BEGINNINGS

IN

AGRICULTURE

BY

ALBERT RUSSELL MANN

SECRETARY TO THE NEW YORK STATE COLLEGE
OF AGRICULTURE AT CORNELL UNIVERSITY

New York
THE MACMILLAN COMPANY
1911

The Rural Text-Book Series

EDITED BY L. H. BAILEY

BEGINNINGS IN AGRICULTURE

The Rural Text-Book Series

MANN, BEGINNINGS IN AGRICULTURE.

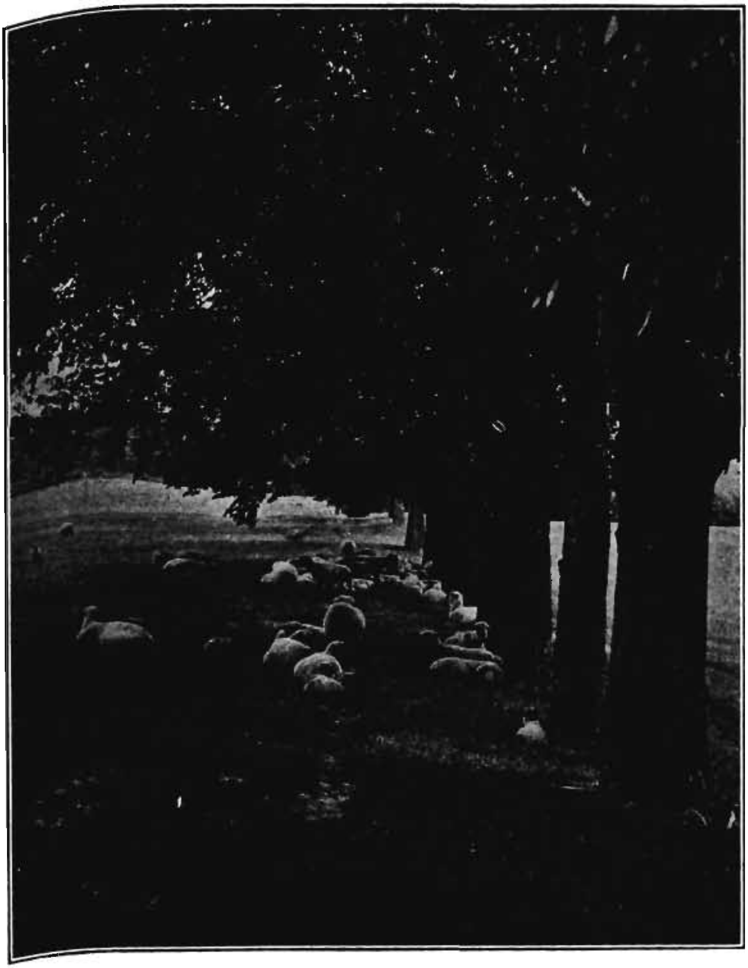
WARREN, *ELEMENTS OF AGRICULTURE.*

LYON AND FIPPIN, SOIL MANAGEMENT.

J. F. DUGGAR, SOUTHERN FIELD CROPS.

B. M. DUGGAR, PLANT PHYSIOLOGY.

Others in preparation.



THE SHEEP IN THE MEADOW.

Set up and electrotyped. Published September, 1911.

Norwood Press
J. S. Cushing Co. — Berwick & Smith Co.
Norwood, Mass., U.S.A.

PREFACE

This book is designed for the purpose of introducing the study of agriculture into the seventh and eighth grades of our elementary schools. It may also meet a need in some of the smaller high-schools and in ungraded special and private schools. When the pupil comes to well-developed high-school work, he will need a more detailed and specific text.

The book is founded on the suggestions in the Report of the Committee on Industrial Education in Schools for Rural Communities, of the National Educational Association. That Committee recommended for the school years 6 to 8, four sets of subjects as follows: first half year, the affairs of agriculture; second half year, the soil; second year, farming schemes and crops; third year, animals. A condensation of this plan into a two-year scheme has been attempted in the present volume.

It has been the aim of the author to cover the work very largely in a nature-study spirit, by which it is meant that the pupil shall be brought into as close touch as possible with the actual farms, soils, crops, animals, and affairs. The problems are intended to set the pupils at work on their own account rather than to enable them to answer questions that may be suggested in the text.

It is, of course, essential to practical school conditions that there shall be reading-matter and recitation-matter in the book. Perhaps Part I, dealing with the general agricultural situation, may be used as a series of introductory reading and discussion exercises, the actual work with subject-matter to begin with Part II. The open-book method of teaching, now used successfully in many schools with history, geography, and other subjects, might be employed advantageously with this text, especially in schools in which nature-study receives little attention.

It is assumed that the teacher will see that the pupils work out the problems, or as many of them as have useful application to the affairs of the particular community. It is to be hoped that there will be a school garden on the premises, or that small areas may be set aside at the homes of the pupils, on which many of the suggestions in the book may be worked out personally. It is specially to be desired that the parents be brought into the work, in order that the agricultural affairs of the community may be related to the school. Therefore, a large number of problems have been presented with this end in view, the expectation being that the pupil will ask the parents for the proper solution of certain of the questions.

Field trips, to study at first hand the subjects discussed in the lessons, will add greatly to the interest and value of the work, and will give it local and personal application. It is important that the pupils shall study the things themselves, so far as it is possible, rather than study about them.

The author realizes that it is very difficult to introduce agriculture on a uniform basis in the schools in all parts of the country, owing to the marked diversity in agricultural conditions; yet there are certain common and underlying problems and situations with which all school children should be familiar. The aim of the book has been to relate the pupil and the school to these general and essential situations. It is assumed that detailed technical discussions of the modes of raising certain crops and animals should not be introduced into the elementary grades. This part of the work must be reserved for the high school and the college.

The author is indebted to his colleagues in the New York State College of Agriculture for much valuable help in the preparation of the manuscript. Special obligation is due Miss Alice G. McCloskey, editor of the *Cornell Rural School Leaflet,* and Mrs. Anna B. Comstock, editor of the *Home Nature-study Course,* for the free use of subject matter and illustrations from their publications. A few illustrations have also been taken from the publications of President J. A. Widtsoe, Utah Agricultural College, Professor J. F. Duggar, Ala-

bama Polytechnic Institute, and Professor M. W. Harper, New York State College of Agriculture, the use of which the author gratefully acknowledges. Invaluable assistance was given by the author's sister, Adda M. Mann, a teacher of long and successful experience.

A. R. MANN.

ITHACA, NEW YORK,
September 1, 1911.

