
300	0	0	James...	.....		
.....			Sydney Plough Co. ...	50	0	0
120	0	0	Wages	.....		
80	0	0	Rent	.....		
50	0	0	Interest	.....		
£2,260	0	0		£2,260	0	0

It does not necessarily follow that, the Dr. and Cr. columns being equal, the postings must be correct, inasmuch as it does not disclose when there is an entry on the right side, but posted to the wrong account, or a posting to the wrong side, with its corresponding entry also on the wrong side.

The making up of a trial balance has so many distinct advantages that it must never be dispensed with. Any error must be at once looked for, because, if allowed to remain, the balancing entry will also be wrong, and *it will be practically impossible to compile a correct balance-sheet and* profit and loss account. It is convenient to remember that if one side is deficient by the same amount as the other side is in excess of the Journal *total, an entry of that amount has usually been posted to the wrong side.*

The trial balance is of great assistance in detecting mistakes in posting, such as taking 6 for 0, 7 for 1, 3 for 5, and *vice versâ*. Another common error is to place the figures in the wrong money column, making 5s. 7d. appear as £5 7*s*.

In actual practice the Journal is not totalled, and the trial balance is made up by stating only the differences between the various accounts. This would then appear as follows, and the method can be recommended when a fair amount of proficiency has been gained.

TRIAL BALANCE BY DIFFERENCE.

Dr. £	s.	d.		*Cr.* £	s.	d.
.....			Capital	1,050	0	0
360	0	0	Bank	.....		
150	0	0	Horse	.....		
100	0	0	Stock	.....		
50	0	0	Plant	.....		
....	....		Crops	100	0	0
.....			Dairy	10	0	0
300	0	0	James...	.....		
.....			Sydney Plough Co. ...	30	0	0
120	0	0	Wages	.....		
80	0	0	Rent	....		
50	0	0	Interest	.....		
£1,210	0	0		£1,210	0	0

In the above example, very little time is saved, owing to its extreme simplicity, but where numerous accounts, many of which have been balanced off, are concerned, the economy in labour is considerable.

Closing the Accounts.

The posting into the ledger having been proved correct, we now proceed to close the accounts.

Leaving the Capital Account for the time being, we find that £1,110 has been received by the Bank Account, and £750 paid out, leaving a Dr. balance of £360. This balance is temporarily placed on the Cr. side, thus bringing the totals into agreement, and closing the account for the year. This balance is inserted as shown, both sides totalled and ruled off, as seen from the entries in *italics*. It will be seen later that this balance is brought back to the Dr. side (where it belongs, as it were) in commencing the account for the new year.

In the Horse Account, the valuation £140, or our estimate of what they are worth at the end of the year, is entered as a Cr. balance, and the difference between their original price and present value (£10) is carried to a Profit and Loss Account, as being the cost of using the horses throughout the year.

The Stock Account shows that £400 was paid for them. £300 worth has been sold, and £300 worth remains on hand; consequently a profit of £200 has been made, and to balance the account this amount is debited.

The other entries are treated in similar fashion, all cash, stock, crops, &c., on hand, and all amounts owing to or by the owner being carried to a Balance-sheet, and any differences to a Profit and Loss Account. In the case of wages, rent, and interest, it is clearly seen that they are losses in themselves, although contributing to the net gain.

Profit and Loss Account.

The Profit and Loss Account will now be prepared as follows, the items being transferred to the side opposite to that on which they appear in the

ordinary Ledger account (thus adhering to the essential principle of double entry, that every debit must have a corresponding credit):—

PROFIT AND LOSS ACCOUNT.

Dr. (*Losses*).	£	s.	d.	*Cr.* (*Gains*).	£	s.	d.
To Horse	10	0	0	By Stock	200	0	0
,, Plant	10	0	0	,, Crops	160	0	0
,, Wages	120	0	0	,, Dairy...	10	0	0
,, Rent	80	0	0				
,, Interest	50	0	0				
,, Capital a/c (net gain)	100	0	0				
	£370	0	0		£370	0	0

It will be noticed that this—like the wages, rent and interests accounts—carries out the second important rule referred to—"Debit losses; credit gains."

The Americans, following the order in which these items appear, are slightly more accurate, and usually call this a loss and profit account.

The way in which the profits have been made is thus disclosed. If the horse-hire, wages, rent, &c., were charged to the crops, and the book-keeping carried out in further detail, the statement would have a different aspect, though the result would be the same.

The profit of £100 shown in this account represents an increase in the farmer's wealth, and is credited to, *i.e.*, transferred to the opposite side of, the Capital Account, the business now representing £100 more than was originally put into it. A loss would be debited to the Capital Account as in the transactions for 1928, which are shown hereunder. The Capital Account is then balanced and ruled off.

Balance-sheet.

As the name suggests, this is not a true account, but a mere statement of liabilities (on the left) and assets (on the right). It has no debit or credit sides, the words "To" and "By" are not used, and the entries are not transferred from one side of an account to the opposite side of the balance-sheet. Instead, the various "Balance" and "Valuation" entries are brought straight down and entered on the same side of the balance-sheet, which should then balance, *i.e.*, the totals of the two sides should be equal.

The balance-sheet will appear as follows:—

BALANCE-SHEET

Liabilities.	£	s.	d.	*Assets.*	£	s.	d.
Sydney Plough Co.	50	0	0	Horse (as per valuation) ...	140	0	0
Capital	1,050	0	0	Stock ,, ...	300	0	0
Difference, being profit ...	100	0	0	Plant ,, ...	40	0	0
				Crops ,, ...	60	0	0
				Bank (as per Ledger) ...	360	0	0
				James (book debt) ...	300	0	0
	£1,200	0	0		£1,200	0	0

It will be noticed that the actual return has been £50 for the use of the £1,000 capital and £100 as a general profit.

Opening Books for a Going Concern.

It may happen that, when a farmer takes over a property or commences keeping accounts, his capital does not consist exclusively of cash, but also of horses, plant, stock, crops on hand, &c., and he may have certain outstanding debts. These are known respectively as assets (things owned), and liabilities (things owed), and must be journalised according to the rule—Assets, Dr., To Liabilities, Cr (including Capital, which is a debt owed by the business to the proprietor). In the following example, Bull's balance sheet for 1927 is journalised :—

		£	
Assets, Dr			
House		140	
Stock		300	
Plant		40	
Crops		60	
Bank		360	
James		300	
To Liabilities, Cr.—			
Sydney Plough Co			£50
Capital			£1,150

THE SECOND YEAR.

To continue the work in the second year the balances in the Money, Property, and Personal accounts should be "carried forward" or "brought down" to the opposite side of each account, below the line which rules off the previous year's entries, thus :—

CAPITAL ACCOUNT.

		£	s.	d.			£	s.	d.
1927	To Balance c/d (carried down)	1,150	0	0	By Bank		1,000	0	0
					,, Interest		50	0	0
					,, Profit & Loss a/c		100	0	0
		£1,150	0	0			£1,150	0	0
1928.					By Balance b/d (brought down)		1,150	0	0

HORSE.

1927	To Bank	150	0	0	By Balance (Valuation) c/d		140	0	0
					,, Profit & Loss a/c		10	0	0
		£150	0	0			£150	0	0
1928	To Balance b/d	140	0	0					

JAMES.

1927	To Stock	300	0	0	By Balance c/d		300	0	0
		£300	0	0			£300	0	0
1928	To Balance b/d	300	0	0					

The reason for transferring the balance, when brought down, to the opposite side will be apparent in the last example above. James not having paid for the stock, his account shows a debit balance of £300, and in opening the account for the new year's transactions, the amount of his indebtedness must be shown as a debit, *i.e.*, in the same position as the original debit entry.

The following example will illustrate the method of dealing with the second year's transactions:—

During the following year, 1928, J. Bull sells horses for £60, and buys stock from James for £100. He pays the Sydney Plough Company £48, being allowed £2 discount, and accepts £195 from James in full settlement of his account. He buys seed for £5, sells hay for £75 and dairy produce for £30, and pays £100 for house expenses. Wages paid total £90. Interest is charged on capital at 5 per cent. per annum. At end of year he owes rent £40, that for the first half-year. £40, having been paid.

Valuations at the end of the year are, stock £560, crops £120, dairy produce on hand £5. Plant and horses are depreciated at rate of 10 per cent. per annum.

The Journal and Ledger will appear as under:—

Date.	Dr.	Cr.	Ledger f.	Dr. £ s. d.	Cr. £ s. d.
1928.					
	Bank, Dr. ...		2	60 0 0	
	To Horse		3		60 0 0
	Stock, Dr. ..		4	100 0 0	
	To James		8		100 0 0
	Sydney Plough Co., Dr.		9	50 0 0	
	To Bank ...		2		48 0 0
	,, Discount ..		13		2 0 0
	Bank, Dr. ...		2	195 0 0	
	Discount, Dr. ..		13	5 0 0	
	To James		8		250 0 0
	Crops, Dr. ...		6	5 0 0	
	To Bank ...		2		5 0 0
	Bank, Dr. ...		2	75 0 0	
	To Crops ...		6		75 0 0
	Bank, Dr. ..		2	30 0 0	
	To Dairy ...		7		30 0 0
	House Expenses, Dr. ...		14	100 0 0	
	To Bank... ...		2		100 0 0
	Wages, Dr. ...		10	90 0 0	
	To Bank... ...		2		90 0 0
	Interest, Dr. ...		12	57 10 0	
	To Capital		1		57 10 0
	Rent, Dr.		11	80 0 0	
	To Bank ...		2		40 0 0
	,, Landlord ...		15		40 0 0
				£847 10 0	£847 10 0

1. CAPITAL.

1928.	£ s. d.		£ s. d.
To Profit and Loss ...	17 10 0	By Balance b/d ...	1,150 0 0
,, Balance c/d ...	1,190 0 0	,, Interest ...	57 10 0
	£1,207 10 0		£1,207 10 0
1929		By Balance b/d ...	1,190 0 0

2. BANK.

1928.			
To Balance b/d ..	360 0 0	By Sydney Plough Co. ...	48 0 0
,, Horses ...	60 0 0	,, Crops	5 0 0
,, James ...	195 0 0	,, House Expenses	100 0 0
,, Crops	75 0 0	,, Wages	90 0 0
,, Dairy	30 0 0	,, Rent ..	40 0 0
		,, Balance c/d ...	437 0 0
	£720 0 0		£720 0 0
1929.			
To Balance b/d ...	437 0		

3. HORSE.

1928.	£	s.	d.		£	s.	d.
To Balance b/d	140	0	0	By Bank	60	0	0
				,, Depreciation	8	0	0
				,, Balance c/d	72	0	0
	£140	0	0		£140	0	0
1929.							
To Balance b/d	72	0	0				

4. STOCK.

1928.							
To Balance b/d ..	300	0	0	By Valuation	560	0	0
,, James	100	0	0				
,, Profit and Loss ...	160	0	0				
	£560	0	0		£560	0	0
1929.							
To Balance b/d	560	0	0				

5. PLANT.

1928.							
To Balance b/d.	40	0	0	By Depreciation. . .	4	0	0
				,, Balance c/d. . .	36	0	0
	£40	0	0		£40	0	0
1929.							
To Balance b/d.	36	0	0				

6. CROPS.

1928.							
To Balance b/d. . .	60	0	0	By Bank	75	0	0
,, Bank	5	0	0	,, Valuation	120	0	0
,, Profit and Loss .	130	0	0				
	£195	0	0		£195	0	0
1929.							
To Balance b/d. .. .	120	0	0				

7. DAIRY.

1928.							
To Profit and Loss .	35	0	0	By Bank	30	0	0
				,, Valuation	5	0	0
	£35	0	0		£35	0	0
1929.							
To Balance b/d. .. .	5	0	0				

8. JAMES.

1928.							
To Balance b/d.	300	0	0	By Stock	100	0	0
				,, Bank	195	0	0
				,, Discount	5	0	0
	£300	0	0		£300	0	0

9. SYDNEY PLOUGH COMPANY.

1928.	£	s.	d.		£	s.	d.
To Bank ...	48	0	0	By Balance b/d.	50	0	0
,, Discount ...	2	0	0				
	£50	0	0		£50	0	0

10. WAGES.

1928.						
To Bank ...	90	0	0	By Profit and Loss ...	90	0	0
	£90	0	0		£90	0	0

11. RENT.

1928.						
To Bank ...	40	0	0	By Profit and Loss ...	80	0	0
,, Landlord ...	40	0	0				
	£80	0	0		£80	0	0

12. INTEREST.

1928.						
To Capital ...	57	10	0	By Profit and Loss ...	57	10	0
	£57	10	0		£57	10	0

13. DISCOUNT.

1928.						
To James ...	5	0	0	By Sydney Plough Co. ...	2	0	0
				,, Profit and Loss ...	3	0	0
	£5	0	0		£5	0	0

14. HOUSE EXPENSES.

1928.						
To Bank ...	100	0	0	By Profit and Loss ...	100	0	0
	£100	0	0		£100	0	0

15. LANDLORD.

1928.						
To Balance ...	40	0	0	By Rent ...	40	0	0
	£40	0	0		£40	0	0
1929.				By Balance b/d. ...	£40	0	0

The Profit and Loss Account and Balance-sheet would be as follows :—

PROFIT AND LOSS ACCOUNT.

Dr.	£	s.	d.	*Cr.*	£	s.	d.
To Horse	8	0	0	By Stock	160	0	0
,, Plant	4	0	0	,, Crops	130	0	0
,, Wages	90	0	0	,, Dairy	85	0	0
,, Rent	80	0	0	,, Capital (net loss)	17	10	0
,, Interest	57	10	0				
,, Discount	3	0	0				
,, House Expenses ...	100	0	0				
	£342	10	0		£342	10	0

BALANCE-SHEET.

Liabilities.	£ s. d.	*Assets.*	£ s. d.
Landlord	40 0 0	Bank	437 0 0
Capital ...	1,190 0 0	Horse	72 0 0
		Stock	560 0 0
		Plant	38 0 0
		Crops	120 0 0
		Dairy	5 0 0
	£1,230 0 0		£1,230 0 0

Though the operations of the year 1928 show a small loss, it must be noted that £100 has been expended on housekeeping, the capital has been increased by £40 by the addition of interest charged upon the year's profits, and provision has been made for the payment of the amount of rent owing.

It should be helpful to note that in property accounts (Cattle Account, Machinery Account, &c.) the debtor side always contains the stock on hand at the beginning of the period plus any purchases, while the credit side always shows any sales, plus the stock on hand at the end of the period. The difference between the two sides so set out gives the profit or loss, depending on whether the credit or debit side represents the greater value.

SOME FURTHER CONSIDERATIONS.

The system described herein furnishes the actual profit or loss on the whole of the farming operations for the year, and it will probably be best for the beginner to become thoroughly accustomed to this before attempting the more difficult process of analysing the gains or losses from the various branches.

This involves a careful dissection of—

1. The proportion of rent to be charged to each.
2. A strict appropriation of the labour, both of the farmer and his family, and of the wages men.
3. A close estimate, first of the cost of the upkeep of the horses, and then of the amount to charge per hour to the crops for teams, implements, &c.
4. An approximation of the value of the feed of the horses, stock, &c., to be credited to the Crop Account, and debited to the various Live Stock Accounts.

This involves such an amount of calculation, and so many transfers and adjustments, that it is likely to deter the beginner from continuing with his books, but to the man thoroughly interested in his work they present no difficulty. The principle is the same throughout, the object aimed at being to charge each branch of the business, for which an account is kept, with the whole of the direct and indirect expenses which it involves, or from which it benefits, and to credit it with its due proportion of the receipts, in order to ascertain the real profit or loss on that particular branch.

Valuations of Stock.

Under the Federal Income Tax Assessment Act, the farmer is given the option of valuing his stock at "cost price," or "market selling value." Whichever method be adopted must be continued from year to year, so that the value of stock on hand at the beginning of each period, must be the same as that shown at the close of the previous period. The cost of natural increase can be taken only between definite limits, as set out in the directions accompanying the income-tax forms.

The "cost price" method is to be preferred, because of the fluctuations in "market selling value." If the "cost price" method be adopted, an average cost price must be struck *in order to value stock on hand*, by considering the numbers and value of stock on hand at the beginning of the period, as well as the purchases and natural increase during the year. For example:—

Value of cattle on hand at 1st July, 1928 (200)		£1,600
Add purchases at cost price ... ... (150 at £7)		1,050
Natural increase at value adopted ... (120 at £3)		360
Total cost of 470	=	£2,410
Average cost		£5 2s. 6d.

Then the value of cattle on hand at 30th June, 1929 = 250 (say) at £5 2s. 6d. = £1,281.

Repayment of Principal with Interest.

When land is obtained as a conditional purchase or a homestead selection, where repayments are being made under a loan from, say, the Rural Bank, and in fact whenever payments include interest with the principal, it should be noted that the principal is reduced by the total amount of the payment, less the interest.

For instance a payment of £15 on a C.P. might consist of £9 principal and £6 interest, and would be journalised thus,

	£ s. d.	£ s. d.
Loan a/c	9 0 0	.....
Interest a/c, Dr.	6 0 0	.....
To Bank		15 0 0

The former reduces the total liability, whereas the latter is an expense for the current year.

Capital Cost.

Where a property is being constantly improved, a distinction should be made between permanent additions and current expenses. The former appear in the balance-sheet as assets, while the latter become part of the Profit and Loss Account. For instance, an orchardist who purchases unimproved land and gradually clears, fences, and plants the ground as circumstances permit, would probably utilise the space between the trees for the first few years for general crops and thus support himself. Under such conditions he might only charge to a Land or Orchard Account the actual outside costs.

Assuming the purchase in 1926 of 27 acres at £10 per acre, clearing 12 acres at £8 per acre, fencing at £60, and wire-netting at £50 per mile, ploughing and subsoiling at £3 per acre, trees at £8 10s. per acre, and planting at £2 per acre.

In 1927 a further area of 10 acres was cleared and planted at the same rates. The cultivation, pruning, &c., of planted areas cost £2 per acre per annum. The net cost to date of the orchard would then be as under:—

SPECIMEN ORCHARD ACCOUNT.