CONTENTS

PART I. THE AFFAIRS OF AGRICULTURE

PART II. THE SOIL

PART III. FARM PLANTS

PART IV. FARM ANIMALS

CHAPTER I

THE COMMUNITY IN WHICH I LIVE

Happy the man whose wish and care
  A few paternal acres bound,
Content to breathe his native air
  In his own ground. — POPE.

IT is a beautiful country in which I live. To the south is the village, with its churches and school, and with little dwelling-houses scattering out into the fields. There is a factory with tall chimneys that roll out windrows of smoke. On all other sides is the wide open country. There are long meadows, and hills that slope up to the sky. There are winding roads, bounding broad, green, fertile fields. There are brooks that dash down the hillsides and then wander over lowlands and sleep in the deep marshes. There are dense pieces of woodland and sentinel trees standing in the fields. Beyond the nearest highway is a sandy field in which sorrel grows. To the west of the road is land of hard clay, now rank with grass and clover, and in the spring yellow with the gold of dandelions. Beyond the barn is a wild sweep of pigweeds, invading the land that has been neglected and teaching lessons of thrift and of ability to seize opportunities. There are cattle dozing under maple trees at noonday. There are flocks of crows that travel westward in the morning and eastward at night. Stretching outward one sees miles of corn and meadow and grain and other crops.

The work that we do. — Every family in this country where I live has its own means of gaining a livelihood. One man is a stone mason. Others work in the factory. A number buy and sell in the village. One is employed by the government to care for the mails.

Some are physicians; some, clergymen. Many are farmers. All together they make up the community, each person contributing some share to the welfare of the whole. Every occupation in which they engage is necessary, and therefore one is as worthy as

Fig. 1. — There are grain fields, and hills that slope up to the sky.

another. My father's occupation is farming, and he is a member of the community.

The division of labor. — One part of the community depends on all other parts. If the blacksmiths should move from the village, father would be obliged to drive six miles farther to have his horses shod, and that would mean less work done on the farm or else extra labor to hire. If those persons who produce milk were to retire from the business, the village people would be obliged to keep cows, or to pay to have milk brought in from other places. If those who deliver the mail were to cease delivering, the farmer would be obliged to drive to the village, as formerly, or else go without his mail. There is division of labor, — one person performing one kind of work for the community, another person performing some other work. Each depends on the other, and the welfare of the community is dependent on all.

Problem 1. How many kinds of occupations are represented in your community, — say in your school district? What do the people do for a livelihood?

Problem 2. What is the leading occupation, — the one that engages the greater number of persons? Would you say that your community is a farming community, manufacturing community, trading community, wage-earning community, or some other kind? Give the reason for your answer.

Problem 3. What is the leading farming occupation? Do most of the farmers call themselves fruit-growers, or dairymen, or grain-farmers, or cotton-farmers, or general farmers, or stockmen, or gardeners, or florists?

Problem 4. What establishments in the community, or near by, make manufactured products from the materials that the farmer raises, — as beet-sugar factories, cotton mills, creameries, canning factories, grist mills, cider mills, pickle factories?

Problem 5. Are there any establishments that manufacture articles chiefly for the farmer's use, — as barrel factories, fertilizer factories, implement factories? Perhaps your teacher will want you to visit one or more of these establishments, and then to describe them.

Problem 6. Compute as nearly as you can the number of different persons who have contributed to your food-supply. Compute the number who have contributed to your clothing. How many countries have contributed to your food-supply? To your clothing?

Problem 7. Write a short essay on the division of labor in your community, telling what each group of persons does, and in what way one part of the community is dependent on another.

CHAPTER II

THE GEOGRAPHY OF THE LOCALITY AND THE CONTINENT

A GREAT many years ago, when our country was new, pioneers came and settled in this protected valley. Their families grew up, other families moved in, the store and the shop came, and there was established a community. In like manner, one after another, settlements sprang up in other localities farther to the west.

The local geographical conditions. — In each of the communities *the leading industries were determined largely by the special* natural advantages that the locality offered. One, because of good water power, became a manufacturing center; another, situated on the banks of a navigable river, became a shipping or commercial center; one, in a cold and densely wooded region, became a hunting and trapping center; others, with rich soil and favorable climate, became farming centers. Some of the farming regions had long seasons, some short; some had much rain, others little; some were on steep, rocky hillsides, others in rich, deep valleys; some developed one kind of farming, some another kind.

This region is part of the world. — There are many conditions in this local world, of which the school-house and the farm-house are the centers. If the locality were to be magnified one hundred or one thousand times, we should have such conditions as make up a state or perhaps a whole country. We should then have greater range of climate, more varieties of soil, more kinds of animals and of plants.

Now that we know something of our local world, we may learn of the greater world beyond.

The continental topography. — Geographers tell us that the United States, not including its possessions, covers an area of

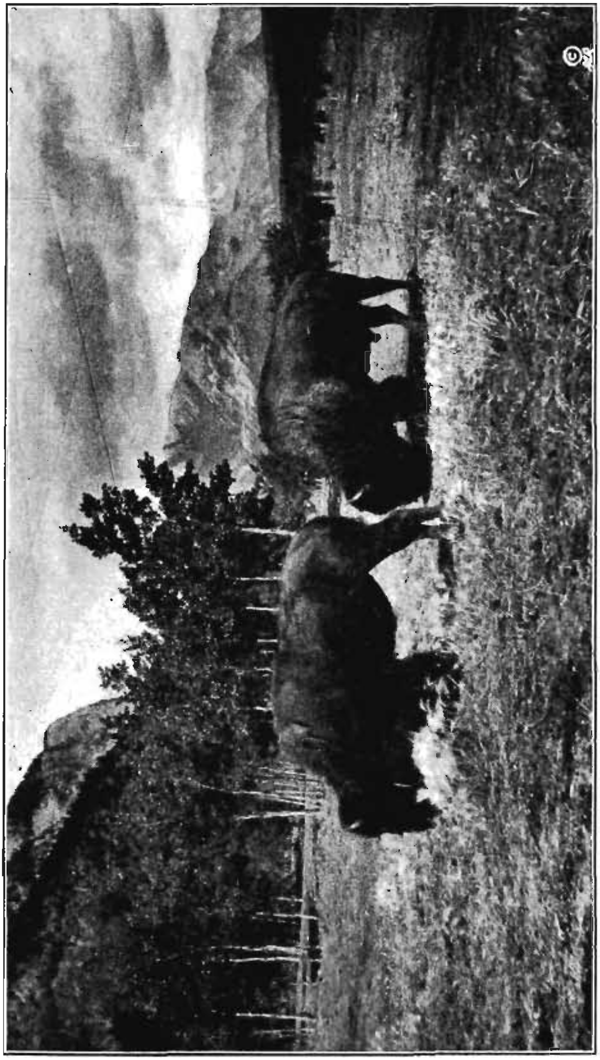


Photo by Rich.