Dr.		£ s. d.	*Cr.*	£ s. d.
1926.	To Purchase of Land ...	270 0 0	By Balance c/d (net cost to date) ...	612 10 0
	,, Clearing	96 0 0		
	,, Fencing	33 0 0		
	,, Wire-netting ...	27 10 0		
	,, Ploughing	36 0 0		
	,, Trees	102 0 0		
	,, Planting	24 0 0		
	,, Cultivation	24 0 0		
		£612 10 0		£612 10 0
1927.	To Balance b/d ...	612 10 0	By Sale of Timber ...	30 0 0
	,, Clearing	80 0 0	,, Balance c/d (net cost to date)	876 10 0
	,, Fencing (say) ...	20 0 0		
	,, Wire-netting (say) ...	15 0 0		
	,, Ploughing	30 0 0		
	,, Trees	85 0 0		
	,, Planting	20 0 0		
	,, Cultivation (22 acres)	44 0 0		
		£906 10 0		£906 10 0

It will thus be seen that such an account gives a brief history of the owner's expenses in laying out his orchard; on the start of the third year, capital outlay will probably cease, and a return may be forthcoming after the fourth year. This, however, is best credited to a Fruit Account, and becomes one of the gross profits for the year. The question of making some small allowance for depreciation on such an orchard can only be left to the owner's judgment and knowledge of local conditions. Renewals and a gradual replacement of trees when needed can be charged as current expenses.

The Plant Book.

Where the implements in use are of a mixed character and have varying lengths of effective life, making a fixed depreciation is on the whole undesirable, and a special plant book may be used with decided benefit. This may be ruled according to circumstances, and the insertion of other particulars may add to its value.

Name of Implement (and if necessary where procured).	Date of Purchase.	Cost.	Probable Life.	Amount of Depreciation.	Value at end of 1925.	Value at end of 1926.	Value at end of 1927.	Value at end of 1928.
		£	Years.		£ s. d.	£ s. d.	£ s. d.	£ s. d.
4-furrow plough ..	10-1-'25	40	4	25 % or £10	30 0 0	20 0 0	10 0 0	.....
Spring cart ..	20-2-'25	20	10	10 % or £2.	27 0 0	24 0 0	21 0 0	18 0 0
Reaper and binder..	20-2-'25	120	5	20 % or £24	96 0 0	72 0 0	48 0 0	(Sold, £30)

The addition of all these items will give the valuation of the plant for the current year. Any period longer than six months may be taken as a year and all under that time neglected.

The plough may possibly have a nominal value at the end of the fourth year, and this can be put down in the column, if desired. The price, £50, for the binder will be credited to the Plant Account in the usual way, and it thus drops out of the valuations for the year.

Consignments Outwards.

This term is used to express the consignment of goods, stock, &c., to be sold on commission by an agent at a distance. In the majority of cases the account sales and cheque are received within a week or two, and they may well be treated as cash sales, the net return being journalised on receipt of the remittance. Where, as in the case of orchardists, consignments are being sent almost daily, and to different agents, it may be wise to enter them as sent in a book ruled as under, so that none may be overlooked :—

Date.	Goods Consigned.	Consignee or Agent.	*Expenses Prepaid.	Account Sales.		† Amount Received.	Remarks.
				Date.	Net Amount.		
1925.				1925.	£ s. d.	£ s. d.	
Feb. 6	30 boxes peaches	Jones	5 -	Feb. 14	7 5 0	7 5 0	1 short delivered
,, 10	15 boxes grapes	Smith	3 6	,, 20	4 10 6	4 10 6	Claim on Railway.
,, 14	1 box peaches	Short delivered on 6th.		Mar. 15	0 4 9	0 4 9	See below.

* Pay from Petty Cash. † Enter in Journal, Bank Dr.—To Fruit.

Sales on credit might also be entered in this book, if desired, pending settlement, and a glance through its pages will then show all supplies unpaid for.

In a few cases, such as sending cattle or sheep long distances by road, cold-storing fruit before sale, or shipments overseas, a considerable time might elapse before a settlement was made. Even in these cases, the above book would be suitable, avoiding the necessity for consignment accounts in the ledgers. When a balance-sheet is to be prepared, however, the outstanding items in the consignment book must be valued, and taken into account as produce on hand.

Conclusion.

Only a few of the salient points connected with book-keeping on the farm have been dealt with in this article. Other books for recording the receipts of cash, the doings of the labourers, transactions in bills, &c., may be used where the operations are extensive, or where further details are desired ; but their use involves little difficulty after the elementary stages have been passed, and they can be ruled to suit varying conditions.

SECTION XVII

Farmers' Calendar.

The experience of every successful agriculturist is that it is only by timely and thorough preparation of the soil that cropping can be satisfactorily carried on. To provide a calendar giving specific details for each district in a handy form is manifestly impossible, and in the following pages the aim of the Department has been to provide the farmer, and more especially the newcomer, with a general indication of the practices that have been proved successful by many years of observation and experience in certain distinct localities.

By comparison of the altitude, average annual and monthly rainfall, and other conditions of their own districts with those for which specific details are given, farmers in districts other than those specified should be able to arrive at a fairly accurate estimate of the seasonal operations suitable for their own particular locality.

No doubt, however, there still remains a number of localities entirely unrepresented by the conditions obtaining in any of the districts described, and growers who are situated in such areas are invited to communicate with the Department for advice.

The various districts in the calendar are:—

Upper North Coast.

Comprising the Tweed, Richmond, Clarence, and Bellinger River districts, and including all the coastal area from the Bellinger River valley to a little north of Murwillumbah, with the exception of Dorrigo and other elevated plateaux, which, on account of cold nights are more akin to the tablelands in cultural matters.

Central North Coast.

Comprising the Nambucca, Macleay, Hastings, Manning, and Hunter River districts, and with slight modifications the directions apply to the whole area. Allowance must be made for the appearance of early and late frosts on the Hunter, and slightly earlier plantings must be made on the Nambucca and Macleay for spring crops.

Hawkesbury–Nepean.

Directions for the Hawkesbury-Nepean district apply to Camden, Campbelltown, Liverpool, Penrith, Picton, Richmond, Sackville, St. Mary's, Windsor, Wiseman's Ferry.

South Coast.

These directions apply to Araluen, Bateman's Bay, Bega, Berry, Bodalla, Bulli, Candelo, Cobargo, Eden, Gerringong, Kiama, Merimbula, Milton, Moruya, Nelligen, Nowra, Pambula, Picton, Shellharbour, Ulladulla, Wollongong, Wolumla.

Northern Tableland.

Directions for Northern Tableland apply to districts adjacent to the Great Northern Railway from Woolbrook to Tenterfield, and to districts of somewhat similar elevation (from 2,000 feet) in the northern zone of the State.

Central Tableland.

These directions, with slight modifications, are applicable to Bathurst, Blayney, Carcoar, Orange, and other fairly elevated adjoining districts.

Southern Tableland.

These directions apply to Moss Vale, Goulburn, Crookwell, Braidwood, Queanbeyan, Cooma, Bombala, Delegate and Dalgety districts.

North-western Slopes.

The directions under this heading apply generally to the country west of a line from Singleton to Tenterfield, except such portions as have an elevation of 2,000 feet or more. The following localities would be included:—Tamworth, Manilla, Barraba, Werris Creek, Curlewis, Gunnedah, Boggabri, Narrabri, Wee Waa, Pallamallawa, Warialda, Bingara, Delungra, Mount Russell, and Inverell.

The Inverell district, which includes Delungra and Mount Russell, is a later district with a higher average rainfall and maize-growing is carried on more extensively than in those localities which lie to the west and south.

Central-western Slopes.

These directions, with slight modifications to meet differences in altitude and other natural conditions, apply to the following districts:—Binnaway, Canowindra, Cargo, Coolah, Cowra, Dubbo, Dunedoo, Eugowra, Eumungerie, Forbes, Gilgandra, Grenfell, Gulgong, Meadooran, Molong, Mudgee, Parkes, and Wellington. They would apply also, in a very large degree to the slightly earlier districts of Condobolin, Narromine, and Trangie.

South-western Slopes and Riverina.

Directions apply to the majority of districts along the southern line and branches from Murrumburrah to Albury:—Cootamundra to Temora, Wyalong, Lake Cargelligo, Rankin Springs, Barellan and Hillston; Junee to Narrandera, Tocumwal and Hay; Wagga to Tumbarumba; The Rock to Oaklands and Westby; Henty to Rand; Culcairn to Holbrook and Corowa. Also the Moama to Deniliquin and Balranald (Victorian) lines.

Murrumbidgee Irrigation Area.

Directions apply to the areas watered by the Murrumbidgee irrigation works.

North-western Plains.

The directions for North-western Slopes apply to the plains of the north-west, except that cropping is much more restricted in that district by reason of the difficulty of cultivating the soil at times, and by the fact that the soil is not sufficiently retentive of moisture by the present methods of cultivation to ensure successful cropping, except in years of good rainfall. The treeless plains are generally devoted to grazing. Water suitable for limited irrigation and good for stock may be obtained at varying depths on the plains.

The districts covered would include Moree, Gular, Coonamble, Baradine, and Gwabegar.

JANUARY.

Upper North Coast.

Crops to sow—

Maize—for green fodder; for grain blight-resistant varieties may be sown, but good yields cannot be expected.

Sorghum—for green fodder; may also provide grain for poultry and pigs.

Millet—for green fodder; cut before seeds ripen for hay for horse-feed; provides grain fairly useful for poultry.

Sweet potatoes—small planting.

Pumpkins—sow on small scale.

Marrows—sow on small scale.

Grass—after scrub fires paspalum grass-seed may be sown this month.

Vegetables—sow Swede and White turnips, red and silver beet, cabbage, lettuce, peas (a few), radish.

Get land ready for oats, barley, and rye for green feed.

Silage making commences.

Sugar-cane—keep down weeds by chipping and scuffling.

Central North Coast.

Crops to sow—

Maize—for green fodder and silage. Rather late for grain, although varieties such as Fitzroy, Leaming, Golden Superb, and Hickory King may be tried.

Sorghum—Saccaline and other varieties may be sown this month for winter use.

Millets—Manchurian and Hungarian may still be sown for green fodder.

Potatoes—small sowings for autumn crop, late in the month; use early-maturing varieties.

Pumpkins—a small sowing early.

Cowpeas—in the maize or sorghum plots or alone.

Tomatoes—plant out for late crop.

Turnips—sow swedes late in month.

Grasses—after scrub fires, paspalum and Rhodes may be sown.

Vegetables—sow seed of French and other beans, beet, cabbage, cauliflower, cucumber, leek, lettuce, parsnip, radish, silver beet, sweet corn, turnips.

Transplant tomato and other seedlings from previous sowing, choosing cool weather.

Mulch, hoe and water freely.

Get land ready for barley, oats, rye, field peas, turnips, lucerne, mangolds, grasses, and clovers. Aim at the destruction of weeds and the conservation of moisture. Silage making commences this month.

Hawkesbury-Nepean.

Crops to sow—

Maize—for green fodder and silage. In sheltered situations a quick-maturing variety might mature grain, but the practice is risky, and areas should be small.

Sorghum—for green fodder and silage.

Millet—when hay is scarce, the rapid growth of millet affords a ready means of replenishing the supply. Hungarian is best for this purpose.

Vegetables—sow French and *butter* beans, silver beet, cauliflower, cabbage, leek and green bush marrows for late crop; plant out celery and tomatoes.

Get land ready for autumn sowings of cereals, legumes, rape, lucerne, and for autumn crop of potatoes. The land should be left open to catch any rain, and cultivated whenever a crust forms, in order to conserve soil-moisture.

South Coast.

Crops to sow—

Maize, sorghum, and Japanese millet for green fodder.

Red clover.

Vegetables—sow seed of French beans, beet, cabbage, cauliflower, cucumber, leek, lettuce, parsnip, radish, silver beet, squash and (for late planting) some tomato seed.

Transplant celery and tomato plants.

Get land ready—by ploughing for winter fodder crops. Keep cultivator going among row crops where it is possible.

Northern Tableland.

Crops to sow—

Maize, sorghum, millet—can still be sown on a small scale for autumn green feed or for silage.

Barley—an early sowing could be made for cutting, and then be allowed to make a second growth.

Potatoes—only very quick maturing varieties.

Peas—may be sown this month in the milder portion of the district.

Vegetables—sow beans, cabbage, cauliflower, celery, leek, lettuce, parsnip, radish, silver beet, and Swede turnip.

Transplant cabbage, cauliflower, leek.

Harvesting of the grain crops will be in operation, and the summer crops, such as maize, potatoes, &c., are apt to be neglected; all available time should be given to cultivation, stirring the soil after rain to conserve the moisture and to keep down weeds.

Central Tableland.

Crops to sow—
Maize—very early varieties for green fodder for autumn use.
Sorghum—very early varieties for green fodder for autumn use.
Millet—for green fodder for autumn use.
Swedes—main crop may be sown.
Barley, Rye, Wheat, Oats } small sowings of any of these crops may be made towards end of month for early winter green fodder.

Vegetables—sow swedes, French and butter beans, parsnip, radish. Peas for late crop. Sow in seed-beds cabbage, Brussels sprouts, broccoli, leek, celery, lettuce, silver beet
Transplant cabbage, cauliflower, and celery.

Get ready land for autumn cropping. All land from which cereal crops have been harvested should be ploughed lightly, or cultivated as early in this month as possible; moisture is thereby conserved, weeds destroyed, and shed grain given a chance to germinate.
Cultivate fallows with tined implements to control weed growth and conserve moisture.

Southern Tableland.

Crops to sow—
Maize, Japanese millet—for green fodder.
Turnips and mustard—for sheep feed.
Clovers (Subterranean clover particularly) if weather is favourable.

Other work—give close attention to the potato crops, check weed growth, watch for the potato moth and hill if necessary to check the trouble. Plough ground for autumn sown crops. Get ready any areas to be sown with lucerne—it is necessary that the weed seed be worked out. See to the wheat drill, that it is in working order.

Vegetables—sow seed of beans (French and broad), cucumber, lettuce, parsnip, radish, cabbage, silver beet, squash, and Swede turnip.
Transplant celery, cabbage, cauliflower, and leek plants.
If weather is dry, keep the surface soil well worked and give plants an occasional good watering.

See that drains are in good order, so that in event of heavy rain the surplus water can get away easily.

North-western Slopes.

Crops to sow—
Maize and sorghum — early-maturing varieties for green feed and silage.
Millets and Sudan grass—for grazing and hay.
Potatoes—often a successful crop can be obtained if early-maturing varieties, such as Factor and Early Manhattan, are grown.

Vegetables—sow French beans, marrow, squashes.

Prepare land for winter fodder crops, such as rape, and for the cereals, wheat, oats, barley.

Central-western Slopes.

Crops to sow—
Too late for summer crops under general conditions.

Get land ready for autumn crops. Plough stubble or new ground if possible. Keep the fallowed land clean by grazing with sheep, and by shallow cultivations to maintain a suitable mulch.

South-western Slopes and Riverina.

Crops to sow—
There are few, if any, crops which can be safely sown this month. All the attention possible should be devoted to keeping soil in a condition to conserve moisture.

Get land ready for early sowings of rape and swedes for sheep, and break up or scarify land intended for cereals in autumn.

Murrumbidgee Irrigation Areas.

Crops to sow—
Maize—for green feed only; for grain small areas may still be sown, but the practice is risky.
Millet—for green feed only.

Vegetables—sow carrots, turnips (white), cabbages, cauliflowers, beetroot, French beans, radish, lettuce, potatoes (end of month).

Get land ready for next cereal crops. Even a short fallow is better than none. The same applies to land intended for lucerne.

North-western Plains.

Crops to sow—

Conditions are generally unfavourable this month for sowing any main crops.

Special attention in the way of cultivation should be given to all growing crops to destroy weeds and conserve soil moisture, and to fallows by cultivation and the use of sheep.

Get land ready for winter cereals. Early ploughing is recommended.

FEBRUARY.

Upper North Coast.

Crops to sow—

Japanese millet—sow for green fodder (on high ground).

Rye—sow for green fodder and silage.

Sorghum— do do

To balance these, add a leguminous crop, (say) cowpeas.

Swede turnips, mangolds and carrots—for winter food for cows and pigs.

After fires, paspalum seed may be planted. Rye and Prairie grass seed may be sown.

Vegetables—sow seed and plant out cabbage, cauliflower, lettuce, celery. Sow peas (a few), beet, carrot, cucumber, leek, parsnip, potato, radish, silver beet, turnip.

Transplant tomato, silver beet.

Get land ready for lucerne; choose a good spot where soil is deep and drainage is good.

Silage-making continues.

Central North Coast.

Crops to sow—

Maize—for green fodder and silage.

Sorghum—Saccaline and other varieties for late winter and early spring use.

Oats—Algerian, for grazing.

Rye—for grazing, Black Winter or Slav for preference.

Barley, rye, rape—for green fodder.

Potatoes—autumn crop—sow early and use early varieties.

Turnips—sow extensively.

Mangolds—small lot latter end of month.

Field peas and vetches—for green fodder and green manure.

Winter grasses and clovers—autumn sowing.

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tables—sow broad beans, beans of
ther varieties, beet, cabbage, cauli-
er, carrot, celery, cucumber, leek,
onion, parsnip, peas, potatoes,
ilver beet, turnip, kohl rabi.

Transplant cabbage, cauliflower, celery, eschalot, silver beet, tomato.

Keep water going freely, mulch and hoe.

Get land ready for lucerne and other autumn sown crops. Silage making.

Hawkesbury-Nepean.

Crops to sow—

Maize—for green feed and silage

Sorghum—for green feed and silage.

Millet—for green feed, hay, and silage.

Barley—latter end of month sow either Cape or Skinless for green fodder, preferably with vetches or Grey field peas for complete ration. Rape and barley form an excellent mixture for sheep and pigs.

Potatoes—plant autumn crop for market and home use.

Rape—sow largely for pig feed and green manure.

Turnips and swedes—sow towards end of month for market and stock purposes.

Cabbage and kale—sow for field culture.

Vegetables—sow French and butter beans, beet, cabbage, cauliflower, celery, leek, lettuce, onions, radish, carrots, and parsnips (end of month). Plant out cabbage, cauliflower, and celery if weather is favourable.

Get land ready for main cereals, lucerne and autumn sowings of grass seeds; also break up ground where shade or shelter trees are to be planted.

South Coast.

Crops to sow—

Japanese millet, sorghum, and mangolds —for fodder for dairy cattle.

Red clover—it is a wonder plant on cold soils—and Subterranean clover.

Vegetables—sow seed of beans (French and broad), beet, cabbage, carrot, cauliflower, celery, cucumber, leek, lettuce, onion, parsnips, peas, radish, silver beet, white and Swede turnips

Transplant—cabbage, cauliflower, celery, eschalots, silver beet, and tomato.
Plant potatoes.

Get silo ready for filling—if there is not one on the farm, no time should be lost in its erection.

Northern Tableland.

Crops to sow—

Barley—either Cape or Skinless for green feed; the latter should be sown *more* thickly than the former, as it does not stool well.
Rape, tares (or vetches)—for winter feed.
Rye—for green feed.
Turnips—Swede and white.
Grasses—in coolest parts.