FIG. 2. — In the far north vegetation is scant. Alaska.

3,026,789 square miles. Canada is even larger, with 3,745,574 square miles. This vast area, extending from the ever-frozen and desolate north to the warm sub-tropical south, is broken by lofty mountain ranges, between which are fertile valleys and wide plateaus, winding rivers, and broad, deep lakes. These changing physical features unite to form what we call the topography of the land.

Plant geography. — Because of its great extent and varying topography, and the conditions under which it was formed, North America has many different kinds of climate and of soil, and therefore has a great variety of plant life. In the far north, where the ground is always frozen, except a thin surface layer for a few weeks in summer, vegetation is very scant; there are a few scrubby willows and birches and short-season grasses and flowering plants, such as can endure a severe climate.

As we move gradually southward we find a greater range of plant life, and the plants grow more profusely. Along the southern border of the great forests of Canada and jutting down into the United States, there is a region where wild small-fruits abound, — as blackberries, raspberries, and cranberries. Here, in places, the potato, timothy-grass, and some of the more hardy grains thrive.

Moving southward again, we enter the warmer, humid regions, those having moderate rainfall, and including southern Canada and the United States except large areas in the west and southwest. In this region we find such crops as wheat, oats, rye, barley, varieties of corn, potatoes, sugar-beets, and tree-fruits, in the more northern parts, with the addition of peaches, hemp, lima beans, sorghum, and tobacco farther south. In the extreme south, cotton, sugar-cane, rice, peanuts, pecans, oranges, and lemons are staple crops.

In the arid and semi-arid regions in the west, where the rainfall is insufficient and irrigation is required to grow crops to advantage, corn, grains, potatoes, sugar-beets, fruits, alfalfa, kafir, sorghum, and sweet-potatoes are grown.

FIG. 3. — The topography varies, and also the plants that are grown.

As we move from one geographical region to another, we find a constant change in farming conditions and in the kinds of crops.

Relation to markets. — After the plants and animals are grown, the farmer must place them on the best markets; he needs good avenues of transportation to reach the markets. Here, again, the geography is important, — the nearness to cities or shipping ports, and the accessibility of rail and water routes. The farmers in a locality will produce the kinds of crops and animals for which they have a ready market, and which they can transport to market by the means that are available.

The geography of a locality, then, has much influence in determining the kind of farming, as the plants must be chosen to suit the soils, the climate, and the markets.

Problem 8. What are the leading crops in your state or general geographical region? Are some crops grown more largely in certain parts of the state than in others? Can you tell why?

Problem 9. Is the rainfall in your locality sufficient to meet the needs of the farm crops? Is the growing season long or short? If there are high hills, is the season any shorter on the hilltops than in the valleys? Can you tell why?

Problem 10. Are there different kinds of soil in your locality? What kinds of plants grow on each? Is there any noticeable difference between the soil on the hilltop and that in the lowlands? If there is a difference, see whether you can find the reason.

Problem 11. Determine what kinds of farm produce are sold by the farmers, and whether the products are sold in your village or city, or shipped away. If shipped away, where do the products go? How many kinds of shipping facilities are there, and what kinds of products are shipped by each?

Problem 12. With a map, trace out the leading farming regions on the continent, and write in each region on the map the names of the plants or crops grown in that region. Make a special map of your own state, showing the crops that are grown most largely in the various parts of it.

CHAPTER III

AGRICULTURE

One of the occupations in which persons engage is agriculture; and more persons are engaged in this occupation than in any other. About one-third of the population of North America are farmers. Farming is therefore a very important industry in this country. It leads also because it produces most of the food-supply for the nation, and the raw materials for many other industries.

Fig. 4. — With the westward growth, cattle ranches were established.

What agriculture is. — When we use the word "farming," we usually think of the running of a farm and the raising of products on the land. The products are plants or parts of plants, which we call crops, and animals or their products. When we speak of "agriculture," we more often mean all the enterprises connected with the farm in addition to the raising of plants and animals; but there is no real distinction between farming and agriculture.

Agriculture includes marketing, the making of farm buildings, good roads, farm forests, farm machinery, farm labor, the farm home, farm life, and everything else in which the farmer is interested in connection with his business.

Agriculture was the first settled occupation of man. We read that the first man whom God created was placed in a garden to keep it. From that time to the present, all progress of the human race has been closely associated with agriculture.

Indian agriculture. — Before the white man came to America, the Indians cultivated a few plants for food, more especially maize (commonly known as Indian corn), and beans, squashes, pumpkins, and sunflowers. Cotton and tobacco also were raised. Most of the food-plants were harvested in their wild state without cultivation. When Jamestown was founded, every family of the Algonquin, or Virginian Indians, had its garden, prepared by the men and planted by the women. The New England Indian families also had their gardens of one half acre to about one and one half acres in extent, which they tilled with their clam-shell hoes. The families helped one another, and when a field was to be broken up, as an old chronicle records, they had a "loving, sociable, speedy way to dispatch it. All the neighbors men and women, fortie, fiftie, etc., joine and came in to helpe freely."

The southeastern Indian towns had their farms in one piece, in which each family had a small lot fenced about by a strip of grass, poles, or other means. Each year they elected an overseer who directed all the garden work. At daybreak he awakened the families by a loud cry, gathered the men with their simple tools in the public square, and at sunrise led them into the fields. Later the women came with the food.

The southwestern Indians, in the arid regions, conducted farming by means of irrigation.

While the Indian methods of farming were crude, yet the early colonists found a system of agriculture that was of great help to them.

Colonial agriculture. — The colonists continued the cultivation of corn, tobacco, cotton, beans, melons, squashes, and potatoes, which they found here; and they introduced many crops from Europe. Wheat was the first crop brought over by the Virginia colony. At this time the chief live-stock was hogs and goats and a few cows; but cattle were rapidly introduced from Europe. The first cattle ranches in America were in Virginia. From the

FIG. 5. — Extensive wheat farms were developed.

first the colonists had a few horses for use as pack animals, but most of the farm work was performed by oxen.

Cattle were brought into New England in 1624, but cattle-raising did not become important at that time, except for dairying. Corn was the most important crop. The New England colonists followed the Indian custom of planting beans and pumpkins among the corn. Wheat, rye, buckwheat, and barley were grown to a limited extent. The meadow grasses were cultivated; among them was timothy, which has remained the principal hay crop to the present day.