Vegetables—sow broad beans, beet, cabbage, carrot, leek, lettuce, parsnip, radish, silver beet, spinach. Onion seed may be sown on carefully-prepared land. Sow thinly in drills; keep free from weeds, and thin out later.
Transplant eschalot, leek, silver beet, cabbage or cauliflower in rich, well-worked land.

Get land ready for grasses, lucerne, and clovers.

Central Tableland.

Crops to sow—

Barley, rye, wheat, or oats—as the main winter green fodder.
Rape—should be sown largely. A mixture of rape and barley, rape and oats, *or rape and rye in alternate drills is* preferable to rape alone.
Swedes may still be sown.
Sow kale, lucerne, and black tares in well-prepared land towards end of month.

Vegetables—sow in seed-beds onions for main crop. Sow cabbage, Brussels sprouts, broccoli, leek, beet, lettuce, radish, turnip, silver beet, *and celery.*
Transplant cabbage, broccoli, leek, celery, and eschalots. Make a small sowing of carrots.

Keep fallows clean *by feeding-off and* cultivation.

Southern Tableland.

Crops to sow—

Rye and field peas—for green fodder.
Barley and field peas or wheat (Firbank or Thew) and field peas may be sown on small areas if the season is favourable where early green winter fodder for dairy stock is required.
Lucerne and Subterranean clover. This is a good month to sow lucerne seed *providing the weed seed has been* worked out of the ground, and there is sufficient soil moisture. Get the crop up and doing before the ground becomes cold.

Vegetables—sow seed of broad beans, beet, cabbage, carrot, celery, leek, lettuce, onion, parsnip, radish, silver beet, spinach, white and Swede turnip.
Transplant cabbage, cauliflower, celery, eschalot, leek and silver beet plants.
Hot weather conditions have to be met. Keep ground well worked and weed growth down. See that plants do not lack soil moisture.

North-western Slopes.

Crops to sow—

Millets and Sudan grass—for feeding off.
Rape, barley, wheat and oats—in the latter part of the month for grazing.

Vegetables—sow French beans (early in *month), and cabbage, cauliflower, peas,* Swede and white turnip later in the month.

Get land ready for wheat, oats barley, and *rape.*

Central-western Slopes.

Crops to sow—

Rape—for early grazing and greenstuff.
Mustard— do
Barley— do
Rye— do
Tares (or vetches) do
Field peas do
Early sown crops of rape are likely to be attacked by aphis; to keep the pest in check the crop should be kept fed off until cool weather sets in. Barley or mustard, sown with rape, tends to reduce the danger of "bloating" when *stock are first put upon the* crop

Vegetables—sow *French beans, beet, turnip*, radish, lettuce, silver beet, swedes, cabbage, cauliflower.

Get land ready for autumn crops by *continuing* to break up stubble or new land, and by working the fallows to check weeds and evaporation.

South-western Slopes and Riverina.

Vegetables—sow cabbage and cauliflower in seed-beds for transplanting later on. If soil is sufficiently moist, sow white turnips and swedes. Growing crops will need especial attention, and if weather is dry, an occasional watering.

In applying the water, stir up the soil beforehand, and then cover the moist ground with a mulch of old straw, leaves, or anything that will help to conserve the moisture.

Other work—It is rather early for sowing any of the main crops yet. All the time possible should be devoted to preparing land for—

Rape—for green feed, which may be sown in fallowed land or after showers.

Oats—for green feed.

Wheat—for green feed.

Swedes and turnips—sow if weather be favourable.

Commence long summer fallow.

Murrumbidgee Irrigation Areas.

Crops to sow—

This is a bad time to sow crops, though towards the end of the month Cape or Skinless barley may be sown for green feed. Oats may also be sown for grazing, and tick beans in mid-month, for green manure.

Vegetables—sow cabbage, cauliflower, carrots, beetroot, parsnips, turnips (white and Swede), lettuce, potatoes, peas (early in month), French beans.

Get land ready for all classes of autumn-sown crops.

North-western Plains.

Vegetables—cabbage and cauliflower seed may be sown to provide young plants for setting out towards the end of March.

Other work—Get land ready for autumn crops by ploughing stubble or new land, and by working the fallows to check weeds and evaporation.

MARCH.

Upper North Coast.

Crops to sow—

Oats—sow as much as desired for green fodder.

Barley—sow as much as desired for green fodder.

Rye—sow for green fodder (grazing).

Rape—sow for green fodder for pigs and dry cows.

Field peas, Vetches—sow alone, or in combination with oats, rye, or barley, as winter food for milch cows.

Potatoes—plant largely as desired.

Grasses—sow Cocksfoot, rye grasses and Prairie.

Clover—sow White or Dutch, and Red.

Vegetables—sow cabbage, onions, leek, lettuce, peas, globe artichokes, French bean, beet, carrot, celery, herbs, parsnips, radish, silver beet.

Transplant available seedlings.

Get land ready for lucerne.

Plant evergreen trees for shade.

Central North Coast.

Crops to sow—

Maize—for green fodder only. Leaming Hickory King and Golden Superb.

Sorghum—Saccaline can be sown early in the month in northern portion of district for late winter and spring use.

Oats, Barley, Wheat, Rape, Rye—for green fodder.

Field peas and vetches alone or with the above mentioned cereals for fodder.

Tick beans, clovers, and winter grasses.

Onion—plant seed, late in month in seed-beds.

Vegetables—sow broad beans, French and other varieties (northern districts), beet, cabbage, cauliflower, carrot, celery, herbs, leek, lettuce, onion, parsnips, peas, potato, radish, silver beet, Spanish turnip, kohl rabi.

Transplant cabbage, cauliflower, celery, eschalots, lettuce, silver beet.

Keep ground well manured. For winter elevate bed rows so that water will drain off.

Get land ready for lucerne, clovers, and winter fodders, mangolds, &c.

Hawkesbury-Nepean.

Crops to sow—

Hungarian millet may be sown for green feed or silage early in the month.

Wheat—sow for green forage.

Oats—sow for green feed, in conjunction with vetches or field peas.

Barley—sow for green feed alone or with rape.

Rye—on poorer soils where other cereals fail to flourish rye may be grown for stock feed, provided it is cut before the seed is ripe.
Lucerne—may be sown this month
Rape—sow largely for pig feed and green manure.
Turnips, swedes, kohl rabi, tree-kale, and thousand-headed kale may be sown.

Vegetables—sow French beans (sparingly), broad beans, beet, cabbage, cauliflower, celery, lettuce, leek, peas, radish, carrot, herbs, parsnips, silver beet, spinach, turnips.
Transplant cabbage, cauliflower, celery, lettuce, silver beet.

Get land ready *for sowing grasses and* make final preparations of land for lucerne, and for planting out shelter trees.

South Coast.

Crops to sow—
Wheat, oats, barley and rye for green fodder. Field peas sown with any of these crops increase the feeding value, and superphosphate will be found a very useful help to the growing plants.
Lucerne—now is a good time to sow lucerne, so that the plants may become firmly established before the ground becomes cold. Have the ground clean and weeds in check.
Winter pasture grasses and clovers, particularly Subterranean clover.

Vegetables—sow seed of beans (French and broad), beet, cabbage, carrot, cauliflower, celery, cucumber, leek, lettuce, onion, parsnip, peas, radish, silver beet, white and Swede turnip.
Transplant cabbage, cauliflower, celery, eschalot, silver beet, and tomato.

Northern Tableland.

Crops to sow—
Rape may be sown for feeding stock in winter.
Wheat, oats, barley, for grain or hay, may be sown. Cape or Skinless barley, two of the best, may be sown with tares or vetches if required.
Rye may also be sown with tares for green food or for hay, if cut early.
Clovers for feed or hay may be planted.
Field peas may be sown alone or in conjunction with wheat, oats, barley, or rye for green feed in milder sections.
Lucerne—the latter part of March is a good time to sow lucerne to enable roots to establish themselves well in *the soil before cold weather sets in.*

Vegetables—sow broad beans, beet, cabbage, carrot, leek, lettuce, onion, parsnip, radish, silver beet, spinach, white and Swede turnip.
Transplant cabbage, cauliflower, eschalot, leek, onion, silver beet.

Plough land for spring cropping; the earlier the ploughing the deeper it should be, except that too much clay subsoil should not be brought to the surface.

Central Tableland.

Crops to sow—
Wheat—the earliest sowing of this cereal for the main crop may be made about the end of the month, if it is intended to graze sheep upon it during winter. The lighter portions of the farm should be chosen for this purpose. Late-maturing varieties should be used.
Barley, oats rye, and rape should still be sown early in the month for green fodder.
Kale, white mustard, clovers, Black tares, field peas, grasses, and sheep's burnet.
Lucerne—the main crop, may be sown this month upon well prepared land.
Onions—for main crop.

Vegetables—sow onions, radish, spinach, leek, eschalots, Savoy cabbage, broccoli, and white turnips. Make a small sowing of carrots and lettuce.
Transplant Savoy cabbage, broccoli, onions, leek, eschalots, and silver beet.

Southern Tableland.

Crops to sow—
Wheat—for hay, green feed, or grain.
Barley and rye—for green feed.
Field peas—for green feed, sown with wheat, barley, or rye.
Sunrise oats—for early green fodder might be sown.
Lucerne, clovers, mustard, rape, and turnips. Rye grass, Cocksfoot, Prairie grass—may be sown now; and some clover should be added to the mixture.

Vegetables—*sow seed of broad beans,* beet, cabbage, carrot, leek, lettuce, onion, radish, silver beet, spinach, white and Swede turnip.
Transplant cabbage, cauliflower, celery, eschalot, leek, and silver beet plants.

Other work—keep the cultivator going among row crops and the harrow where it can be used on any broadcast or drilled crops to check evaporation by stirring the surface soil. See that on established lucerne patches the harrow is used after every cut. Pasture improvement can be attended to.

Keep plants moving. Watch potato crops for sign of the moth—the grub causes big loss. See to the planting of suitable trees or shrubs for shelter and shade for stock. Select native plants, if possible.

North-western Slopes.

Crops to sow—
Wheat, barley, and oats—for grazing and green feed, and subsequently for hay crops.
Rape, clovers, swedes, vetches, and grasses—for grazing and green fodder.

Vegetables—sow beet cabbage, carrot, cauliflower, leek, lettuce, onions, parsnip, radish, silver spinach beet, turnip.

Prepare land—for cereals and lucerne.

Central-western Slopes.

Crops to sow—
Rape, Kale, Mustard } for grazing and greenstuff.
Wheat, Oats, Barley } for grazing and silage.
Early in March is the most favourable time for the main crops of rape.
Field peas for grazing and grain.
Lucerne for grazing, if conditions are suitable.

Vegetables—sow beet, cabbages, cauliflowers, onions, carrots, parsnips, turnips, swedes, radish, lettuce, silver beet.
Transplant cabbage, cauliflower, celery, leek, eschalot, silver beet.

Get land ready—for lucerne. Finish the preparation of the land intended for wheat, oats, and barley; shallow cultivations with fine implements or harrows are preferable.

South-western Slopes and Riverina.

Crops to sow—
Rape—sow as largely as desired.
Oats—for greenstuff, hay, and grain.
Barley—for green fodder, with or without peas or vetches.
Lucerne on land which has been fallowed and kept free from weeds.
Subterranean clover and Wimmera rye grass in favoured parts.

Vegetables—sow cabbage, cauliflower, carrots, parsnips, beet, turnips, swedes, onions, and a few rows of peas.

Prepare land for long summer fallow.

Murrumbidgee Irrigation Areas.

Crops to sow—
Barley—for green feed.
Oats—for green feed and hay.
Wheat—for green feed.
Tick beans—for green manure crop.
Vetches—with cereal for green feed.
Turnips—broadcast for a field crop.
Rape can still be sown.
Clovers, Cocksfoot, Prairie, rye grasses.

Vegetables—sow carrots, parsnips, beetroot, broad beans, turnips (white and Swede), lettuce, cabbage, silver beet, radish, herbs, leek.
Transplant eschalots, tree onions, garlic, cabbage, cauliflower.

North-western Plains.

Crops to sow—
Barley, oats, and wheat for winter feed and silage.
Grass, lucerne, and rape.

Vegetables—cabbage and cauliflowers sown last month may be planted out if the weather is not too hot, otherwise they had better be left in the seed-bed, where they can be shaded until the weather begins to cool off; sow seeds for succession.

Get land ready for sowing wheat, oats barley, rye, and lucerne. By working the surface at this stage, the soil will be got into good condition by April, and weeds, which at this stage commence to grow luxuriantly, will be checked, and the majority got rid of by scarifying.

APRIL.

Upper North Coast.

Crops to sow—
Wheat, oats, and barley—sow for greenstuff; also wheat and oats for hay.
Rye—sow for greenstuff (grazing).
Lucerne—make main sowing.
Rape—sow for winter feed for pigs.
Field peas—sow for cattle feed, and seed for pigs.

Vegetables—sow broad beans, peas, onions, turnips, beet, carrot, herbs, leek, lettuce, radish, silver beet, spinach, and, in frost-free situations, French beans.

Plant out rhubarb, cabbage, cauliflower, celery, leek, silver beet, onion, lettuce.

Central North Coast.

Crops to sow—

Oats, Wheat, Barley } for green fodder and hay.
Rye, Rape } for green fodder.

Field peas and vetches—for fodder alone, or with cereals.

Tick beans—for fodder and green manure.

Mangolds.

Lucerne—probably best month for sowing.

Clovers and winter grasses—good month for sowing.

Onions—*sow in seed-bed.*

Vegetables—sow broad beans, French beans (in frost-free situations), beet, carrot, cabbage, kohl rabi, turnip, herbs, leek, lettuce, onions, parsnip, peas, radish, silver beet, spinach, turnips, rhubarb (also divide latter).

Transplant cabbage, cauliflower, celery, eschalots, leek, lettuce, onion, silver beet.

Other work—plough under all stalks, &c., and cowpea crops sown during summer. Let them decompose by leaving the land under fallow for spring crops.

Hawkesbury-Nepean.

Crops to sow—

Wheat—sow late varieties for green feed and hay.

Oats—sow largely for hay, and with peas and vetches for green feed. Too early for river flats.

Barley—for grain for pigs and poultry, and for green feed, either alone or with rape.

Rye—for green feed and grain.

Turnips, swedes, rape, and kale—may still be sown.

Mangolds may be sown on rich ground for stock feeding.

Lucerne—make main sowing in well prepared soil.

English grasses and clovers—sow either in well cultivated land or in roughly scratched-over pasture, if weather be favourable.

• Field peas and vetches—may be sown for pig feed or green manure.

Tree planting—for shade, shelter, and ornament—should receive attention this month.

Vegetables—sow broad beans, carrots, parsnips, leek, onions, lettuce, parsley, peas, eschalots, beet, radish, silver beet, spinach, and herbs. Winter rhubarb may be planted out, also cabbage, cauliflower, celery, leek, onion, silver beet, herbs.

South Coast.

Crops to Sow—

Wheat, oats, barley, and rye, with field peas—for green winter fodder for stock.

Clovers—particularly Subterranean—and pasture grasses.

Lucerne.

Vegetables—sow seed of beans (broad), beet, cabbage, carrot, cauliflower, celery, leek, lettuce, onion, parsnip, peas, radish, silver beet, white and Swede turnip.

Transplant cabbage, cauliflower, celery, eschalots, silver beet, and tomato.

Other work—harrow the pastures—it helps to freshen the grass, it breaks up the cowpats, and disturbs insects which might be harbouring in the grasses. See that the pastures contain a percentage of clovers. Harrow the lucerne patches after every cut. See to the maize-sheller.

Northern Tableland.

Crops to sow—

Wheat, barley, and oats for green fodder, hay or grain.

Rye for green feed or grain.

Lucerne may also be sown, although it is late.

Tares, vetches, &c., may be sown in combination with rye or barley. The former are good for ploughing under in orchards during the winter months.

Vegetables—sow broad beans, beet, cabbage, herbs, leek, lettuce, onion, radish, silver beet, spinach, and white turnip.

Transplant cabbage, eschalot, leek, lettuce, onion, and silver beet.

Get land ready for main crops of cereals and hay, and spring crops.

Central Tableland.

Crops to sow—

Wheat—as much as possible of the main crops should be sown. Sow the late-maturing varieties first.

Barleys can be advantageously sown towards the end of the month for the main crops.

Oats can be sown freely this month; comparatively early sowing frequently ensures good plump grain.

Rye may be sown for the main crop; it thrives upon very light soils.

Lucerne may be sown for the main crop.

Kale, Red clover, Black tares, field peas and grasses may be sown.

Vegetables—sow white turnips, Savoy cabbage, broad beans, leek, onion, radish, and herbs. Make small sowings of spinach and lettuce.

Transplant onions, leek, Savoy cabbage, broccoli, and eschalots.

Southern Tableland.

Crops to sow—

Wheat and oats—for hay, green fodder, or grain.

Barley and rye—for green fodder.

Field peas—for growing in with other green fodder.

Rape, mustard, turnips, lucerne.

Vegetables—sow broad beans, beet, cabbage, carrot, leek, lettuce, onion, radish, silver beet, spinach, white and Swede turnip.

Transplant cabbage, cauliflower, eschalot, herbs, leek, and silver beet plants.

Clean the garden of any spent plants.

Other work—Cultivate where possible to conserve soil moisture, especially for lucerne.

North-western Slopes.

Crops to sow—

Wheat, oats, and barley—for hay and grain crops.

Clovers, grasses, rape, vetches, and swedes—for grazing, &c.

Vegetables—sow beet, cabbage, carrot, cauliflower, herbs, leek, lettuce, onions, parsnips, radish, silver beet.

Prepare land for cereals (wheat, oats, barley) and for spring sowings. If the season has been favourable the earlier sown grazing crops—rape, wheat, barley, &c.—may now be fed off. It is wise after each feeding of such crops to give the land a thorough harrowing. This induces more vigorous growth and helps to check weeds.

Central-western Slopes.

Crops to sow—

Lucerne—in a well prepared seed-bed.

Wheat and oats—for hay and grain: Mid-season and late-maturing varieties.

Barley and rye—for greenstuff, hay, and grain.

Rape, tares or vetches, field peas—for grazing.

Wimmera rye grass—for grazing.

Vegetables—sow silver beet, radish, lettuce, leek, beet, peas, onions, carrots, parsnips, turnips, swedes, cabbages, and cauliflowers; and transplant any seedlings available.

Get land ready for the final sowings of wheat. Keep the ground between the drills of rape and other growing crops loose to conserve moisture, kill weeds, and stimulate growth of crop.

Top-dress pastures with superphosphate.

South-western Slopes and Riverina.

Crops to sow—

Wheat—for hay and grain.

Rape may still be sown on a small scale.

Barley—for grain, and in combination with tares and greenstuff for silage.