The westward growth. — With the close of the Revolutionary War there came to the colonists a vast territory reaching westward to the Mississippi River, and agriculture was extended to the west and the south. Cotton became the most important crop in the south. Mules were raised for work on the cotton plantations. Live-stock raising took on new importance, and cattle, of both milk and beef breeds, and horses were imported, especially from England. The improvement of plants and animals went hand in hand with the importation of the best animals from Europe. Much attention was later given to the improvement of farm machinery, and new and better implements were introduced. Farming became more specialized as better means of transportation were provided. More than 30,000 miles of railroads were built before 1860.

As still other land to the west was added to the area of the United States, agriculture gradually pushed to the Pacific coast, and the large cattle ranches of the middle west and the great wheat and corn farms were developed. Railroads were extended, and many new labor-saving farm machines were devised. The grain separator or thresher, the twine-binder, the check-rower, the weeder, the riding cultivator, the disk harrow, the cream separator, the Babcock test, and many other implements greatly affected the methods of farming. As the arid and semi-arid regions, with their scant rainfall, were invaded, farming by irrigation was developed.

In Canada, the westward expansion took place more slowly, although agriculture became well developed in the older eastern provinces. With the recent completion of great continental railroads, however, the vast western Canadian country was opened up; and the great provinces of Manitoba, Saskatchewan, Alberta, and British Columbia are already large producers of wheat, cattle, and other products. The greatest expansion into new territory on the North American continent is now taking place in these provinces.

In the last thirty years, farming in the United States and Canada

The westward growth. — With the close of the Revolutionary War there came to the colonists a vast territory reaching westward to the Mississippi River, and agriculture was extended to the west and the south. Cotton became the most important crop in the south. Mules were raised for work on the cotton plantations. Live-stock raising took on new importance, and cattle, of both milk and beef breeds, and horses were imported, especially from England. The improvement of plants and animals went hand in hand with the importation of the best animals from Europe. Much attention was later given to the improvement of farm machinery, and new and better implements were introduced. Farming became more specialized as better means of transportation were provided. More than 30,000 miles of railroads were built before 1860.

As still other land to the west was added to the area of the United States, agriculture gradually pushed to the Pacific coast, and the large cattle ranches of the middle west and the great wheat and corn farms were developed. Railroads were extended, and many new labor-saving farm machines were devised. The grain separator or thresher, the twine-binder, the check-rower, the weeder, the riding cultivator, the disk harrow, the cream separator, the Babcock test, and many other implements greatly affected the methods of farming. As the arid and semi-arid regions, with their scant rainfall, were invaded, farming by irrigation was developed.

In Canada, the westward expansion took place more slowly, although agriculture became well developed in the older eastern provinces. With the recent completion of great continental railroads, however, the vast western Canadian country was opened up; and the great provinces of Manitoba, Saskatchewan, Alberta, and British Columbia are already large producers of wheat, cattle, and other products. The greatest expansion into new territory on the North American continent is now taking place in these provinces.

In the last thirty years, farming in the United States and Canada ıas made noteworthy advancement. Agricultural colleges, experiment stations, and departments of agriculture have been estab-

ꟳIG. 6. — When the arid regions were invaded, in the search for new land, farming by irrigation became necessary.

ished, and much expert attention has been given to the problems of the farmer.

Values. — When we compare agriculture with other industries, we find it far in the lead in its investment and output. A single farm may not seem to be a large business, but when we add together the money invested in all farm property in the United States, the sum is more than twice as much as the capital invested in all manufactures. There is one half more horse-power used on American farms than in all our factories. When we think of the large number of persons who secure their living by farming, and the large number of other persons who are employed in factories which use the raw materials from the farm, we begin to realize the enormous values that are involved in the business.

Problem 13. What proportion of the people in your locality are farmers? What proportion are engaged in manufacturing? What proportion are merchants? Which group, as a whole, has the most money invested in its business?

Problem 14. What farm products are shipped from your vicinity? What manufactured products? If we could put all the farm products together, would they have greater or less value than the manufactured products? The manufacturer makes his living by what he sells. Does the farmer make a considerable part of his living aside from what he sells?

Problem 15. Can you find out who was the first farmer in your locality and what kind of farm he had? Which are the oldest houses? Do they stand near the main road? If there are fences, which are the oldest and how are they built? Did the farmers in your locality always conduct the same kind of farming as now? Are there any evidences left by Indians to show that they once lived there?

Problem 16. Relate any history or historical incident that illustrates the agricultural development of your locality. Write an account of any of the leading former farmers of the locality.

Problem 17. In the old Indian days, when there was special farm work to be done, all the neighbors "joine and came in to helpe freely." Do the neighbors in your community ever do that now? Do you suppose that the threshing, or the husking bee, or the barn raising, has any resemblance to the way in which the Indians worked together? How many advantages can you name from such coöperation among neighbors?

Problem 18. Is there much new land that can be taken up for farming anywhere in America? When the land is all occupied, how are we to raise the larger crops that will be needed? Is there any land on your father's farm that is now idle but might be used for farming if drained or irrigated or otherwise improved? How can your father make his farm produce more without buying additional land?

CHAPTER IV

THE FARMER

We have learned that farming is one of the leading industries in the United States and Canada. It is worth our while to become acquainted with the man who, on his own farm, master of his work, makes it so.

What the farmer contributes. — There are three things we all must have in order to live, — food, clothing, and shelter. We may

Fig. 7. — The farmer is master of his work.

let all other possessions go, but these three are indispensable. Where can we get them except from the farm? All food (except that from the sea) comes originally from the farm, or at least from the land; silks and woolens, cotton goods and linen goods, all are made from animal and plant products raised on the farm; the wood for buildings is taken from the great farm, for trees are a farm crop, as we shall learn later. These necessities are what the farmer contributes to the nation.

Nature of the farmer's business. — Every man in the community has his business, his means of earning a living and of helping others to live. The farmer's business is to make an honest living from his farm, by the raising and selling of crops and live-stock, or their products. His business is very different from that of other men. He buys relatively little and usually does not sell the things that he buys. He produces the things that he sells, and brings to the market newly created materials. Even when he buys materials to sell, he multiplies them or increases their value. When he buys cattle to sell, he usually keeps the cattle until they are mature or

FIG. 8. — Stock is reared for sale.

fat; he makes his money largely on the feeding and the care that he gives them.

In some parts of the country, most of the farmers make their livelihood from selling butter and cheese; in others, from selling milk; in others, from selling corn; in others, from selling cattle and pigs to which the corn has been fed; in others, from cotton; in others, from vegetables or fruit or grain; in others, from flowers and nursery products. As in the village there are general stores in which one can buy almost anything he needs, and special stores in which he can buy drugs or shoes or clothing or jewelry, so there are general farms and special farms. One farmer may produce milk, eggs, fruit, grain, and potatoes for sale; another may produce only vegetables or cotton or wheat or fat stock for sale. The character of one's business, or farming, is determined by the kind of product he sells.