Lucerne—sow as much as land is well prepared for.

Wimmera rye grass, Subterranean clover, and trefoil can be sown this month.

Vegetables—sow a moderate area of peas and broad beans, also cabbages and cauliflowers for future transplanting.

Transplant cabbages and cauliflowers as they become fit. Sow onions, carrots, parsnips, and white turnips.

Get land ready for the further sowing of wheat, which it is desirable should be completed during next month.

Murrumbidgee Irrigation Areas.

Crops to sow—

Wheat—commence with late-maturing varieties about mid-month.

Barley—for green feed.

Oats—for green feed, grain, and hay.

Lucerne—the best month for autumn sowing.

Field peas—for pig feed or green manuring.

Either field peas or tares in combination with cereals for green feed.

Cocksfoot, rye, and Prairie grasses, provided the season is favourable.

Vegetables—sow turnips, carrots, beetroot, parsnips, radish, lettuce, broad beans, onions, silver beet, herbs, leek.

Transplant cabbage, cauliflower, lettuce, silver beet.

North-western Plains.

Crops to Sow—

Wheat, oats, barley, lucerne, grass—any of the hardy winter crops.

Vegetables—sow broad beans, silver beet, radish, lettuce, leek, onions, peas, carrots, parsnips, turnips and swedes.

Plant out cabbage and cauliflowers and sow seed for later plantings.

Prepare land for later sowings of cereals.

Top-dress pastures with superphosphate.

MAY.

Upper North Coast.

Crops to sow—
Barley—sow for green feed.
Wheat and oats—sow for hay and with field peas or vetches for green feed.
Rye—sow for green feed (grazing).
Grasses and clover—but it is getting *late*.
Vetches and field peas.

Vegetables—sow French beans on frost-free areas, broad beans, peas, lettuce, cabbage, turnips, beet, radish, herbs, leek, onion, parsnip, silver beet, spinach, turnips, and carrots. Plant out a few rhubarb roots.
Transplant cabbage, celery, herbs, leek, lettuce, onion, silver beet.

Get a small plot trenched and well prepared for asparagus.

Central North Coast.

Crops to sow—
Wheat and oats—for green feed and hay.
Barley and rye—for green feed.
Field peas and vetches alone or in combination with cereals.
Rape, lucerne, clovers, tick beans.

Vegetables—sow broad beans, beet, cabbage, carrot, lettuce, peas, radish, silver beet, spinach, turnip, potato, onions.
Transplant cabbage, celery, eschalot, herbs, leek, lettuce, onion, rhubarb, and silver beet.
Dig up and manure land for spring sowings.

Other work—plough up all idle land and fallow.

Hawkesbury-Nepean.

Crops to sow—
Wheat—sow quick-maturing varieties for green feed, hay, and grain.
Oats—main crop for hay.
Barley—green feed, and for pig and poultry grain.
Rape—when weather conditions have been unfavourable for previous sowing, rape may be sown now.

Vegetables—sow broad beans, carrots, leek, lettuce, onions (for pricking out), parsley, herbs, peas, and eschalots.
Plant out asparagus roots, though June is preferable, also cabbage, celery, herbs, leek, lettuce, onion, silver beet.

Get land ready for late sowings of wheat and rye for winter green feed.

South Coast.

Crops to sow—
Wheat, oats, barley, rye, and field peas may be sown, but they will not run up to any height until October.

Vegetables—sow seed of broad beans, beet, cabbage, carrot, celery, leek, lettuce, onion, parsnip, peas, radish, silver beet, white and Swede turnip.
Transplant cabbage, celery, eschalots, and silver beet.
Clean up the garden of all old plants; dig up old beds to sweeten the soil.

Other work—the ground, as a rule, is cold from now until August, and unless a plant is well established, there will be little growth. Plough up ground after silage and green fodder crops have been removed, particularly after sorghum, for the stubble holds the red stain disease. Maize-pulling will occupy a lot of time this month.

Northern Tableland.

Crops to sow—
Wheat, barley, and rye—for green fodder, hay or grain.
Vetches may be sown in combination with the cereals for green fodder.

In view of the severity of the winter in this district, no effort should be spared to provide abundance of winter fodder—silage, hay and grain.

Vegetables—sow broad beans, beet, cabbage, herbs, lettuce, onion, radish, spinach, and white turnip.

Transplant cabbage, eschalot, leek, lettuce, onion, rhubarb, and silver beet.

Get land ready for the sowing of cereal crops and other crops in spring.

Central Tableland.

Crops to sow—
Wheat—if possible complete this month.
Barley—main crops.
Oats and rye.
Lucerne preferably early in the month.
Clovers, tares, field peas, Sheep's Burnet, and many grasses.

Vegetables—make sowings of broad beans, cabbage, lettuce, onion, radish, spinach.

Transplant onions, Savoy cabbage, broccoli, eschalots, and leek. Plant tree onions, potatoes, onion and garlic.

Southern Tableland.

Crops to sow—
Wheat and oats—for hay, grain and green fodder.
Barley, rye and field peas—for green fodder.
Rape, turnips, and mustard—for sheep-feed.

Vegetables—sow broad beans, beet, cabbage, leek, lettuce, onion, radish, silver beet, spinach, white and Swede turnip.
Transplant cabbage, eschalot, herbs, leek, rhubarb, and silver beet.
Clean up the garden of all trash—it harbours pests.

North-western Slopes.

Crops to sow—
Wheat, oats and barley—main sowing.
Lucerne and clovers—most suitable month to sow
Rape and swedes.

Vegetables—sow broad beans, beet, cabbage carrot, cauliflower, herbs, leek, lettuce, onion, parsnip, radish, silver beet, spinach, and white turnip.
Transplant rhubarb.

Prepare land for the sowing of cereals and for spring crops.

Central-western Slopes.

Crops to sow—
Lucerne—in a well prepared seed-bed.
Wheat and oats—for hay and grain: Mid-season and late-maturing varieties.
Barley—for greenstuff, hay, and grain.
Rye—for greenstuff, grain and straw.
Rape and tares, field peas, and Wimmera rye grass—for grazing.

Vegetables—sow peas, onions, parsnips, carrots, swedes, cabbages, broad beans, *radish, lettuce, beet, spinach, silver* beet. Plant out any seedlings available.

South-western Slopes and Riverina.

Crops to sow—
Wheat—this is the best month for main sowings of grain crops.
Barley—for grain.
Field peas—for green feed or seed.
Vetches or tares—for green feed.
Rape—for green feed.
Lucerne and Wimmera rye grass.

Vegetables—plant tree onions, potato onions, and eschalots. Make a final transplanting of cabbage and cauliflower. Sow peas and broad beans as largely as required.

Fallowing may commence this month.

Murrumbidgee Irrigation Areas.

Crops to sow—
Wheat—main varieties for grain and green feed.
Oats—main crops.
Barley—for malting.
Tares and field peas may be sown with the cereals for green feed.

Vegetables—sow carrot, beetroot, lettuce, peas, onion, broad beans, cabbage, leek, radish, silver beet, spinach, turnip.
Transplant cabbage, lettuce, leek, onion, silver beet.

North-western Plains.

Crops to sow—
Wheat and oats—for hay and grain.
Barley—for green feed or grain.
Lucerne and Wimmera rye grass.

Vegetables—sow broad beans, radish, lettuce, carrot, spinach, leek, onions, turnip, parsnip, peas.
Plant out and sow seed for a succession of cabbage and cauliflower.

Get land ready for spring sowing of maize, sorghum, and other green fodder and silage crops. At this stage the area should be ploughed and left in the rough to take the greatest advantage of the mellowing influences of the weather during the winter months.

JUNE.

Upper North Coast.

Crops to sow—
Wheat and oats—sow for green fodder; not too late for a hay crop.
Rye—sow for green fodder.

Vegetables—sow French beans (on frost-free area), broad beans, peas, parsnip, beet, carrot, silver beet, spinach, tomato (under cover), cabbage, endive, lettuce, radish. Plant chokos, asparagus, winter rhubarb, cabbage, herbs, leek, lettuce, onion, silver beet.

Get land ready for potatoes and for artichokes for domestic use and fodder. The latter crop is a useful one to be harvested by pigs.

Central North Coast.

Crops to sow—

Wheat, oats—for green feed and hay.
Barley, rye.
Clovers.
Tomatoes—sow seed.
Onions—transplant plants into permanent bed.

Vegetables—sow broad beans, beet, cabbage, carrot, lettuce, peas, onion, radish, silver beet, tomato, turnip.
Transplant cabbage, eschalot, lettuce, onion, silver beet, also rhubarb and asparagus roots.
Dig up and manure land for spring sowings.

Other work—plough over weedy fallowed land. Plough under stalks of all late-sown maize crops.

Hawkesbury-Nepean.

Crops to sow—

Wheat—sow only quick-maturing varieties.
Oats—for hay and green feed.
Barley—for greenstuff—may still be sown for succession.
Rye—late crops are worth a trial on the poorer classes of soil.
Onions should be transplanted.
Artichokes may be planted from now on.

Vegetables—sow broad beans, cabbage, leek, parsnip, peas, herbs, silver beet, endive, carrot, spinach.
Transplant rhubarb, asparagus, cabbage, herbs, leek, lettuce, onion, silver beet.

Get land ready for potato (main crop) and maize. Spread all available farmyard manure on the ground and plough in to mellow.

South Coast.

Crops to sow—

Oats and rye may be sown where a late sowing is necessary for green fodder.

Vegetables—trials may be made with seed of cabbage, lettuce, peas, radish, and turnip. Make an early sowing of potatoes in frost-free situations. Sow tomato seed for early crop.
Transplant asparagus, cabbage, eschalot, herbs, leek, onion, rhubarb, and silver beet.

Get land ploughed for corn and conserve all the soil moisture possible. On the average, dry windy weather prevails in the spring, and early preparations should be made.

Northern Tableland.

Crops to sow—

Wheat and oats may be sown for hay or grain.

Vegetables—sow broad beans, cabbage lettuce, radish, and onion.
Transplant cabbage, eschalot, herbs, leek, lettuce, onion, and rhubarb.

Central Tableland.

Crops to sow—

Wheat may still be sown, although somewhat late to give best results.
Oats, barley, and rye may be sown.

Vegetables—sow peas and broad beans for main crop. Sow cabbage in seed-beds.
Transplant cabbage and herbs. Plant out tree onion, potato onion, garlic, eschalot, and rhubarb.

Plough ground for fallow for next season's wheat crop.
All land for summer crops should be ploughed as soon as possible.

Southern Tableland.

Crops to sow—

Oats for hay, green fodder, or grain.
Get ground ploughed for sowing of spring crops, especially potatoes.

Vegetables—sow seed of broad beans, cabbage, lettuce, radish.
Transplant cabbage, eschalot, herbs, leek, rhubarb, asparagus.
Get ground ready for spring crops.

North-western Slopes.

Crops to sow—

Wheat, oats and barley.

Vegetables—sow broad beans, beet, cabbage, carrot, cauliflower, leek, onion, parsnip, radish, silver beet, and white turnip.
Transplant rhubarb.

Prepare land for spring sowings. The feeding off of cereals for hay should cease early in this month.

Central-western Slopes.

Crops to sow—

Wheat—late plantings of early maturing wheats may be made on well-prepared land up to the end of the month with a prospect of getting profitable, though not maximum, returns. The main sowings, however, should be completed by end of May.

Vegetables—sow cabbage, broad beans, radish, beet, spinach, silver beet, lettuce, endive, leek, carrot, parsnip, turnip, and peas.
Transplant cauliflower, onion, rhubarb, asparagus, silver beet, and leek.

Get land ready for planting out shade and shelter trees where necessary, and fruit trees.

Fallowing for next year's cereal crops should now be commenced.

South-western Slopes and Riverina.

Crops to sow—

Wheat—it is now late for wheat, and sowing of ordinary varieties cannot be safely extended into first week of this month except in favourable localities. Where delay has occurred early-maturing varieties only should be sown.

Vegetables—sow carrot, parsnip, lettuce, broad beans, white turnip, peas, and onion in limited quantities only where water will be available.

Get land ready for sweet potatoes, lucerne, Sheep's Burnet, and for final sowing of barley for fodder.

Fallowing should commence this month.

Murrumbidgee Irrigation Areas.

Crops to sow—

Wheat—season is getting too late, but early-maturing varieties may be sown if conditions are favourable.

Oats—may yet be sown for green feed or hay.

Barley—for malting.

Vegetables—sow beetroot, carrot, peas, lettuce, cabbage, radish, silver beet, spinach, turnip, tomato (under shelter). Plant out asparagus and rhubarb.

Transplant cabbage, lettuce, leek, onion, silver beet.

Plough land for spring-sown crops and rice.

North-western Plains.

Crops to sow—

All sowings should be completed, but late sowings of early varieties may be made.

Vegetables—plant cabbage and sow carrot, broad beans, lettuce, radish, peas, parsnip, turnip, onions, beet, and spinach.

Other work—continue to plough land that is to be sown in the spring; the frost will kill most of the couch grass that is ploughed up now.

Start fallowing for next season's cereal crops.

JULY.

Upper North Coast.

Crops to sow—

Potatoes—main crop towards end of month.

Onions—on small scale.

Vegetables—sow broad beans, beet, peas, French beans (in frost-free situations), Jerusalem artichoke, carrot, cucumber (under cover), radish, silver beet, spinach, white turnip; tomato for early planting (under cover); plant out cabbage, endive, lettuce.

Transplant asparagus, cabbage, choko, eschalot, herbs, leek, onion, lettuce, rhubarb, silver beet; bed sweet potato tubers to secure rooted cuttings.

Get land ready for early spring sowing of maize, sorghum, and millet.

Central North Coast.

Crops to sow—

Wheat } for green fodder and hay—
Oats } early-maturing varieties.

Potatoes—main crop upper rivers; early lots lower down.

Tomatoes—also plant out early plants under cover.

Vegetables—sow Jerusalem artichoke, French beans (sheltered situations), broad beans, beet, carrot, cucumber (in boxes), kohl rabi, lettuce, peas, parsnip, potato, radish, spinach, tomato, turnip.

Transplant cabbage, choko, eschalot, herbs, leek, lettuce, onion, silver beet, and roots of asparagus and rhubarb.

Dig and manure land for spring crops.

Other work—Renovate lucerne beds by top dressing. Prepare land for potatoes and spring crops.

Hawkesbury-Nepean.

Crops to sow—

Limited areas only of oats and rye, for green feed.

Onions—as a field crop. If sown where they are to grow, should be sown this month on ground brought to an extremely fine tilth. If transplanted, they should be sown much earlier (May or June).

Vegetables—sow tomato, cucumber, and melon under good shelter, and set out sweet potato tubers under frames or

glass to secure stocks of rooted cuttings for early planting. Sow a few carrot, lettuce, radish, onion, and peas. Plant out Jerusalem artichokes, asparagus, summer rhubarb, cabbage, leek, lettuce, onion, silver beet.

Tree planting of deciduous kinds for shade should be completed.

Get land ready for potatoes. Plough in any fresh stable manure so that it will be mellowed before planting time. It will be well to break up and expose to atmospheric influence land intended for early maize crops.

Prepare new ground for cropping by deep ploughing, so that frosts may act beneficially upon the soil, and couch and other tenacious perennial growths may be destroyed.

South Coast.

Crops to sow—

A small sowing of oats may be made, though it is rather late for winter crops.

Vegetables—sow seed of French beans (where frost-free), beet, carrot, lettuce, peas, silver beet, turnip. Plant potatoes and artichokes in frost-free situations.

Transplant asparagus, cabbage, eschalot, herbs, leek, onion, and silver beet plants.

Get land ready for spring sowing. Crops sown in March should be fit to cut now if the season has been fair. Top-dress and harrow the lucerne paddock.

Northern Tableland.

Crops to sow—

Generally growth is at a minimum this month, and only in northern districts and lower altitudes is any cereal, such as wheat, oats, or barley grown.

Rye—this may still be sown for green fodder or grain.

Vegetables—sow broad bean, cabbage, lettuce, onion, peas, and radish.

Transplant asparagus, cabbage, eschalot, herbs, leek, lettuce, onion, and rhubarb.

Get land ready for spring crops by ploughing and cultivating.

Central Tableland.

Crops to sow—

Oats and rye—may be sown, but, generally speaking, they should be in.

Vegetables—sow peas and broad beans. Sow in seed-beds cabbage and early cauliflower; transplant cabbage, herbs, rhubarb, eschalots, asparagus.

Get land ready for spring cropping. Plough deeply and work in any available crude farmyard or stable manure.

Southern Tableland.

Crops to sow—

Oats may be still sown as required.

Other work—Westerly winds "tuck" stock up, and the question of shelter for the stock should be considered. Shelter makes a big difference especially to lambing ewes. Stall feeding of dairy stock at this season means added profits. Well-made silage is very useful.

Vegetables—sow broad beans, cabbage, lettuce, and radish.

Transplant asparagus, cabbage, eschalot, herbs, leek, and rhubarb

North-western Slopes.

Crops to sow—

Wheat and oats—though it is wise to have cereals sown before this month, for, as a rule, lighter yields result from sowing later than May.

Lucerne—may be sown, but is better sown in autumn.

Vegetables—sow broad beans, beet, carrot, leek, lettuce, onion, peas, radish, silver beet, white turnip, and, protected from frost, tomato.

Transplant cabbage, rhubarb.

Prepare land for spring sowing. Feeding off of cereal crops for grain should cease this month. Harrowing of cereal crops will generally be inadvisable after this month. The time to cease this operation is indicated by the spindling of the plants, i.e., the definite development of stems containing immature ears, for these ears may be damaged.

Central-western Slopes.

Crops to sow—

This is a risky month to sow any farm crops.

Vegetables—sow beet, spinach, silver beet, turnip (white), broad beans, peas, radish, leek, cabbage, lettuce, onion, endive,* sow tomato seed and plant sweet potatoes in cold frames or under cover.

Transplant cabbage and cauliflower.

Get ready for spring crops of lucerne and potatoes, land ploughed in the autumn.

Fallowing should be continued, and land prepared for spring and summer crops.

South-western Slopes and Riverina.

Vegetables—sow tomato seed and plant sweet potatoes under cover for early plants.

Transplant cabbage and cauliflower, and sow seed for later use.

Plough land to lie fallow for wheat, barley, oats, &c., to be sown in autumn.

Murrumbidgee Irrigation Areas.

Vegetables—sow peas, lettuce, tomato (under cover), herbs, cabbage, beet, radish, silver beet, spinach, turnips.

Plant out asparagus and rhubarb, cabbage, leek, lettuce, onion, silver beet.

Work land—for spring sown crops and rice.

North-western Plains.

Vegetables—sow and plant cabbage, broad beans, carrot, radish, lettuce, peas, and spinach.