The farmer must make an honest living, — he must not rob his land. His success depends on the fertility of his land. As the manufacturer invests money to keep his buildings and machinery in repair, so the farmer must keep his factory, or his land, at its best so that he can have a permanent paying business. Time and money invested in keeping the farm in repair usually pay large dividends. The best farmers are the ones who apply business methods to their farming.

The farmer's year's work. — Nearly every day brings to the farmer a new task, calling for a different kind of effort and drawing on new powers. A progressive farmer must be a growing, broadening man, becoming more intelligent and more expert with the years. While he works with his hands, his mind will be active in solving new problems.

Every farm boy and girl knows that the farmer has his full year's work. In the winter, when the land is quiet, and while he is feeding his stock and perhaps getting out his wood, he becomes carpenter and mechanic as well as farmer, and repairs his buildings and tools and machines, and makes the many things that he has needed but has had to wait for. At the same time he is looking forward to spring and summer so that he may not be unprepared for them. If he is a careful man and takes stock of his business, now is the time when he will cast up his accounts and discover the real gains and losses and determine changes in his farming.

When the frost is out of the ground, and the warm days begin to come, the father and his son swing into the furrow behind good, steady teams and turn over great stretches of land for the summer's crops. Then follow the fitting, the seeding, the care, on to the harvest — the hay and the grain harvest, the corn harvest, and the apple harvest. And each morning and evening, as the sun rises, and before it sets, the cattle may be driven to the barn, milked, and returned again to pasture. If the man is a grain farmer alone (as in some parts of the west and of California), he may take a vacation after the harvest.

As the autumn advances, and the crops are securely stored for the winter or sent to the market, when the slaughtering is past and the smoke-house closed, and perhaps a few acres have been plowed so as to be ready for the spring, the farmer has the sense

FIG. 9. — The farmer swings into the furrow behind a good, steady team.

of satisfaction in the work of his hands. But he is not through. To-morrow will have its tasks. He is ready for them.

Problem 19. What does your father's farm contribute to the community? What kinds of food products does your father sell? Does he sell any product that is manufactured into clothing?

Problem 20. Go to the grocery store and look over the stock on the shelves. How much of the grocer's stock came originally from the farm? How much of it might have been produced in your locality? What would become of the grocery if the farms should cease to produce? What would the people in the villages do if the grocery store had to close? Are the people dependent on the farmer?

Problem 21. If any of the farmers in your locality keep sheep, what is done with the wool? What farm crops enter into the making of cotton goods and linen goods? How many things kept in a clothing store do you suppose are manufactured from animal or plant products?

Problem 22. How many buildings in the locality can you name that were built from lumber taken from the woods in the vicinity? Is there any kind of factory in the vicinity which uses the wood from the farms? Does your father use wood from his farm, either for his own buildings or to sell? How many of the three necessities of life does he produce? Do some of the farmers in your locality produce all of them?

Problem 23. Does your father keep an account of his farm transactions? How much did he get for his wheat last year? For his hay? From his cattle? Do you know how much it cost him to produce any of these?

Suppose your father has 12 acres of meadow land that yield one ton of hay to the acre, and the hay will sell for only $9 a ton. How much will he receive for his crop? If by investing $20 in fertilizers he is able to increase his crop to $1\frac{1}{4}$ tons per acre, and get a better grade of hay that will sell for $12 a ton, will it be a good investment? If so, by how much? How much interest will he have made on the $20 investment?

CHAPTER V

THE FARM

THE farm is the farmer's place of business. It is the means by which he earns his living and contributes his part to the community. There are buying and selling here. There are production and distribution. The farm is a commercial establishment.

The farm establishment. — In our grandfathers' time, not only were food and materials for clothing produced on the farm, but here, also, the finished products were manufactured. Those were the days of homespun. Now manufacturing is largely a distinct business, and the farm provides merely the raw materials.

Yet we may say that the farm is the greatest of all factories, for it yields new materials that can never be created by machines made by man. The farmer plants his seed, gives it care, and the great soil-and-air factory slowly but surely turns out its wonderful products. And it yields its products, not one at a time, but in numbers too great to be counted.

There are three elements or parts to every farm that must be considered in making a plan for the business, — the home, the farm buildings, and the land.

The home. — Farming is practically the only business of which the home is a part. In nearly all other occupations, the man leaves the home and goes to his work or his business in the morning, and returns home at night, leaving behind the affairs of the day. The farmer lives with his business. The home, therefore, is an essential part of his business, and must be so ordered as to help him; and he must take it into consideration in all his plans for his work.

The farm buildings. — We are likely to judge a farm by its buildings, for they generally reveal thrift or carelessness on the part of the owner; and they are a fair test, for they indicate the farmer's care for his crops and his animals, although the farm may not be profitable in proportion as the buildings are attractive. Good buildings are a help to the farmer, not only for the comfort they bring to his live-stock and for the protection of his harvested crops, but also because they teach order and care and pride. While we may judge of the buildings by their exteriors, it is even more important that the interior, where the stock live and the tools and supplies are kept, be clean and convenient and well-arranged. The health of the animals and ease in doing the work depend on the interior arrangements.

FIG. 10. — We are likely to judge a farm by its buildings.

The house and the farm buildings are part of the farm investment, and they must yield returns to the farmer in good and long-continued service.

The land. — The land is the most important part of the farmer's investment, as it is to give him his living and yield his largest returns. It is his most valuable trust, and must be carefully safeguarded, not only for his use, but also for the use of all who will come after him. The value of a farm to the community depends on the land and the use that is made of it. The land largely determines the kind of farming that is to be done, the products that are to be sold, and the work the farmer has to do.

The plan of the farm. — Any business, if it is to be successful, must be well organized. This is especially true of the farm because of the distances that must be traveled in doing the work. The

Fig. 11. — Negro farming in the south.

farmer should organize or lay out his farm so that he will have the least travel in doing his work, as travel takes time and time costs money, and traveling consumes energy. He must be able to reach all his fields in the most direct way, to avoid long hauls. He places the garden nearest the house because it is most often visited. The barns and pens also are generally near the house, as the farmer must go to them very often to care for his stock. They should be placed where they can be reached most conveniently both from the house and from the fields.

Some parts of the farm are better adapted to the kinds of crops the farmer wishes to grow than are others; the soils, elevations, exposures, and other natural features are different and must be taken into account in laying out a plan for the farm. The size and shape of the fields must be considered in connection with the rotation of crops that is to be followed. The size of the fields will also affect the ease with which the work may be done and the kind of machinery that may be used. The farmer may have to contend with creeks, woods, hills, or other natural boundaries in laying out the fields on his farm.

It is just such factors that make a farm plan necessary. The farmer must include every part of his farm in his plan, so that it may all be used, year after year, for the largest return at the least expense, and without lessening the fertility of the soil. The way in which he subdivides and organizes his farm, therefore, determines in large measure the success of a man's farming.

Attractiveness of the farm. — Our lives are greatly affected by the conditions in which we live. No boy or girl cares to live in a run-down, unattractive place. One slovenly farm is a blot on the neighborhood. As the farm is the farmer's permanent home, where he, his wife and his children are to live, it should provide as much beauty and attractiveness and homelikeness as possible. And no man has the means to make his home surroundings more delightful than has the farmer. Simple planting, in good taste, and a neat and picked-up appearance are the first steps. This is work for boys and girls that will quickly show results. An attractive farm contributes more than merely its products to the community; its own influence for order and neatness is worth while. Better men and women should grow up in neat, attractive, healthful surroundings.

Health on the farm. — The farm should provide the most healthful surroundings, since it can supply room, sunlight, fresh air, good food, and exercise. But sometimes the farmer takes all this for granted and becomes careless; and without care, the farm can soon become a most unhealthful place. Neglect is sure to bring disaster. There are many ways in which disease may enter; one is through the water-supplies, and the farmer must be on his guard against such dangers about his home. Every farm should have a complete water-system, with provision to carry off the waste. Proper sanitation is as necessary on the farm as in the city, and it is not impossible, and frequently not difficult, to secure. It is wiser to provide for health than to fight disease. Very many of our men and women of the future will, as in the past, come from the farms; and they will accomplish their part in the world's work better if they bring vigorous, healthy bodies to their work.

We have learned that many diseases are spread by the common house fly, — that this little insect is one of man's worst foes. Its chosen breeding place is in manure piles and about horse stables. One of the first steps toward making the farm a healthful place is to screen the house against flies, and to keep the horse stables clean and the manure drawn to the fields.

Problem 24. How large, in acres, is the farm on which you live, — your father's place of business? What is the shape of it: oblong, square, irregular? In what direction does the long way of it extend? How is it subdivided? An outline sketch or map, made by simple lines, will help you to understand the farm. Perhaps your father has a plan of the farm; if not, you can help him to make one. Has the farm a name? If you do not live on a farm, secure similar information from some person who does live on one; or, better, if possible, visit the farm and find the information for yourself.

Problem 25. Is the farm uniform (practically all alike) throughout? Explain whether it is level, hilly, or swampy in parts. Tell whether there are brooks, ponds, rocks, or other natural features.

Problem 26. Explain what is chiefly produced on the farm. Also, whether any of the farm is in woodland; whether any of it is in waste or not in use; about how much is "under the plow"; how much is devoted to each kind of crop that is raised.

Problem 27. Are most of the houses on the farms as well kept as those in the village? Are most of the farmyards as neatly planted and kept as those in the village? If not, how can we make both house and yard more attractive than any in the village?

Problem 28. Write a short essay on how the health and the attractiveness of your home can be improved. Number the different items, putting first those things that can be done now and following with the others to be done throughout the year. Keep the paper to discuss with your teacher and your father and mother, and to check off the items as you have the improvement made at home. See how long a list of improvements you can make in one year.

Problem 29. Is there much sickness on your farm? What is the cause? Is the well below the barnyard so that there may be drainage into it? If you have not a water-system in the house, how could you get one?

Problem 30. Give what history you can of the farm: when it was first made into a farm; from whom the first farmer procured it; who has owned it from first to last; whether any unusual events or persons are associated with it; when the house was built, and whether any other house was on it before this one; by whom the house and the barns were built; who dug or drilled the well; what has become of the persons who occupied the farm in the years that are past.

CHAPTER VI

THE FARM PLANTS

PLANTS and animals are the products of agriculture. Plants are raised for food, clothing, shelter, for the farm animals, to supply materials used in the arts, or merely for pleasure. The plants make it possible for the animals to live, and both are necessary for our food-supply.

Plants are grown for food. — A variety of plants must be grown for food, some kinds to be cooked and others to be eaten just as they come from the field or garden. The housewife goes to the garden to get potatoes and turnips and tender sweet-corn and green peas to cook, and onions, radishes, and lettuce to eat fresh and crisp. The farmer must supply equal nutritious and appetizing foods for his live-stock. If they are to do the work for which they are kept, they must have a variety of good, attractive food. Cattle like clean timothy, clover, and alfalfa hay, and hearty foods, as corn and cottonseed meal and gluten meal, and juicy or succulent foods, as corn silage, sugar-beets, and mangels. Generally, the larger part of the crops grown on a farm, except in parts of some of the southern states, are to be used for human or animal food.

For manufacture. — Many farm products are of little use in the form in which they are harvested, and must be sent to factories where they are changed and made into other forms or materials. Cotton is made into cloth, and flax into linens or binding twine; hemp is manufactured into burlap, twine, and carpet warp. From sugar-cane and sugar-beets, sugar and molasses are made. From potatoes, starch is manufactured. Some plants are grown for medicine, some for oils or extracts, some for spices, some for per-

Fig. 12. — Sugar-cane is grown for manufacture.

fumery, some for dyes. In some countries, plants are grown specially for paper making.

For building. — Other plants are grown for building purposes. They are harvested in the woodlot or the forest. They are of many kinds: some are hard, others soft; some of one color, some of another; some grow large, and make long, clean lumber, and others are small and knotty. Because of these differences, these plants serve a great variety of purposes in building.

For pleasure. — Another group of plants is raised solely for pleasure, — because the plants are beautiful or fragrant, and make the home or garden attractive. They are usually flowering plants, but not always. They are grown close by the house, or at the sides or corners of the lawn, or apart in carefully kept beds. They may be grown in glass houses or as field crops to be sold. The florist is a farmer, because he raises plants.

Relation of plants to soil fertility. — If the farmer is to secure the best results from his land and keep it fertile, he must grow a variety of plants. If one crop is grown continuously on the same land, the productiveness of the soil will be lessened. Many cotton plantations in the south and wheat and corn farms in the west yield much less now than formerly because one crop has been grown continuously. When several kinds of crops are grown in succession, or rotation, the demands on the soil are varied; and in the rotation some crops may be grown to turn under and enrich the soil. Returning to the soil plants or parts of plants, or adding vegetable matter as we say, is of very great benefit, as we shall learn later. As plants helped to form the soil in the first place, they are valuable in renewing it when turned back into it.

Certain kinds of plants, called legumes, as clovers, vetches, cowpeas, soybeans, and alfalfa, are especially useful in enriching the soil when plowed under.