Other work—Continue to fallow, and to prepare land for spring sowings of maize, sorghum, Sudan grass, and lucerne.

AUGUST.

Upper North Coast.

Crops to sow—

Potatoes—plant main crop if not already planted in July.

Mangolds—sow in deeply-worked soil.

Maize—large areas should not be attempted this month, but small sowings of early varieties may be made. Planting should not be too thick, nor the depth of sowing more than sufficient to avoid the grain drying out before the first roots take hold. Usually 2 inches at most is ample depth.

Grass-seed—sow all kinds except Prairie, which does better in autumn.

Sweet potatoes—rooted cuttings may be set out.

Artichokes—tubers may be set out.

Vegetables—sow cabbage, endive, kohl rabi, lettuce, parsley, garden swedes, turnip, beet, carrot, French beans, leek, onion, parsnip, peas, radish, rhubarb (seed), silver beet, tomato, capsicum, egg plant. Where situation is warm and sheltered, tomatoes may be set out. Cucumber seedlings should be raised under shelter for setting out at first opportunity. Chokos may be planted near a fence or other support.

Transplant asparagus, rhubarb, cabbage, herbs, lettuce, onion, silver beet.

Get land ready for maize, sorghum, broom millet, cucumbers, pumpkins.

Central North Coast.

Crops to sow—

Potatoes—continue sowing.

Maize—early varieties for early sowing along Macleay and Manning.

Lucerne—spring-sown crops this month.

Artichokes—dig and resow.

Tomatoes—plant out.

Onions—sow seed in permanent bed.

Vegetables—sow artichoke, asparagus, beans, beet, cabbage, carrot, celery, cucumber, herbs, kohl rabi, leek, lettuce, onion, parsnip, peas, potato, pumpkin, radish, rhubarb, silver beet, spinach, squash, tomato, turnip.

Transplant asparagus, cabbage, choko, eschalot, herbs, lettuce, onion, rhubarb, silver beet, and tomato.

Prepare beds for further sowings.

Other work—prepare land for spring crops. Renovate and top-dress lucerne paddocks and pastures. Plough under green manure crops.

Hawkesbury-Nepean.

Crops to sow—

Potatoes—main crop latter end of month. Mangolds and sugar beets—where frosts are not likely to be severe.

Vegetables—sow French beans in frost-free positions, beet, carrots, lettuce, parsnip, onion, leek, capsicum, egg plant, peas, radish, silver beet, spinach; and, under shelter, tomatoes, bush marrows, and cucumbers. Set out tomatoes in warm situations; plant out Jerusalem artichokes, summer rhubarb, cabbage, herbs, lettuce, onion, silver beet.

Get land ready for maize, sorghum, pumpkins, &c.; land intended for laying down to lucerne should receive a final ploughing and be left rough till end of month.

South Coast.

Vegetables—sow seed of beans (French), beet, carrots, cucumber, leek, lettuce, parsnips, peas, radish, silver beet, squash, tomato, turnip. Plant potatoes.

Transplant asparagus, cabbage, choko, eschalot, lettuce, silver beet.

Other work.—Keep the ground stirred after every shower to conserve the soil moisture—windy weather takes a lot out of the ground if a crust is left on top. Where green fodder is being cut the land should be ploughed up as soon afterwards as possible, for rain soaks in better where the land is worked.

Top-dress and harrow lucerne.

Northern Tableland.

Crops to sow—

Wheat, barley, oats and rye—may be sown for green feed, hay and grain.

Vegetables—sow broad bean, beet, cabbage, carrot, herbs, lettuce, onion, parsnip, peas, radish, silver beet, white turnip.

Transplant asparagus, cabbage, eschalot, herbs, lettuce, onion, rhubarb.

Get land ready for all spring crops.

Central Tableland.

Crops to sow—

Lucerne—may be sown upon well prepared land if moisture has been conserved. Upon soil not properly fitted spring sowing of lucerne is risky: it is preferable to sow during the autumn.

Tobacco—at end of month in seed-beds which can be covered from frosts.

Vegetables—sow carrots, parsnips, turnips, broad beans, peas, lettuce, beet, and radish. Sow in seed-beds cabbage, Brussels sprouts, early cauliflower, tomatoes, capsicums, Cape gooseberries, and egg plants.

Transplant asparagus, rhubarb, cabbage, lettuce, early cauliflower, eschalots, herbs.

Stock should be taken off all lucerne paddocks. The surface should be cultivated and the crop top-dressed.

Southern Tableland.

Crops to sow—

Oats may be sown as required.

Vegetables—sow seed of broad beans, beet, cabbage, carrot, lettuce, parsnip, peas, radish, silver beet, and white turnip.

Transplant asparagus, cabbage, eschalot, herbs, lettuce, onion, and rhubarb.

Other work—green fodder crops sown early should be now a nice height for cutting for dairy stock. Land should be got ready for spring planting. Conserve soil moisture by harrowing—westerly winds evaporate a lot of moisture this month. Harrow the pastures—it distributes the manure, especially about the camping grounds of stock. It also kills and disturbs insects which might be sheltering in the plants. Top-dress lucerne with superphosphate and harrow the stand.

North-western Slopes.

Crops to sow—

Lucerne—small sections may be sown.

Vegetables—sow beet, carrot, herbs, leek, lettuce, onion, peas, silver beet, tomato, and white turnip.

Transplant cabbage and, under protection, tomatoes. Red sweet potatoes for raising plants.

Get land ready by ploughing and working for spring sowing. Plough stubble or new land for fallow for cereal growing next year.

Central-western Slopes.

Crops to sow—

Lucerne—sow early on well prepared land.

Potatoes—plant after the middle of the month, and cover lightly with straw if possible.

Vegetables—sow broad beans, beet, cabbage, leek, lettuce, carrot, parsnip, turnip (white), peas, radish. Plant tomatoes, capsicum, egg plants, in seed-boxes or beds, under cover.

Transplant cabbage and cauliflowers.

Cultivation—continue the preparation of land for summer crops, and for fallowing. If possible fallowing should be completed by the end of this month. Renovate and top-dress established lucerne stands.

Get land ready for maize.

South-western Slopes and Riverina.

Crops to sow—

Lucerne—sow early in month in well prepared land.

Potatoes—commence planting.

Vegetables—sow peas on small scale, and tomato seed; cucumbers.

Get land ready for millets, sorghum, maize, pumpkins, melons, and other summer crops. Plough land to lie fallow for wheat, barley, oats, &c., to be sown in the autumn. If possible, ploughing should be completed this month.

Murrumbidgee Irrigation Areas.

Crops to sow—

Lucerne—if the season is favourable; it is not generally advisable to sow lucerne in spring.

Paspalum and Rhodes grass may be sown, but frosts may kill off the young shoots.

Vegetables—sow celery, leek, potatoes, sweet potatoes (in hot beds), beet, carrots, herbs, lettuce, peas, radish, silver beet, and, with protection, tomatoes, cucumbers, melons, marrows, pumpkins, and squashes.

Transplant herbs, lettuce, silver beet, cabbage.

Get land ready for maize, sorghum, millet, beet, mangolds. Prepare rice fields for sowing.

North-western Plains.

Crops to sow—

Lucerne—spring sowings should be made now.

Vegetables—sow carrots, lettuce, radish, peas, spinach; also, tomatoes, marrows, squash, cucumbers, pumpkins, and Cape gooseberries if they can be sheltered at night from the frost.

Get land ready for planting next month by harrowing and cultivating to reduce soil to fine tilth. Continue to fallow.

Renovate and top-dress established lucerne stands.

SEPTEMBER.

Upper North Coast.

Crops to sow—

Maize for grain—further sowings of early or main crop varieties.

Sorghum—for green fodder and grain.

Millet—for green fodder, hay, and grain for pig and poultry feed.

Broom millet—may be sown this month.

Mangolds—for summer feed for dairy cattle.

Pumpkins, squashes, grammas, pie melons—sow in odd corners and in special plots.

Peanuts—for pig and poultry food.

Cowpeas—for fodder and pigs (grazing), also for mixing with maize in silage, and for hay. Useful to renovate soil of worn-out maize paddocks.

Sunflowers—sow in odd corners and around sunny edges of maize crops, &c., for poultry feed and for mixing with cattle rations.

Vegetables—sow all kinds of beans, Jerusalem artichoke, beet, lettuce, tomatoes, cucumbers, melons, asparagus (seed), carrot, herbs, leek, parsnip, peas, radish, rhubarb (seed), silver beet, turnip.

Transplant herbs, lettuce, silver beet, sweet potato, tomato, capsicum, egg-plant.

Get land ready for further sowings of maize, sorghum, millet, and cowpeas.

Central North Coast.

Crops to sow—

Maize—for grain and fodder, main crop varieties.

Sorghum—Saccaline and other varieties.

Millets—for fodder.

Sudan grass, broom millet.

Potatoes—though getting rather late.

Pumpkin, marrow, peanuts.

Cowpeas—with maize or sorghum or alone.

Soy beans, buckwheat, sunflower, artichokes.

Sweet potatoes—plant out cuttings.

Melons, lucerne, summer grasses.

Vegetables—sow artichokes, asparagus, beans, beet, Cape gooseberry, carrot, cucumber, herbs, leek, lettuce, marrow, melon, parsnip, peas, potato, pumpkin, radish, silver beet, squash, sweet corn, tomato.

Transplant choko, eschalot, herbs, leek, lettuce, silver beet, sweet potato, and tomato.

Hoe and work up the soil surface.

Other work—plough under crops for green manure; prepare land for further spring sowing.

Hawkesbury-Nepean.

Crops to sow—

Maize—early or main crop varieties may be sown on river flats towards the end of the month.

Sorghum—sow for green fodder and seed for poultry or pigs.

Broom millet—White Italian is the best.

Millet—for green fodder, hay, and grain for pig and poultry feed.

Pumpkins, squashes, grammas, water, rock, and pie melons—main crops may be sown.

Peanuts—sow for pig and poultry feed in light friable soil.

Cowpeas—sow for green feed either alone or in conjunction with maize, sorghum, or millet.

Lima beans are also worth a trial.

Sunflowers—the Giant Russian is suitable for poultry feed, and mixes well with other crops for silage.

Lucerne—main spring sowing can be made.

Potatoes may still be planted, especially early in month for main sowing.

Jerusalem artichokes—for domestic use and pig feed may be planted in odd rich corners; they are difficult to eradicate, and should not be planted where it is not possible to get the land thoroughly cleaned by pigs or by hand.

Shade trees and hedges—if not planted out in autumn may be put in now.

Vegetables—sow French and other beans, red and silver beet, carrot (main summer crop), cucumbers, vegetable marrows, squashes, water and rock melons, leeks, lettuce, capsicum, egg plant, parsnip, radish.

Plant out sweet potatoes, herbs, lettuce, silver beet, capsicum, egg plant, chokos, and tomatoes.

South Coast.

Crops to sow—

Maize, sorghum and millets—mostly for green fodder.

Cowpeas and mangolds may also be sown.

Vegetables—sow seed of French beans, beet, carrot, cucumber, leek, lettuce, melon, parsnip, peas, pumpkin, radish, silver beet, squash, tomato, and turnip.

Plant potatoes.

Transplant choko, eschalot, lettuce, silver beet, sweet potato.

Keep all crops well cultivated and protect them from wind

Northern Tableland.

Crops to sow—

Oats—sow White Tartarian and Reid. It is too late to sow Algerian or similar long season varieties, as a rule.

Wheat—early maturing varieties, such as Florence and Clarendon, may be sown for both grain and hay.

Maize—a small area may be sown at the end of the month.

Vegetables—Potatoes—make small sowings of early varieties. Sow artichoke, broad bean, beet, cabbage, carrot, herbs, lettuce, parsnip, peas, radish, silver beet, and white turnip, mangolds, and (under cover) tomato.

Transplant cabbage, herbs, lettuce, silver beet.

Get land ready for planting maize in the beginning of October. Also get ready for sorghum, millet, &c.

Central Tableland.

Crops to sow—

Potatoes—for early crop may be planted about the middle of the month. These should appear above ground early in October, when danger from frost is slight. Upon the lower lands planting should be delayed from one week to a fortnight.

Maize—near the end of the month may be sown on the uplands, but not yet on the river flats. Avoid deep planting.

Jerusalem artichokes may be planted about the middle of the month.

Lucerne and grasses.

Vegetables—Asparagus roots should be set out early in the month. Sow asparagus seed. Sow carrots, parsnips, turnips, kohlrabi, beet, cabbage, lettuce, early cauliflower, silver beet, herbs, peas, Brussels sprouts, tomatoes, capsicum, egg plant, radish, mustard and cress. Transplant upon highlands (and under cover) a few tomatoes, Cape gooseberries, capsicums, and egg plants.

Southern Tableland.

Crops to sow—

Oats may still be sown, especially in the very cold places, such as Nimmitabel.

Mangolds for stock food.

Vegetables—Cabbage, carrot, lettuce, parsnip, peas, radish, tomato (under cover), and turnip seed may be sown. Plant early potatoes where conditions are favourable.

Transplant cabbage, herbs, lettuce, silver beet.

Prepare ground for sowing maize next month. Top-dress lucerne with superphosphate; it is most beneficial. Harrow the fertiliser in well.

North-western Slopes.

Crops to sow—

Maize, potatoes, Sudan grass, sorghums, and millets.

Cowpeas—for green fodder.

Broom millet.

Vegetables—sow artichoke, beans (French), beet, carrot, herbs, lettuce, melons, peas (a small sowing), pumpkins, silver spinach, squash, and tomato.

Transplant young plants from previous sowing. In some cases protection will still be needed from late frosts.

Cultivation—continue fallowing land for wheat, and cultivating for further sowing of spring crops.

Central-western Slopes.

Crops to sow—

Potatoes—plant early in month.

Maize, millet, and sorghum—towards the end of month for green feed, silage, and grain.

Cowpeas—for green feed and grazing.

Vegetables—sow asparagus (seed), beet, carrot, parsnip, lettuce, turnip (white), tomato, cucumber, capsicum, egg plant, French bean, radish, silver beet, *marrow, melon, pumpkin.*

Transplant cabbage, lettuce, leek, silver beet, and tomatoes (shelter from frost at night).

Cultivation—commence the cultivation of fallows to create a suitable mulch and prevent evaporation, and to check weed growth.

South-western Slopes and Riverina.

Crops to sow—

Potatoes—planting should be completed.

Pumpkins and squashes—sow and protect seedlings from frost.

Melons and cucumbers—sow and protect seedlings from frost.

Sorghum and millet—sow for green feed and silage.

Maize—sow for green feed and silage. This is also a better time to sow for grain than a month later, in order to avoid hot summer winds during tasselling.

Sudan grass in early districts.

Lucerne in late districts.

Vegetables—in localities not very subject to frost and later, hot winds, sow beans of all kinds (except broad). Transplant tomatoes, and shelter from frosts with a few twigs of pine.

Get land ready for main sowings of sorghum, maize, and millet, including broom millet for heads and seed.

Murrumbidgee Irrigation Areas.

Crops to sow—

Sorghum—for green feed and seed.

Maize—early varieties may be sown this month, but there is a risk of damage to the setting of the grain from the hot, drying winds of midsummer. Green fodder maize may be sown.

Millet—for green feed and seed. These may be grazed off, and then allowed to shoot up for seed for next years' planting.

Sudan grass—for green fodder or hay.

Mangolds, beets, cowpeas, paspalum, Rhodes grass, may all be sown.

Rice—commence sowing at end of month.

Vegetables—sow tomatoes, cucumbers, melons, vegetable marrows, French, runner and Lima beans, pumpkins, artichokes, asparagus (seed), herbs, lettuce, radish, rhubarb (seed), silver beet.

Transplant herbs, lettuce, silver beet, tomato—give protection to tomatoes.

Prepare land for autumn crops to be sown end of year.

North-western Plains.

Crops to sow—

Sudan grass, millet, pumpkins, sorghum, cowpeas, potatoes.

Vegetables—sow French beans, cucumber, artichoke, melons, squash, and marrow.

Transplant tomatoes.

Get land ready for cropping in December with maize, sorghum, cowpeas, for silage and green fodder.

Continue fallowing for wheat.

Prepare silage pits and make silage.

OCTOBER.

Upper North Coast.

Crops to sow—

Maize—late varieties may be sown towards the end of the month, but it is getting too late for good yields from early varieties.

Sorghum and millet—for green fodder, silage, or grain.

Sugar-cane—set out for fodder and milling.

Cowpeas—sow for seed.

Pumpkins—sow extensively for cattle and pigs.

Sweet potato—set out cuttings.

Plant out sets of Queensland cattle cane.

Vegetables—sow runner and Lima beans, squashes, marrows, and melons of all kinds, beet, cucumber, herbs, lettuce, parsnip, radish, silver beet.

Transplant herbs, silver beet, leek, tomato.

Get land ready for later sowings of maize and sorghum for silage.

Central North Coast.

Crops to sow—

Maize—main crop varieties; also for fodder and silage.
Sorghum—Saccaline for fodder.
Millets, Sudan grass—for green fodder.
Broom millet, pumpkins.
Sweet potatoes—plant out cuttings.
Cowpeas—alone or with maize and sorghum.
Artichokes, sunflower, melons and squashes, summer grasses.

Vegetables—sow artichokes, asparagus, beans, beet, Cape gooseberry, cucumber, herbs, lettuce, marrow, melon, peas, parsnip, pumpkin, radish, silver beet, squash, sweet corn, tomato.
Plant out—eschalot, herbs, lettuce, silver beet, sweet potato, and tomato.
Water and protect—keep weeds down.

Other work—cultivate to destroy weeds and conserve moisture.

Hawkesbury-Nepean.

Crops to sow—

Maize—late or main crop varieties may *now be sown on the flats. In many* localities the October sown crops will do better than September sown ones, owing to growth being unchecked by cold weather.
Sorghum—continue sowing for green fodder and silage.
Broom millet—sow without delay.
Cowpeas—main sowings may be made.
Pumpkins, melons—sow as largely as desired.
Sweet potatoes—set out cuttings or "rooted plants" in rows 3 feet apart and 2 feet in rows. Warm, sandy situations suit this crop best.
Lucerne—final sowings may be made early in the month.

Vegetables—sow French and all other kinds of beans (except broad), red and silver beet, carrot, cucumbers, marrows, melons, leeks, onions, lettuce, herbs, parsnip, radish; plant out tomatoes, herbs, silver beet.

South Coast.

Crops to sow—

Maize—main planting for grain and for silage.
Sorghums—if season is favourable.
Japanese millet, mangolds, sunflowers, cowpeas, and velvet beans may be sown.
Paspalum dilatatum, Rhodes grass.

Vegetables—sow seed of French beans, beet, carrot, cucumber, leek, lettuce, melon, parsnip, peas, pumpkin, radish, silver beet, squash, tomato, and turnip.
Transplant choko, eschalot, lettuce, silver beet, sweet potato.

Northern Tableland.

Crops to sow—

Maize—may now be planted, this being the best month generally for New England. Only early-maturing varieties have much chance of ripening properly in the short season. Seed should be sown at a shallow depth.
Millet—for hay or green feed.
Sorghum—for green feed.
Cowpeas—for green feed, hay or grain.
Field peas—For green fodder, hay and grain.
Potatoes—planting generally starts middle of month in cooler localities; earlier in warmer districts.

Vegetables—

Frosts should now be over, except from Black Mountain to Ben Lomond, and, therefore, a number of vegetables may be planted—such as artichokes, beans (French), beet, cabbage, carrot, cucumber, herbs, lettuce, melons, parsnip, peas, potato, pumpkins, radish, silver beet, squash, white turnip, and *(in frost-free localities)* tomatoes.
Transplant cabbage, herbs, lettuce, silver beet, and (in frost-free localities or under cover) tomatoes.

Central Tableland.

Crops to sow—

Maize, sorghums, millets, cowpeas, pumpkins, melons, sunflowers, and Sudan grass.
Mangolds, beet, carrots, Jerusalem artichokes, kale, and kohl rabi.
Tobacco can be transplanted into field about middle of month upon lowlands; it may be set out somewhat earlier upon the highlands.

Vegetables—plant early potatoes. Sow for main crop pumpkins, melons, cucumbers, squashes, sweet corn, French, butter, and Lima beans, peas, silver beet, radish. Sow in seed-beds, cabbage, lettuce, kohl rabi, and herbs.
Transplant cabbage, Brussels sprouts, herbs, lettuce, tomatoes, capsicum, egg plant, and Cape gooseberries.
Make a small sowing of cauliflowers.

Other work—Towards the end of the month the first cut of lucerne will be ready to make into silage, if so desired. Residues of winter-grazing crops should be ploughed under.

Southern Tableland.

Crops to sow—

Maize—for green fodder and grain, except in the colder portions.
Japanese millet—for green feed if the season is moist.
Mangolds—may be sown.

Field peas should be sown if the seed is required.

Potatoes may now be planted.

Vegetables—sow artichoke, French beans, cabbage, carrot, lettuce, melon, parsnip, peas, potato, pumpkin, radish, tomato, and turnip seed.

Transplant cabbage, herbs, lettuce, silver beet, and tomato.

North-western Slopes.

Crops to sow—

Maize, Sudan grass, sorghum, cowpeas, millet, and broom millet.

Vegetables—sow beans (French), beet, herbs, melons, New Zealand spinach, pumpkin, radish, silver spinach beet, sweet potatoes, tomato.

Transplant sweet potato and tomato.

Cultivation—Continue fallowing land for cereals, and ploughing and cultivating land for summer crops. Cultivate between rows of maize and potatoes where sufficiently developed. Hill early-sown potatoes and maize. Generally the rape and early-sown cereal crops will have ceased to produce further growth, and should be finally fed off and the residues ploughed under. Hay-making will be in full swing this month.

Central-western Slopes.

Crops to sow—

Sorghum, maize, Sudan grass, cowpeas, and millet—main sowings for greenstuff and silage. Maize for grain is a risky crop in this district, except on well prepared land, or under irrigation.

Vegetables—sow French beans, melons, pumpkin, cucumber, marrow, squash, silver beet, carrot, parsnip, tomato, lettuce, turnip, radish.

Transplant tomatoes and sweet potato "plants" from cold frame or seed-bed.

Other work—make provision to safeguard the standing crops to be left for grain against fire by cutting stripe for hay around and through them.

Continue to work fallows; they should receive at least one cultivation before harvesting operations commence.

South-western Slopes and Riverina.

Crops to sow—

Sorghum and Sudan grass—sow without delay.

Maize—for green fodder and silage; also for grain under irrigation.

Cowpeas—for green fodder, hay, silage, or green manure.

Millet—for greenstuff and hay.

Vegetables—Pumpkins, squashes, melons, and cucumbers—sow without delay.

Murrumbidgee Irrigation Area.

Crops to sow—

Maize—for green feed. Not a safe month for sowing for grain crops, owing to hot summer winds prevailing during tasselling period.

Sorghum and millet—for green feed and grain.

Rice—main sowing.

Cowpeas—for green feed.

Mangolds, beets.

Sudan grass, Rhodes grass, paspalum.

Vegetables—sow French beans, artichokes, cucumber, melons, vegetable marrows, tomatoes, pumpkins, radish.

Plant out sweet potatoes and tomato.

North-western Plains.

Crops to sow—

Maize, millet, sorghum, Sudan grass, cowpeas, and pumpkins.

Vegetables—sow melons, squash, marrows, cucumbers.

Transplant tomatoes and sweet potatoes.

Other work—commence cultivating fallows to prevent evaporation and weed growth.

NOVEMBER.

Upper North Coast.

Crops to sow—

Sorghum, mixed with cowpeas—sow on any land that is not required for other purposes.

Broom millet—sow a small patch so as to have the crop ripening in succession, which will permit of more time for harvesting.

Maize for grain—best month to plant late varieties.

Maize, mixed with cowpeas—sow for green fodder and silage.

Cowpeas—sow for seed or green feed.

Pumpkins and melons—sow a good patch for storage.

Grammas—sow for storage.

Sugar-cane—plant for milling or fodder.

Vegetables—sow full crop Lima beans; small sowing of cucumbers, squashes, and tomatoes.
Transplant sweet potato, tomato.

Get land ready for late maize and sorghum. Paspalum ground broken up will allow of grass dying, thus making the land more easily prepared for cultivation.

Central North Coast.

Crops to sow—
Maize—main crop varieties for grain, and crops for silage and green fodder.
Sorghum—Saccaline.
Millets—for green fodder.
Broom millet, pumpkins, sweet potato, soy bean, sunflower.
Cowpeas—alone or in maize crops.
Melons, squashes, cotton, summer grasses.

Vegetables—sow French beans, beet, cucumber, lettuce, melons, peas, pumpkin, squash, marrow, sweet corn, tomatoes, turnips. Sow in cool weather.
Transplant silver beet, sweet potato, and tomato. Plant out in cool portion of day.
Hoe and mulch surface soil. Keep down weeds. Water young plants and seeds.

Other work—cultivate to conserve moisture and destroy weeds in furrow crops.

Hawkesbury-Nepean.

Crops to sow—
Maize—main crops may still be sown.
Sorghum and millet—for fodder and silage.
Cowpeas may be sown on land used for cereals, cut as green feed or hay.

Vegetables—sow all kinds of beans (except broad), red and silver beet, pumpkins, vegetable marrows; set out further cuttings of sweet potatoes and tomatoes; sow lettuce seed in permanent bed and thin out.

South Coast.

Crops to sow—
Maize—for grain and silage.
Sorghum—for silage and green fodder.
Cowpeas, velvet beans, sunflowers—for green fodder.

Vegetables—sow seed of French beans, cucumber, lettuce, pumpkin, radish, squash, and tomato.
Transplant sweet potato slips and tomato plants.

Northern Tableland.

Crops to Sow—
Potatoes—main crop.
Maize for grain—early-maturing varieties only may be planted up to the middle of this month. Maize for silage may also be sown.
Sorghum—main crop.
Millet—all kinds may be sown.

Vegetables—sow French bean, beet, cabbage, carrot, cucumber, lettuce, melon, parsnip, potato, pumpkin, radish, squash, tomato.
Transplant cabbage, lettuce, silver beet, tomato.

Central Tableland.

Crops to sow—
Early maize, sorghum, millet, cowpeas, pumpkins, melons, potatoes, sunflowers, and buckwheat.
The residues from rape and other crops should be turned under as quickly as possible.

Vegetables—sow beet, radish, peas, pumpkins, melons, cucumbers, squashes, sweet corn, potatoes, beet, and French, Lima, and butter beans. Sow in seedbeds cauliflowers for main crop, cabbage, and Brussels sprouts.
Transplant cabbage, lettuce, kohlrabi, Brussels sprouts, and tomatoes.

Southern Tableland.

Crops to sow—
Maize—for green fodder.
Potatoes—main sowing.
Japanese millet—if the season is favourable.
Paspalum dilatatum for pasture.

Vegetables—sow artichoke, French beans, cabbage, carrot, lettuce, melon, parsnip, peas, potato, pumpkin, radish, tomato and turnip seed.
Transplant artichoke, cabbage, lettuce, silver beet, and tomato.
Keep ground well worked to check weeds and conserve soil moisture.

North-western Slopes.

Crops to sow—
Maize, sorghum, Sudan grass, cowpeas.

Vegetables—sow beans (French), beet, melon, New Zealand spinach, pumpkin, radish, squash, sweet potato, and tomato.

Cultivation—Work the land between the rows of growing crops, and where maize and potatoes are sufficiently developed, shallow or deep hilling, according to the nature of the soil, should be carried out. The balance

of the rape and early-sown cereal stubble should be ploughed under to prevent seeding.

Cutting for hay and hay-making will be completed this month, and harvesting of the grain crops in full swing. Generally the grain crops are fully matured early in this month, the late-sown July portion coming in in the latter part of the month.

Central-western Slopes.

Crops to Sow—

Maize for grain—early varieties may still be sown.

Maize and sorghum—for greenstuff and silage.

Sudan grass.

Cowpeas for grazing and greenstuff.

Vegetables—sow silver beet, French beans, tomato, radish, marrows, squashes, pumpkins, and cucumbers.

Transplant sweet potatoes and tomato.

Cultivation—as opportunity occurs cultivate the growing crops that are in drills. Cultivate fallows with rigid-tine or springtooth cultivator when necessary, and keep weeds in check by use of sheep.

South-western Slopes and Riverina.

Crops to sow—

There are no crops, except sorghum, maize, Sudan grass, and millet for green feed, that can be safely sown this month, and these only where irrigation is possible.

All drilled crops should receive attention in the way of cultivation of the soil to retain moisture.

Murrumbidgee Irrigation Areas.

Crops to sow—

Maize—for grain, medium early varieties may be sown towards the end of the month

Sorghum—good sowings for late autumn and early winter feed.

Millet, cowpeas, Sudan grass, Rhodes grass, and paspalum.

Rice—should be sown before 2nd week of this month.

Vegetables—sow French beans, cucumber, marrow, melons, pumpkin, radish, squash, tomato.

Transplant tomato, sweet potato.

North-western Plains.

Crops to sow—

Maize, pumpkins, Sudan grass, and sorghum—if they can be irrigated.

DECEMBER.

Upper North Coast.

Crops to sow—

Maize for grain—late varieties.

Maize and cowpeas—for green fodder and silage.

Sorghum and cowpeas—for green fodder and silage.

Broom millet—for broom and seed.

Paspalum—sow seed and plant out rootlings.

Vegetables—sow cabbage, cucumber, celery, cauliflower, radish, pumpkin, marrow, melon, tomato.

Transplant tomato.

Get land ready for further sowings of autumn fodder crops such as maize, or sorghum, with cowpeas.

Cultivation of crops should be continued. Sugar-cane requires particular attention, ploughing between drills and chipping weeds.

Central North Coast.

Crops to sow—

Maize — main crop varieties. Choose blight-resistant varieties.

Sorghum—Saccaline.

Millets—for green fodder.

Broom millet—early in month.

Pumpkins.

Cowpeas alone or in maize crops.

Vegetables—sow French bean, cabbage, cauliflower, celery, cucumber, lettuce, marrow, pumpkin, squash, sweet corn, tomato.

Keep abundant moisture up to young plants.

Transplant sweet potato and tomato.

Keep cultivation implements in action to conserve moisture and destroy weeds.

Hawkesbury–Nepean.

Crops to sow—

Maize for grain—late varieties may be sown during first week of this month; it is getting late for early varieties.

Maize, sorghum, millet—for green fodder and silage.

Cowpeas may be sown for pig feed or green manure, but may not mature seed where early frosts are common.

Vegetables—sow beans of all kinds (except broad), celery (under shade), radish, pumpkins, cucumbers, bush marrows, &c.; set out in seed-bed cabbage and cauliflower.

Transplant tomato.

Get land ready for autumn crops of potato, turnips, rape, and lucerne.

South Coast.

Crops to sow—

Maize, sorghum, cowpeas, sunflowers—for green fodder and silage.

Vegetables—sow seed of French beans, cabbage, cauliflower, celery, cucumber, lettuce, melon, pumpkin, radish, squash, tomato.

Transplant sweet potato slips and tomato plants.

Northern Tableland.

Crops to sow—

Sorghum—may be sown for green fodder and for silage.

Millet—for hay and for green fodder.

Potatoes—may still be planted for the main crop.

Vegetables—sow French bean, beet, cabbage, celery, cucumber, leek, lettuce, parsnip, peas, potato, radish, squash, and swede turnips on the high tableland.

Transplant cabbage and tomato.

Central Tableland.

Crops to sow—

Potatoes—main late crop.

Maize and sorghum—for green fodder.

Pumpkins and melons may still be sown at the beginning of month.

Swedes—a small sowing towards end of month.

Vegetables—sow French and butter beans, cabbage, swedes, Brussels sprouts, celery, squashes, cucumbers, beet, peas, radish, lettuce, and sweet corn.

Transplant cauliflowers, cabbages, and tomatoes.

Cultivate fallows to destroy weed growth and restore mulch after rains.

If practicable, land from which hay was gathered could be ploughed. This may be fallowed in during damp weather.

Southern Tableland.

Crops to sow—

Maize—for green fodder.

Japanese millet, Red clover, and *Paspalum dilatatum*.

Peas as a side line to come in perhaps about Easter. Richard Seddon, Green Feast or Yorkshire Hero are suitable varieties.

Vegetables—sow French beans, beet, cabbage, cauliflower, celery, cucumber, leek, lettuce, parsnip, peas, potato, radish, and squash seed.

Transplant cabbage and tomato plants.

Keep the ground well worked.

Tie tomato plants to stakes, keeping the laterals pinched out—it promotes early setting of the fruit.

Other work—cultivate potato crops to keep the moisture in the ground.

North-western Slopes.

Crops to sow—

Maize, sorghums, millets, cowpeas.

Vegetables—sow French beans, marrow, New Zealand spinach, pumpkin, radish, squashes, tomato.

Cultivation—continue as opportunity arises to cultivate between rows of maize and potatoes, and where these are sufficiently developed hill if advisable. Prepare further land for cropping in January and early autumn. If fallowed land is weedy or set by rains it should be worked with springtooth cultivators or harrows. If an inch or two of soil is loose on the surface the evaporation of moisture is greatly retarded. The cereal harvest is generally completed before the end of this month, and hay stacked in field or shed.

Central-western Slopes.

Crops to sow—

Maize (early varieties) and sorghum—for greenstuff, silage, and grain.

Cowpeas—for grazing and greenstuff.

Vegetables—plant French beans, marrows squashes, pumpkins.

Cultivation—shallow cultivation of fallows with tined implements is necessary this month to control weed growth.

South-western Slopes and Riverina.

Crops to sow—

Maize, sorghum, millet—sow for silage and green fodder only where irrigation is possible.

Vegetables—stake tomatoes, and mulch after watering.

Get land ready, if at all in suitable condition, for early autumn sowing.

Murrumbidgee Irrigation Areas.

Crops to sow—

Maize—for green feed; only sow maize that can be used as green fodder before frosts, and use early-maturing varieties. If sown for grain it must be early in the month. After Christmas is generally too late.

Millet and sorghum.

Vegetables—sow peas (in the garden only), French beans, white turnips, cabbage, cauliflower, celery, tomatoes, sweet corn, cucumber, radish, marrow.

North-western Plains.

Crops to sow—

Maize and pumpkins—only if they can be irrigated.

Other work—commence to plough stubble land for autumn sowing.

A PLANTING TABLE.

The great variation in the conditions under which crops are grown throughout the State, and the variety of purposes for which they are used, make it impossible for general recommendations to be made as to methods of planting, quantities of seed per acre, &c., required. In the following pages an effort has been made to particularise this information to the districts previously described in this calendar. It must be pointed out again, however, that farmers who find that the conditions of the locality in which they are situated are not represented, should communicate with the Department for advice.

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	
Upper North Coast.							
Artichokes ...	Pig and cattle food.	Aug.-Sept.	3ft. ...	6 cwt. tubers.	.....	4-6 ...	
Barley (Skinless) ...	Green fodder	Mar.-May ...	.....	.....	2 bus. ...	4-5 ...	
Beans (Florida Velvet).	Fodder ...	Sept.-Nov.	4ft. ...	15-20 lb.	.....	6½ ...	
	Pulse ...	,,	4 ,, ...	15-20 ,,	.....	7½ ...	
Beans (Mauritius)	Fodder ...	,,	4 ,, ...	15-20 ,,	.....	6 ...	
	Seed... ...	,,	4 ,, ...	15-20 ,,	.....	7 ...	
Broom millet ...	Broom heads	Sept.-Dec....	3-3½ ft.	3-5 lb. ...	.....	6 ...	
Cowpeas	Green fodder		2½ ft. ...	90 lb. ...	30 lb. ...	3½-4½ ...	
	Seed... ...	Sept.-Dec.	3 ,, ...	9 ,, ...	.....	4½ ...	
	Green manure.		.....	.....	20 ,, ...	4 ...	
Field peas (see "Oats" and "Wheat").							
Lucerne	Hay and green fodder.	April ...	.....	.....	15-20 lb.	4-5 (first cut).	
Maize	Grain (early).	Aug.-Sept.	4ft. ...	8-12 lb.	.....	.....	8 to 12 inches between plants or 3 grains every 2 to 3 feet.
	Grain (late)...	Nov.-Dec.	4-4½ ft. ...	8-12 ,,	.....	.....	
	Silage or green fodder.	Aug.-Feb.	3ft. ...	20-25 ,,	1-1½ bus.	3-4½	12 to 16 inches between plants or 3 grains every 2 to 4 feet.
Millet	Green fodder	Sept. to Jan.	.....	.....	8-10 lb.	2 ...	
	Hay ...	,,	.....	.....	8-10 ,,	3 ...	
Oats	Green fodder	Mar.-June	.....	.....	2½ bus.	3 ...	
	Hay ...		.....	.....	.....	5½ ...	
Oats and vetches or field peas.	Green fodder	Mar.-May ...	.....	.....	*2 ,, ...	2½-3 ...	
Paspalum ...	Pasture ...	Dec.-Jan. ...	.....	.....	8 lb. ...	6 ...	
Potatoes	Market ...	Feb. ...	2½ ft. ...	8-10 cwt.	.....	4½ ...	
		July-Aug.	2½ ,, ...	8-10 ,,	.....	4½ ...	
Pumpkins ...	Pig feed ...	Sept.-Nov.	10 ft. ...	3 lb. ...	.....	5 ...	
Rape (Essex) ...	Green fodder	Mar.-April	2½ ,, ...	2 ,, ...	6-8 lb. ...	3 ...	
Rye *	,, ...	Mar.-June	.....	.....	1½-2 bus.	2 ...	
Sorghum	Silage or green fodder	Sept. to Jan.	2½-3 ft. ...	6-8 lb.	20 lb. ...	3-4½	
	Seed... ...	Sept.-Jan.	3 ft. ...	6 lb. ...	.....	4 ...	
Sugar-cane ...	Cattle food ...	Oct. ...	4½-5½ ft.	.....	.....	8 ...	Sets 15 inches apart.
Swedes	Pig feed ...	Feb.-Mar.	3ft. ...	3 lb. ...	.....	4 ...	
Sweet potatoes ...	Fodder and domestic use.	Transplant Sept.-Oct.	3 ft. x 2 ft.	7,260 shoots.	.....	7 ...	
Vetches (see "Oats").							
Wheat	Fodder ...	April-June	.....	.....	1½-2 bus.	4-5 ...	
Wheat and field peas.	,, ...	April-May	.....	.....	*2 bus.	4-5 ...	