Relation of plants to climate. — There is still another reason why different kinds of crops are grown in different localities. The

FIG. 13. — Plants may be raised solely for pleasure. Iris.

plants must be suited to the climate. Some crops demand a long growing season, while others prefer a short season; some require a hot, dry climate, others a cool, moist climate; some need much rainfall, others little. The plants that we grow must be suited to the climate of our region. A few miles to the north or south the same plants might not do well at all. The northern farmer does not attempt to grow cotton or sugar-cane or peanuts or oranges. The southern farmer plants no buckwheat and but little rye or oats, or root-crops for live-stock. There are different varieties of wheat and corn for the north and for the south. Each region has its own varieties of crops.

Relation to farm work. — The kinds of plants that the farmer raises bear a close relation to his work. If he raises garden vegetables or flower plants, which demand constant careful attention, we say that his farming is intensive. If he grows great areas of wheat or corn or sugar-cane, and gives little attention to the individual plants, we say that his farming is extensive. With such large areas he seldom can give much care to the separate plants, except in fitting the soil, planting, and harvesting.

The hay-farmer has his busiest season in mid-summer; the orchardman in late winter and spring with his pruning and spraying, and in the fall with his harvesting and marketing. The work of the stock-farmer is different from that of the crop-farmer, as he markets a different kind of product; that of the rice-farmer and the poultry-farmer is different from any of the others.

The vegetable-gardener, using his land intensively year after year, must apply much fertilizer. The extensive farmer usually cannot afford to invest so much in fertilizer, and must renew his land by crop rotation and the plowing in of vegetable matter or cover-crops.

Plant societies. — Plants have associates and grow in societies. They must live together and get along together, just as folks must do; and to do so, some must yield the best places to others. Plants become accustomed to one another. Some can live in the shade, plants must be suited to the climate. Some crops demand a long growing season, while others prefer a short season; some require a hot, dry climate, others a cool, moist climate; some need much rainfall, others little. The plants that we grow must be suited to the climate of our region. A few miles to the north or south the same plants might not do well at all. The northern farmer does not attempt to grow cotton or sugar-cane or peanuts or oranges. The southern farmer plants no buckwheat and but little rye or oats, or root-crops for live-stock. There are different varieties of wheat and corn for the north and for the south. Each region has its own varieties of crops.

Relation to farm work. — The kinds of plants that the farmer raises bear a close relation to his work. If he raises garden vegetables or flower plants, which demand constant careful attention, we say that his farming is intensive. If he grows great areas of wheat or corn or sugar-cane, and gives little attention to the individual plants, we say that his farming is extensive. With such large areas he seldom can give much care to the separate plants, except in fitting the soil, planting, and harvesting.

The hay-farmer has his busiest season in mid-summer; the orchardman in late winter and spring with his pruning and spraying, and in the fall with his harvesting and marketing. The work of the stock-farmer is different from that of the crop-farmer, as he markets a different kind of product; that of the rice-farmer and the poultry-farmer is different from any of the others.

The vegetable-gardener, using his land intensively year after year, must apply much fertilizer. The extensive farmer usually cannot afford to invest so much in fertilizer, and must renew his land by crop rotation and the plowing in of vegetable matter or cover-crops.

Plant societies. — Plants have associates and grow in societies. They must live together and get along together, just as folks must do; and to do so, some must yield the best places to others. Plants become accustomed to one another. Some can live in the shade, as in the orchard or in the forest; and since they cannot rise into the sunshine and wind and storm, they are content with the cool, moist, quiet protection that is given them by their superiors. The pumpkin vines yield the sunlight to the tall corn, which is a sun-loving plant, and in its shade live their lives largely unnoticed until harvest.

Fig. 14. — Plants have associates. Corn and cowpeas.

Different kinds of soils and locations are associated with different plant societies. In the hard-tramped door-yard there is a society of knot-weed and broad-leaved plantain, with occasional blades of grass and dandelions; in the fence-row there is a society of briars and choke-cherries and hiding weeds; in the dry, open field the wire-grass and mullein and scattered docks associate; in the old pasture the blue-grass and mullein and daisies and devil's paint-brush live together; in the meadow there are timothy, the lower-growing clover, young grasses, and other plants among the grasses.

Some plants associate only with certain others. Cockle associates with wheat, not with oats or corn. Peas and oats will abound in the same field; timothy and clover, corn and pumpkins, barley and peas, cowpeas and sorghum or millet, are close companions and will share a field together. This association may be due wholly to the fact that the plants are adapted to each other's manner of life, or that one (as the cockle in the wheat) ripens at such a time and has seed of so nearly the same size as will allow it to pass unnoticed with the other in the planting.

The farmer takes advantage of plant societies and companions in planning his system for planting his crops.

Problem 31. Why is one kind of farming in your locality different from another? What kinds of crops does the dairy-farmer grow? What does he market? What kinds of crops does the fruit-grower raise? Does he market anything except fruit? What crops does the stock-farmer or the grain-farmer grow?

Problem 32. Are all the crops on your father's farm grown to sell or to feed? Are any grown to turn under to enrich the soil? What kinds? Why are these kinds better than others for this purpose?

Problem 33. Do all of the farmers have their busiest seasons at the same time of year? What is the busiest season on your father's farm? Why? Which kind of farmers have to work the greatest number of hours in the day — the dairy-farmers, the fruit-farmers, the stock-farmers, the grain-farmers, or the general farmers?

Problem 34. What kinds of work are done in the dull season on your father's farm so as to lighten the work during the busy season? On the best farms in your locality are the farmer and his help busy during the dull season and on the rainy days?

Problem 35. How many different kinds of plants are growing in your meadow? How do they behave together? Which ones seem to be leaders? How many kinds of plants are in the pasture?

Problem 36. Does your father mix two or more kinds of seed for any of his crops? What seeds does he put together? Why? How do the different kinds of plants share the ground when they are growing? Some of the crops that are sown together, as oats and peas, must be harvested together; others may be harvested separately. What makes the difference? What companion crops can you name?

Problem 37. Write the story of the crops raised on your father's farm or any other farm you may know about — name the plants that are raised for food, or manufacture, or building, or pleasure. If any are manufactured, tell how, and into what they are made.

CHAPTER VII

THE FARM ANIMALS

WHEN man was yet in a savage condition, he captured animals from the wilds and made them his slaves. He lived largely by hunting, and the meat of wild beasts formed much of his food. As he came to live a more settled life, he gradually hunted less and produced more of what he required. This made it necessary for him to domesticate wild creatures for work, for food, and, later, for clothing.

The source of farm animals. — When once wild beasts were domesticated, it was possible to modify them so that they would more nearly meet the needs of man in a settled life. Thus, the earliest ancestors of all farm animals lived originally in the wild. They were different in appearance and usefulness from our farm stock to-day, which have been gradually brought into their present condition through years of domestication and care.