* This mixture consists of 1½ bushel cereal, and ½-bushel legume.

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.	months.	
Central North Coast.							
Artichokes ...	Pig fodder ...	Aug.-Oct. ...	3 to 3½ ft.	5-6 cwt. tubers.	.....	4-6 ...	
Barley	Green fodder	Feb.-May ...	.....	.....	2 bus. ...	3-4 ...	
Broom millet ...	Brush for brooms and seed.	Aug.-Nov.	3 ft. ...	4-6 lb. ...	.....	4 ...	
Buckwheat ...	.....	Aug.-Nov....	.....	.....	20 lb. ...	4 ...	
Cotton	.....	Sept.-Oct.	3-4 ft. ...	10-12 lb.	.....	3-4 ...	Thickly in drills.
Cowpeas ...	Seed	Sept.-Dec.	3 ft. ...	8-9 lb.	.....	4-4½ ...	
	Green manure		.....	.....	20 lb. ...	4 ...	
	Green fodder		3 ft. ...	8-9 lb.	30 ,, ...	4 ...	
	Fodder ...		2½-3 ft.	24-30 lb.	60 ,, ...	4-5 ...	
Field peas ...	With cereals for fodder.	Mar.-June	.....	20-25 ,,	40 ,, ...	.....	
	Green manure		2½-3 ft.	24-30 ,,	60 ,, ...	4 ...	
Grasses—							
Cocksfoot ...	Pasture ...	Mar.-June	.....	.....	40-50 lb.	4-6 ...	
Prairie	,, ...	Mar.-June	.....	.....	40-50 ,,	4-6 ...	
Rhodes	,, ...	Sept.-Mar.	.....	.....	6-8 lb.	4-6 ...	
Rye grass ...	,, ...	Dec.-June	.....	.....	2 bus. ...	3-4 ...	
Indian cat.e ...	Green fodder	Sept.-Oct.	4-5 ft. ...	Sets 8-10 in. in rows.	.....	.....	Permanent.
Lucerne	Green fodder and hay.	April, June and Aug.	.....	.....	15-20 lb.	.....	
Maize ...	Grain—early	Aug. to Feb.	3-3½ ft.	10-12 lb.	.....	4-4½ ...	
	late ...		3½-4 ,,	8-10 ,,	.....	4½-6 ...	
	Green fodder or silage.		2½-3½ ,,	14-20 ,,	1 bus. ...	4-4½ ...	
Mangolds	Pig and cow fodder.	Aug.-Mar.	3 ft. ...	4-6 lb.	.....	6-8 ...	
Melons and squashes.	Domestic use	Aug. to Dec.	Hills 4-6 ft. apart each way	1-3 ,, ...	.....	2½-3 ...	
Millet	Green fodder	Sept.-Dec....	3 ft. ...	3-4 ,,	8-12 lb.	2½-3 ...	
Oats	Green fodder and hay.	Feb.-June	.....	.....	1½-2 bus	3 (5 for hay).	
Onions	.....	April, May and Aug.	1-2 ft. ...	3-4 lb. ...	.....	6-11 ...	Sown in seed-bed. ¼ lb. seed gives enough plants to sow an acre in drills 2-3 feet apart—plants 4-5 inches.
Paspalum ...	Pasture ...	Aug.-Mar.	.....	.....	8-12 lb.	6 ...	
Peanuts	Pig feed, domestic use, and oil.	Aug.-Nov....	Hills 4 ft. apart each way	20-25 lb. in husks 8-10 lb. shelled.	.....	4-5 ...	
Potatoes	.....	July-Aug. and Jan.	2½-3 ft. ...	10-12 cwt.	.....	4-4½ ...	Sets 10-14 inches apart in rows.
Pumpkins ...	Domestic use, cow and pig fodder.	Aug.-Dec.	7-11 yds. 3-6 yds. in row, 6-11 yds square.	4-6 lb.	.....	4-5 ...	
Rape	Green fodder	Feb.-May ...	2-3 ft. ...	2-4 ,, ...	6-8 lb.	2½ ...	
Rye	,, ...	Feb.-May ...	.....	.....	2 bus. ...	3½-4 ...	
Sorghum	,, ...	Aug.-Feb.	3 ft. ...	6-8 lb.	15-20 lb.	4-5 ...	
Soybeans	Green manure and fodder.	Aug.-Nov....	3 ,, ...	4-5 ,, ...	20 lb. ...	4-6 ...	
Sudan grass ...	Pasture ...	Sept.-Dec....	.....	4-8 ,, ...	20-25 lb.	4-6 ...	
Sunflowers ...	Feed and stock feed, silage.	.....	4 ft. ...	8-10 lb.	14-20 ,,	4-5 ...	
Swede turnips ...	Domestic use, pig and cow fodder.	Jan.-Mar....	3 ft. ...	4-6 lb. ...	4-6 lb. ...	4 ...	
Sweet potatoes ...	Domestic use, pig and cow fodder.	Oct.-Dec.	3-4 ft. ... square.	11-14 thousand slips.	.....	6-7 ...	

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	

Central North Coast—*continued.*

Tick beans ...	Green manure and fodder.	Sept.-Dec....	3-4 ft. ...	10-14 lb.	30-40 lb.	4-5 ...	
Vetches and tares.	Fodder ...	Mar.-June.	.....	.....	30-40 ,,	4-5 ...	
	Green manure		.....	.....	30-40 ,,		
	With cereals		.....	.....	20-30 ,,		
Wheat ...	Green fodder and hay.	Mar.-June	.....	.....	2 bus. ...	3-5 ...	

Hawkesbury-Nepean.

Barley ...	Greenstuff ...	Mar. to May	7 in. ...	1½ bus.	2 bus. ...	4 ...	Generally sown with peas.
Broom millet ...	Broomheads	Sept. to Dec.	3 or 3½ ft.	2-4 lb. ...	.....	6-7 ...	
Cabbages ...	Market ...	Jan. (in seed beds).	3 x 2 ft.	7,260 plants.	.....	4-6 ...	
Cowpeas ...	Greenstuff ...	Sept.-Dec....	2 ft. 6 in.	7-10 lb.	20-30 lb.	4-6 ...	
Field peas ...	Greenstuff with barley, oats or wheat.	April-May	Drilled with cereal.	½ bus. peas. 1 bus. cereal.	Same as drilled.	4-5 ...	
Lucerne	Greenstuff and hay.	April ...	.....	.....	12-15 lb.	5 (first cut).	Permanent (3-6 ft. cuttings per annum).
Maize	Greenstuff or silage.	Sept.-Jan.	3 to 3½ ft.	15-20 lb.	1-1½ bus.	4-5 ...	Keep cultivators going.
	Grain ...	Sept.-Dec....	4 to 5 ft.	8-12 ,,	.....	5-7 ...	See remarks under Upper North Coast on distances for sowing.
Melons	.....	Sept.-Nov.	Hills 6 x 8 to 6 x 10 ft.	2-3 lb. ...	.....	4-6 ...	Keep cultivated until runners cover ground.
Millet	Greenstuff ...	Sept.-Feb....	7 in. ...	6-10 lb.	10-15 lb.	2½-4 ...	
Oats	Grain ...	Mar.-May ...	7 ,, ...	1½ bus.	2 bus. ...	4 ...	
	Hay ...	,, ...	7 ,, ...	1½ ,, ...	2 ,, ...	5 ...	
Potatoes	.....	Aug. and Jan.-Feb.	2½ to 3 ft. in row, 14 in. apart.	7-10 cwt.	.....	5-6 ...	
Pumpkins ...	.....	Sept.-Nov.	10 x 10 ft. to 12 x 12 ft. hills.	2 lb. ...	.....	5-7 ...	Keep cultivated until runners cover ground.
Rape	Greenstuff ...	Feb.-Mar.	7 in. or 2 ft. 6 in.	10 lb. or 3 lb.	10-15 lb.	2-3 (2 or 3 cuttings).	Pigs or sheep may be turned into crop when 12 inches high. The wider sowing permits of cultivation.
Rye	Greenstuff ...	Mar.-June	7 in. ...	1½-2 bus.	2 bus. ...	4 ...	
Sorghum	Grain ...	,, ...	7 ,, ...	1½-2 ,,	2 ,, ...	6 ...	
	Greenstuff and silage.	Sept.-Dec....	2½ to 3 ft.	6-8 lb. ...	15-20 lb.	5-6 (2 cuttings).	
Swedes	.....	Feb.-Mar.	2 ft. 6 in.	2-3 ,, ...	6 lb. ...	4 ...	
Sweet potatoes ...	.....	Transplant Sept.-Oct.	3 x 2 ft.	7,260 rooted cuttings	.....	6-8 ...	2 cwt. seed needed to produce the cuttings.
Tares (see "Vetches").							
Tomatoes	.....	June (under cover) to Dec.	4 x 4 ft. to 6 x 6 ft.	2,745 to 1,210 plants.	.....	4-6 ...	
Turnips	.....	March ...	2 ft. 6 in. x 3 ft.	2-3 lb. ...	6 lb. ...	4 ...	
Vetches (or tares)...	Greenstuff with barley, oats or wheat.	April-May	Drilled with cereals.	*1½ bus.	Same as drilled.	4-5 ...	
Wheat	Greenstuff ...	,,	7 in. ...	1 bus. ...	1½ bus.	4 ...	
	Hay ...	,,	7 ,, ...	1 ,, ...	1½ ,, ...	5 ...	

* This mixture consists of ½bushel legume, and 1 bushel cereal.

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	
South Coast.							
Barley	Green fodder	Mar.-May	6 in.	1½ bus.	2 bus.	5	
Beans	Domestic	Aug. to May	2 ft.	45 lb.	.....	3	Sow any month except June-July, according to situation.
Beet and mangel wurzels.	Fodder	Spring and autumn.	3 ,,	6 ,,	.....	7-8	Thin out to about 1 foot.
Clover	Pasture	Jan.-May	.....	.....	12 lb.	5	
Cowpeas	Fodder	Oct.-Dec.	2 ft.	20 lb.	40 ,,	4-5	Cultivate until they run.
Grasses	Pasture	Winter growing—Mar.-May; Summer—Oct.-Dec.	.....	.....	1 to 2 bus.	5 (to establish)	
Lucerne	Greenstuff or hay.	Mar.-April	8 in.	7-10 lb.	16 lb.	6 (first cut).	
Maize	Grain	Sept.-Jan.	3½ to 4½ ft.	9-12 ,,	.....	5-6	For grain—early sowings of early varieties, 3½ feet between drills and 2 to 12 inches between plants, or 3 grains every 2 to 3 feet; late sowings 4 to 4½ feet between drills and 12 to 16 inches between plants, or 3 grains every 3 to 4 feet.
	Fodder	Sept.-Jan.	2½ to 3 ft.	20-25 lb.	1-2 bus.	3-4	
Millet (Japanese)	,,	Oct.-Jan.	6 in.	.....	7 lb.	2½-3	
Oats	Hay	Mar.-May	6 ,,	1½ bus.	1½ to 2 bus.	5	Harrow until plants are 3 inches high.
Onions	Market and domestic.	Feb.-Aug.	2 ft.	2 lb.	.....	6	Cultivate freely; keep weeds in check.
Peas (Field)	Fodder	Feb.-Oct.	2 ,,	40 ,,	1½ bus.	3-4	Cultivate between rows.
Potatoes	Market and domestic.	June-Aug.	3 ,,	7-10 cwt.	.....	3-4	
Pumpkins	Domestic	Sept.-Dec.	6 x 6 ft. or 8 x 8 ft.	2 lb.	.....	5-6	Cultivate between rows until they run.
Pumpkins (cattle)	Fodder	,,	6 x 6 ft. or 8 x 8 ft.	2 ,,	.....	5-6	,, ,,
Rape	,,	Mar.-May	6 in.	6-10 lb.	15 lb.	4	Fit to graze in 6 to 8 weeks
Rye	,,	,,	6 ,,	1 bus.	1½ bus.	4	
Rye grass	Pasture	,,	.....	.....	1 to 1½ bus.	5	
Sorghum	Fodder	Sept.-Dec.	2½ to 3 ft.	6-8 lb.	15-20 lb.	5-6	
Tares or vetches	,,	Mar.-May	2 ft.	40 lb.	1½ bus.	4-5	Cultivate.
Turnips (Swede)	Cattle or pig fodder.	,,	2 ,,	2 ,,	.....	6	Cultivate, and thin out to rows.
Wheat	Grain or hay	,,	6 in.	1 bus.	2 bus.	5	
Northern Tableland.							
Barley	Grain	Autumn and spring.	7 in.	40-60 lb.	50-70 lb.	5-7	Quicker maturing when spring sown than when autumn sown.
	Green fodder	,,	7 ,,	40-60 ,,	50-80 ,,	4-6	Best fed when in ear (3-5 months).
Clover	Green fodder and hay.	,,	7 ,,	6 lb.	10 lb.	7	Three cuts in flower in a year except in cooler parts.
Grasses	Pasture	,,	7 in. to 3 ft.	15-3 lb.	20 ,,	.....	
Lucerne	Green fodder and hay.	,,	7 in.	6 lb.	10 ,,	2½	Three cuts in flower in a year except in cooler parts.
	Grazing	,,	.....	.....	4 ,,	.....	
	Grain	Oct.-Nov.	3½ ,,	10 lb.	.....	4½-6	Plants 12-15 inches apart in rows or hills of 3 plants, 3 feet apart.
Maize	Green fodder or silage.	,,	3 ft.	20 ,,	60 lb.	3-4	
Mangold	Stock feed	Sept.	2 ,,	3 ,,	..	5-7	

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	

Northern Tableland—*continued.*

Oats	Grain ...	Autumn and spring.	7 in. ...	40-60 lb.	50-70 lb.	5-7 ...	
	Green fodder	,,	7 ,, ...	40-60 ,,	50-80 ,,	4-6 ...	
Peas and beans ...	Green or dry seed.	Aug. to Dec.	2½-3 ft. ...	50-60 ,,	100 lb.	3-5 ...	Green, 3 months; mature, 5 months.
Potatoes	Culinary ...	Oct. to Dec.	2-3 ft. ...	12-8 cwt.	.....	4-6 ...	
Rape	Green feed ...	Autumn and spring	7 in.-3 ft.	8-2 lb. ...	10 lb. ,,	.....	May be fed-off or cut at any time.
Rye	Grain ...	,,	7 in. ...	40-60 lb.	50-70 lb.	5-7 ...	
	Green fodder	,,	7 ,, ...	40-60 ,,	50-80 ,,	4-6 ...	
Sorghum	Green fodder and silage.	Oct. to Dec.	2½-3½ ft.	8-6 lb. ...	14 lb. ...	4-6 ...	Should not be fed until nearly mature, and should be cut 24 hours before feeding.
Sudan grass ...	,, ...	Nov. ...	7 in.-2½ ft.	14-4 lb.	14 ,, ...	2½ ...	Two crops in 12 months may be obtained by cutting before plants are too fully in flower.
Turnips	.....	Autumn and spring.	2-3 ft. ...	4-3 lb. ...	10 ,, ...	4-6 ...	
Wheat	Grain ...	,,	7 in. ...	40-60 lb.	50-70 lb.	5-7 ...	
	Green fodder	,,	7 ,, ...	40-60 ,,	60-90 ,,	4-6 ...	

Central Tableland.

Artichokes ...	Domestic use and stock food.	Mid. Sept.-Nov.	3 ft. ...	6 cwt. ...	.....	6-7 ,,	Sow like potatoes.
Barley	Malting, green feed and silage.	April and May.	7 in. ...	¾ to 1 bus.	1 to 1½ bus.	5-6 ...	May be grazed 2 to 3 months after sowing, the second growth allowed to mature grain.
Cowpeas	Grain and fodder.	Oct.-Dec. ...	3-4 ft. ...	6-8 lb. ...	.....	6 ...	
Lucerne	Hay, green feed and silage.	Mid Mar.-May.	7 in. ...	12-15 lb. on river flats.	15 lb. on river flats.	Perennial.	Autumn sowings preferable, but in very cold districts spring sowing advisable. Grazing lucerne may be sown in 3 ft. drills also.
	Grazing ...	Aug.-Sept.	7 in. ...	4-6 lb. ...	8 lb.		
Maize	Grain ...	Sept.-Dec....	4½-5 ft. ...	8-12 lb.	Not recommended.	4-5 ...	Earliest maturing varieties advisable. Distance of rows and plants apart varies according to soil.
	Green feed, silage.	,,	3-3½ ft. ...	8-12 ,,			
Melons	Market ...	Sept.-Nov.	10 x 10 ft.	1-1½ lb.	.....	5 ...	
Millet	Green feed, silage.	Sept.-Jan.	7 in. ...	3-8 lb.	12-15 lb.	3-6 ...	Most suitable as quick catch crop for green feed or rough hay.
	Grain ...	,,	30 in. rows				
Oats	Grain ...	April-May	7 in. ...	40-50 lb.	60 lb. ...	7½-8 ...	Late maturing varieties preferable for grain and hay. May be fed off to end July, and crop then allowed to mature.
	Hay, green feed, silage.	,,	7 ,, ...	45-60 ,,	60 ,, ...	6-7 ...	
Onions	Main crop ...	Feb.-April...	15 x 6 in.	10-12 oz.	.....	6-8 ...	Sow seed in nursery beds and transplant.
Potatoes	Tubers ...	Oct.-Dec. ...	2½-3 ft. ...	8-10 cwt.	.....	5-6 ...	Plant whole tubers free of scab and with strong shoots, 15 in. apart in rows.
Pumpkins ...	Domestic use and stock feed.	,,	10 x 10 ft.	2 lb. ...	.....	7 ...	
Peas	Domestic use	Sept.-Dec....	2-3 ft. ...	60 ,, ...	.....	3 ...	

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	

Central Tableland—*continued.*

Peas (Field) ...	Stock feed ...	April-May	7 in. ...	60 lb. ...	.....	4-6 ..	May be grazed or ensiled or allowed to mature grain for stock feed. May be sown in combination with wheat, oats or barley for green feed.
Rape	Green feed or grazing.	Mar. ...	7	2-3 ,, ...	7-8 lb. ...	3-6 ...	May also be sown in rows 24 in. 6 in. apart.
Red clover ...	Pasture ...	April-May	.....	.....	10 ,, ...	Perennial.	Should be included in pasture grass mixtures also.
Rye ,, ...	Grain, hay, green feed and silage.	,,	7	40-50 ,,	50-60 ,,	5-6 ...	May be grazed 2 to 3 months from sowing.
Sheep's Burnet ...	Grazing ...	,,	.....	.....	20 ,, ...	Perennial.	
Sorghum	Grain, fodder or silage.	Sept.-Dec....	3-4 in. ..	6-8 lb. ...	12-14 lb.	6 ...	Sow non-saccharine varieties for grain and saccharine varieties for fodder and silage.
Sudan grass ...	Grazing, hay, silage or green feed.	Oct.-Jan. ...	7 in. ..	8-10 ,,	10-12 ,,	2-6 ...	Seed must be free of sorghum-sudan crosses.
Turnips (Swedes)...	Domestic use and stock feed.	Jan.-Mar. ...	2-3 ft. ...	2 ,, ...	.....	6 ...	
Vetches or tares ...	Green feed or grazing.	Feb.-April...	2-3 ,, ...	15-20 ,,	50-60 ,,	6-7 ...	May be sown with winter cereals for green feed.
Wheat	Grain, hay ...	April-May	7 in. ...	50-70 ,,	70 ,, ...	7-8 ...	Sow varieties in correct season; vary seed per acre according to time of sowing and variety; sow graded seed and treat for bunt with copper carbonate.
	Green feed and silage.	End Mar.-May.	7 ,, ...	60-70 ,,	70 ,, ...	5½-7 ...	

Southern Tableland.

Barley	Green fodder	Mar.-May ...	7 in. ...	60 lb. ...	80 lb. ...	5-6 ...	Autumn sowing.
	Grain ...	Mar.-April	7 ,, ...	60 ,, ...	80 ,, ...	5-6 ...	
Clover (Red) ...	Pasture ...	Feb.-April...	7 ,, ...	7-9 ,, ...	15 ,, ...	5-6 ...	
Field peas ...	Green fodder	Feb.-May ...	2ft. 4 in.	60 ,, ...	120 ,, ...	4-5 ...	
Grass (Rye) ...	Pasture	Feb.-April...	7 in ...	25 ,, ...	20-30 lb.	7-8 ...	
Lucerne	Hay ...	Feb. & Mar.	7 ,, ...	10 ,, ...	15 lb. ...	7-8 ...	
Maize	Green fodder	Oct.-Nov.	3ft. ...	30 ,, ...	50 ,, ...	4-5 ...	
	Grain ...	Oct. ...	3ft. 6 in.	10 ,, ...	.....	5-6 ...	
Mangolds	Fodder ...	Spring and autumn.	3ft. ...	5-7 lb. ...	.....	6-8 ...	
Millet (Japanese)	Green fodder	Nov.-Jan.	7 in. ...	5 ,, ...	8-10 lb.	3-4 ...	
	Hay ...	,,	7 ,, ...	5 ,, ...	8-10 ,,	.....	
Mustard	Grazing ...	Mar.-April	7 ,, ...	2 lb. ...	4 lb. ...	3-6 ...	
	Green fodder	Mar. ...	7 ,, ...	60 lb. ...	80 lb. ...	6-8 ...	
Oats	Hay ...	Mar.-July	7 ,, ...	60 ,, ...	80 ,, ...	6-8 ...	
	Grain ...	May-July ...	7 ,, ...	60 ,, ...	80 ,, ...	7-8 ...	
Onions	Main crop ...	Feb.-Aug.	15-18 in.	2-3 lb. ...	.....	6-7 ...	Space 4-6 inches apart, in rows.
Potatoes	,, ...	Nov. ...	2ft. 6 in.	10-12 cwt	.....	4-6 ...	
Pumpkins	,, ...	Oct.-Nov.	8ft. x 8ft	2 lb. ...	.....	2-6 ...	
Rape	Grazing ...	Mar.-April	7 in.	2-4 lb. ...	4 lb....	3-4 ...	
Rye	,, ...	,,	7 in. ...	60 lb. ...	90 ,, ...	3-4 ...	
Swedes	,, ...	Feb.-April...	36 in. ...	2 ,, ...	4 ,, ...	4-5 ...	
Turnips	,, ...	,,	36 ,, ...	2 ,, ...	4 ,, ...	3-4 ...	
	Green fodder	Mar. ...	7 ,, ...	90 ,, ...	120 ,, ...	6 ...	
Wheat	Hay ...	April & May	7 ,, ...	90 ,, ...	120 ,,	7 ...	
	Grain ...	April-June	7 ,, ...	60 ,, ...	80 ,, ...	8 ...	

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	
North-western Slopes.							
Barley	Grain ...	April-May	7 in. ...	40-50 lb.	54-75 lb	4-7 ...	
	Green fodder or silage.	Mar. ...	7 ,, ...	40-50 ,,	54-75 ,,	3-4 ...	Most value when in flower.
Beans	Green or dry seed.	Sept. to Jan.	2½-3½ ...	50-60 ,,	.....	2½-4½	
Grasses	Pasture ...	Winter—April-May. Summer—Aug.-Sept.	7 in.-3½ ft.	15-3 ,,	20 lb. ...	.....	
Lucerne	Hay or green fodder.	April-May.	7 in. ...	8 ,, ...	12 ,, ...	2½ ...	Up to 5 cuts (one-third in flower) may be obtained of rainfall sufficient.
Maize	Grain ...	Early districts—Sept.-Dec. Late districts—Oct.-Nov.	3½-4½ ft.	10-7 lb.	.....	4½-6 ...	
	Green fodder silage.	.....	2½-3 ,, ...	15-12 ,,	40 lb	3½-4 ...	
Oats	Grain ...	April-June	7 in. ...	30-50 ,,	40-60 ,,	4-7 ...	Autumn sowing is safer and the more profitable.
	Hay ...	Mar.-April...	7 ,, ...	30-50 ,,	40-60 ,,	3-5 ...	
	Green fodder or silage.	Mar ...	7 ,, ...	30-50 ,,	40-60 ,,	3-4 ...	
Peas	Green or dry seed.	Feb. & July-Aug.	2½-3½ ...	50-60 ,,	.....	2½-4½	Green, 2½ months; mature 4½ months.
Potatoes	Market ...	End Aug. ...	2½-3 ,, ...	10-8 cwt.	.....	3½-4½	
Rape	Green feed ...	Feb. ...	7 in.-3½ ft.	8-2 lb. ...	10 lb. ...	.....	May be fed-off or cut at any time.
Sorghum	Green fodder or silage.	Early districts—Sept.-Jan. Late districts—Oct. to Dec.	2½-3½ ft. ...	8-7 ,, ...	14 ,, ...	3-5 ...	Should not be cut until it has tasselled and should be left 24 hours from cutting before feeding.
Sudan grass ...	Green fodder and silage.	Early districts—Sept.-Jan. Late districts—Oct. to Jan.	7 in.-2½ ft.	14-4 ,,	14 ,, ...	2½ ...	By cutting before the crop is fully in flower, 3 cuts *may* be obtained.
Turnips	Stock feed ...	.....	2-3 ft. ...	4-3 ,, ...	10 ,, ...	3-5 ...	
Wheat	Grain ...	Feb. to Mar	7 in. ...	30-60 lb.	50-75 lb.	4-7 ...	Autumn sowing is safer and more profitable.
	Hay ...	April to June.	7 ,, ...	30-60 ,,	50-75 ,,	3-5 ...	
	Green fodder or silage.	Mar. ...	7 ,, ...	30-60 ,,	50-75 ...	3-4 ...	
Central-western Slopes.							
Barley	Grazing, greenstuff, silage, grain.	April to May.	7 in. ...	½ to 1 bus.	1 to 1½ bus.	4-6 ...	Fit to graze for greenstuff 6-10 weeks after planting. Will continue to grow after being cut or grazed.
Cowpeas	Grazing, greenstuff and pulse.	Oct. to Jan.	2½ to 3 ft.	8-12 lb.	*Not recommended.*	3-6 ...	*After being cut or grazed* cowpeas will continue to grow until frosts set in.
Field peas ...	Grazing, silage and grain.	April to May.	7 in. ...	1 bus. ...	,,	4-6 ...	May be used in conjunction with wheat or oats for silage; in which case use 20 lb. seed per acre.
Lucerne	Greenstuff, hay, silage	April and May.	7 ,, ...	8-10 lb. hay; 12-15 lb. river flats.	15 lb. on flats.	Perennial.	First cut 3-4 months. Graze heavily for short periods. Maintain 4 in. to 6 in. growth through winter if severe.
	Grazing ...	,,	,, ...	4 lb. ...	8 lb.		

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.).	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	
Central-western Slopes—*continued.*							
Maize	Greenstuff or silage.	Sept. to Jan.	3-3½ ft. ...	12-15 lb.	Not recommended.	4 ...	For grain—Average distance between plants in rows should be 18-24 in. If birds are troublesome and destructive, dip seed in coal tar and dry with ashes. For grain only early maturing varieties should be grown in the drier district.
	Grain ...	,,	4½ to 5 ft.	6-8 lb. ...	,,	4-5 ...	
Millet	Greenstuff or silage.	Sept. to Feb.	7 in. ...	3-4 lb. ...	10-12 lb.	2½-4 ...	Makes a rough class of hay for standby purposes. Handy for summer green feed, giving quick feed after break in weather.
Oats	Grain ...	Mid April to end May.	7 in. ...	40-50 lb.	50 lb. ...	5-7 ...	Practice being generally adopted is to sow oats early, feed off during autumn and winter and then allow to run on when a fair crop of hay or grain is obtained.
	Grazing, hay greenstuff and silage.	24 Mar. to 15 April.	7 ,, ...	45-55 ,,	60 ,, ...	5-6 ...	
Potatoes	Domestic ...	End of Aug. or Feb.	2½ to 3 ft.	8-10 cwt.	.....	3-4 ...	Plant whole tubers with strong shoots. Discard seed affected with scab.
Rape	Grazing or greenstuff.	Early Mar.	14 in. to 3 ft.	2-4 lb. ...	5-6 lb. ...	3-6 ...	Fit for grazing 6-8 weeks after planting and until spring, when if allowed to run up will produce hay and grain.
Rye	Grazing, greenstuff silage, hay, straw, grain.	April and May.	7 in. ...	40-50 lb.	50-60 in.	4-6 ...	Fit for grazing 6-8 weeks after planting and until spring, when if allowed to run up will produce hay and grain.
Sorghum	Greenstuff, silage and coarse hay.	Sept. to Jan.	2½ to 3 ft.	6-8 lb. ...	12-15 lb.	5 ...	Sow broadcast if needed for pit silage; sown in rows considerable waste with coarse stalks unless chaffed.
Sudan grass ...	Grazing, green feed, silage, hay, and grain.	,,	7 in. ...	8-10 lb.	10-12 lb.	From sowing till advent of frosts.	Care should be taken to obtain seed free from sorghum - sudan hybrids. A hay or grain crop is greatly improved by grazing the crop lightly when 4-6 in. high.
Tares and vetches	Grazing or greenstuff.	Feb. to May	2½ to 3 ft.	12-20 lb.	30-60 lb.	5-6 ...	
Wheat	Grain ...	Mid April to end May.	7 in. ...	50-70 lb.	70 lb. ...	5-7 ...	To prevent smut treat the seed with dry copper carbonate 2 oz. per bus. Quantities of seed per acre will vary according to variety and time of sowing.
	Hay, green-feed and silage.	End Mar. to mid-April.	7 ,, ...	60-75 ,,	75 ,, ...	5-7 ...	

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.).	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	

South-western Slopes and Riverina.

Barley	Grain	May-end June.	7 in.	40-50 lb.	60 lb.	5-6	
	Green fodder or silage.	Mar.-April	7 ,,	50-60 ,,	60 ,,	3-5	
Barley and field peas.	Green fodder or silage.	April-May	7 ,,	40 lb.	45 ,,	3-5	
Field peas	Green fodder	May	7 ,,	30 ,,	30 ,,		
	Green manure.	,,	7 ,,	60 lb.	60 lb.	4-7	
Grasses	.....	Mar. to May	.....	.....	20-40 lb.	4-5	
						.....	A few lb. each of various kinds.
Lucerne	Pasture	Mar. to June.	7 in.	4 lb.	10 lb.	Perennial.	
	Hay	Autumn and spring	7 ,,	6 to 10 lb.	12-15 lb.		
Maize	Green fodder	Oct.-Dec.	3 ft.	15-20 lb.	Not recommended.	4-5	
Millet	Fodder	Oct.-Dec.	7 in.	8 lb.	10 lb.	3-4	
Oats	Grain	April-May	7 ,,	40-70 lb.	40 ,,	5-7	
	Hay and green fodder.	Mar.-May	7 ,,	40-70 lb.	50 ,,	5-6	
Oats and field peas.	Green fodder or silage.	April-May	7 in.	30-50 lb.	65 ,,	4-6	
			7 ,,	30 ,,	30 ,,		
Onions	Domestic	.....	3 ft.	2	.....	.....	
Potatoes	Domestic	Oct.-Nov.	3 ft. x 15 in.	5-7 cwt	.....	4-5	
Pumpkins	Fodder	Oct.	10 ft.	2 lb.	.....	5-6	
Rape	,,	Mar.-April	7 in.	3 ,,	3-4 lb.	.....	
Rye	Green fodder	,,	7 ,,	45 ,,	60 ,,	3-4½	
Sheep's Burnet	Pasture	Mar.-May	7 ,,	10 ,,	20 ,,	Perennial.	
Sorghum (early varieties).	Green fodder	Oct. to Dec.	2½ to 3 ft.	4-8 lb.	15-20 lb.	4-5	
Swedes	Fodder	Mar.-April	3 ft.	2 lb.	.....	.....	
Tomatoes	Domestic	.....	5 x 5 ft.	1 oz.	.....	.....	
Turnips	Fodder and table.	Mar.-April	2 ft.	2 lb.	.....	.....	
Vetches	Green manure.	April-May	7 in.	30-40 lb.	60 lb.	4-5	
	Green fodder	,,	7 ,,	30-40 ,,	60 ,,	4-6	
Wheat	Grain	April-June.	7 ,,	50 to 80 lb.	60 ,,	6	
	Hay	,,	7 ,,	45-to 80 lb.	60 ,,	5	

Murrumbidgee Irrigation Areas.

Barley	Grain	May and June.	7 in.	40-45 lb.	60-70 lb.	5-6	
	Green feed	Feb.-Mar.	7 ,,	50-60 ,,	70 lb.	3-5	Use Cape varieties.
Barley and peas or tares.	,,	.....	7 ,,	50-60 ,,	70-80 lb. barley, 35 lb. peas, &c.	3-5	
Broom millet	Broomheads	Oct.	3½ ft.	8 lb.	.....	4-5	
Clovers	Grazing	April and May.	.....	.....	Varies according to variety.	5-6	Sow alone.
Cotton	.....	Sept.	3-4 ft.	10-12 lb.	.....	3-4	Thickly in drills.
Field peas or tares	Green feed	Mar. and April.	7 in.	50-60 ,,	.....	4-5	
	Green manure.	,,	.....	70-80 ,,	.....	4-5	

A PLANTING TABLE—*continued.*

Crop.	Purpose for which grown.	Time of Sowing.	Drilled.		Broadcast.	Period of growth of crop (approx.)	Notes.
			Distance drills apart.	Quantity seed per acre.	Quantity seed per acre.		
						months.	
Murrumbidgee Irrigation Areas—*continued.*							
Grasses—							
Paspalum	Pasture	Sept.	.....	10-12 lb.	.....	.....	Sow with cover crop such as millet through seed drill using the manure box.
Cocksfoot	"	April	.....	40-50 "	.....	.....	" "
Rhodes	"	Sept.	.....	6-8 "	.....	.....	" "
Prairie	"	April	.....	40-50 "	.....	.....	
Lucerne	Pasture and hay.	April	7 in.	8-10 "	Not advisable.	Perennial.	Advisable to sow in autumn only.
Maize	Grain	Early to mid-Dec.	4 ft.	8-10 "	"	4-6	Plants should not be closer than 15 to 18 inches in the rows.
	Green feed	Sept. to Jan.	3 "	20-25 "	35 lb.	3-5	
Millet	"	End Sept. to Jan.	7 in.	8-10 "	12-15 lb.	2½-4	
Oats	Hay	April	7 "	60 "	60-70 "	4-6	Sow early and feed off.
	Green feed	Mar. to May	7 "	60-80 "	70-80 "	3-5 "	
Oats and peas or tares.	"	"	7 "	50-60 "	70 lb. oats, 35 lb. peas, &c.	3-5	
Pumpkins	Table	Oct. and Nov.	9 ft.	2 lb.	.....	5-6	Triamble variety best. Sow with superphosphate on ridges.
Rape	Green feed	Mar.	7 in.	4-5 lb.	5-6 lb.	3-6	
Rice	Grain	Early Oct.	7 "	100 lb.	.....	7	Advisable to commence permanent flooding as early as possible, when plants are approximately 6 in. high.
Rye	Green fodder	Feb. to May	7 "	60 lb.	60-70 lb.	3-4½	
	Straw	April	7 "	40-45 lb.	50-60 "	5-6	
Sorghum	Green fodder	Sept. to Jan.	14 in.	14 lb.	20-25 "	3½-6	
Sudan grass	Grazing or hay.	Sept. to Jan.	7 in.	10 lb.	.....	.....	Sow alone.
	Seed		3 ft.	6 "	.....	.....	
Tick beans	Green manure	Feb. to April.	14 in.	60 lb.	Not advisable.	6-7	Sow early for best results.
Vetches	Green fodder.	.....	.....	.....	.....	.....	Best sown with a cereal.
Wheat	"	April and May.	7 in.	50-60 lb.	65-75 lb.	4-6	
	Hay	April	7 "	60 lb.	60-70 "	5-7	

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[Frontispiece and 1 Map.]

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