Nearly all our farm animals were brought to this country from the Old World. Most of them had been domesticated before the new era. The turkey is the only one domesticated from wild ancestors in America. The bison can be domesticated, and some persons are now endeavoring to develop a new race of useful farm animals from it. There are other wild beasts that some day may become part of our regular farm stock.

While there are many wild beasts that might be useful if domesticated, the number of kinds that have been domesticated is not great. Those common to the farm are horses, cattle (oxen, dairy and beef cattle), sheep, hogs, goats, chickens, ducks, geese, turkeys, guinea-fowl, pigeons, silkworms, and bees. Mules have been used as draft animals from very early times, but they were not domesticated from a wild condition. They are produced by the ass or jack and the horse. In the southwestern part of the

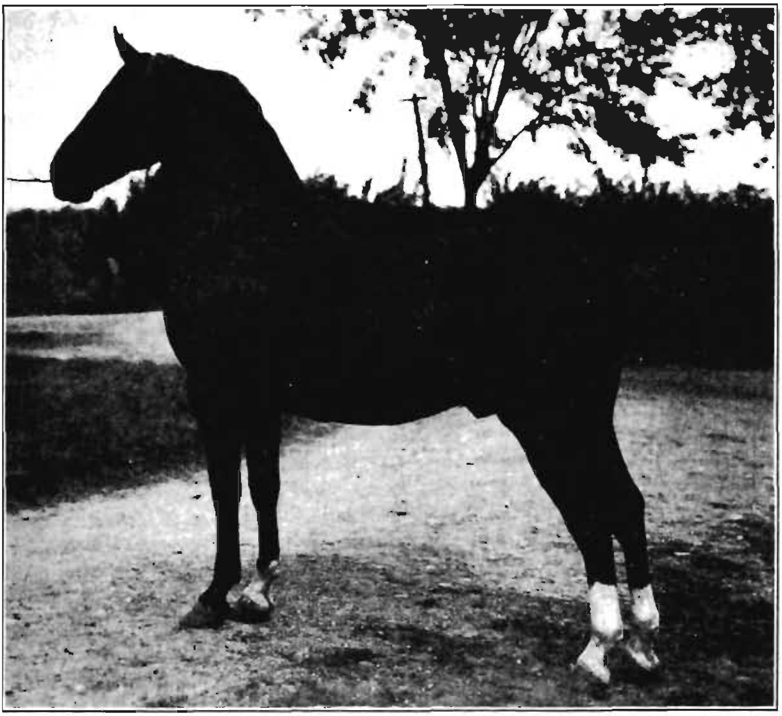


FIG. 15. — Coach horse. Animals may be developed for refinement and beauty as well as for service.

United States there are a few ostrich farms. Occasionally a farmer will raise only pets for sale, but pets are not usually classed as farm animals.

Animals are necessary. — Live-stock is as essential a part of the farm as are the crops. Animal food products, such as meat, milk, butter, and eggs, are equally in demand on the market with plant food products. It would not be possible to farm large areas if there were not animals to help bear the burden of the work, even with all our machinery.

The savage used the skins of wild beasts for clothing before he learned how to weave; and to-day many of our finest and warmest clothes are made from animal products. Man has always enjoyed the companionship of animals, and some are raised for this purpose alone.

Animals are reared for food. — If the human race had depended on hunting for its meat food, we should long ago have destroyed all

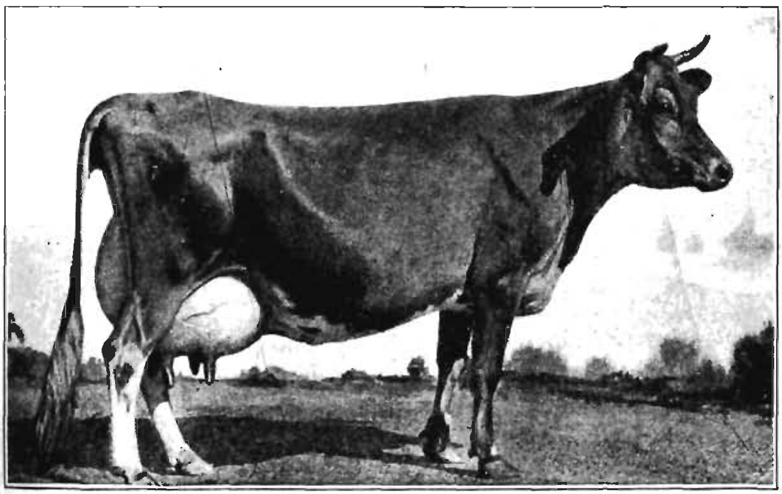


FIG. 16. — Jersey cow. Many generations of domestication and care have been required to bring farm animals to their present form and usefulness.

our wild animals and the demand would not have been satisfied. Large areas of land, great stores of crops, and the time of countless numbers of men are required merely to raise the live-stock necessary for food purposes. Nearly every farm keeps some stock.

To fill the demands for meat, great cattle ranches were established on the western plains. Gradually these great ranches are becoming less numerous, and more attention is being given to the rearing of live-stock on the smaller farms.

Steers, sheep, hogs, and poultry contribute to the meat supply. Equally important, also, are their products, milk, cheese, butter, eggs, wool, and lard.

Many farm crops cannot be eaten in their raw condition by man. When fed to the farm stock they are changed into forms in which he can use them. About 80 per cent of all the corn raised in the United States is fed to domestic animals. Hay and much of the grain and root-crops are made of use to man only by feeding them to animals.

For work. — The Indian in America made little progress because he had no beasts to do his work. It was not until animals were enslaved and trained to bear the heavy part of the work that farming was possible on a large scale. The slow-going but steady oxen lightened the labor and made it possible to farm larger areas. To-day horse-power is used everywhere on our farms, and horses are a necessary part of the farm equipment. One horse, well directed, can do as much work as ten men.

For clothing. — The fur-bearing animals of North America meant as much to its early inhabitants as do all the flocks and herds of the present day to us. It was the chase and the barter for pelts that drew many of the earliest European adventurers across the ocean. We are still dependent on wild animals for some of our finer pieces of clothing. The fur of the beaver, buffalo, seal, opossum, raccoon, skunk, red fox, silver fox, rabbit, muskrat, mink, marten, otter, ermine, bear, and others, secured by hunting and trapping, brings high prices in cities for use in clothing.

Woolen goods are made from the fleece of our common sheep. The raising of sheep for their fleeces for manufacture into clothing is now one of the great farm industries in America. Mohair is made from the hair of the Angora goat.

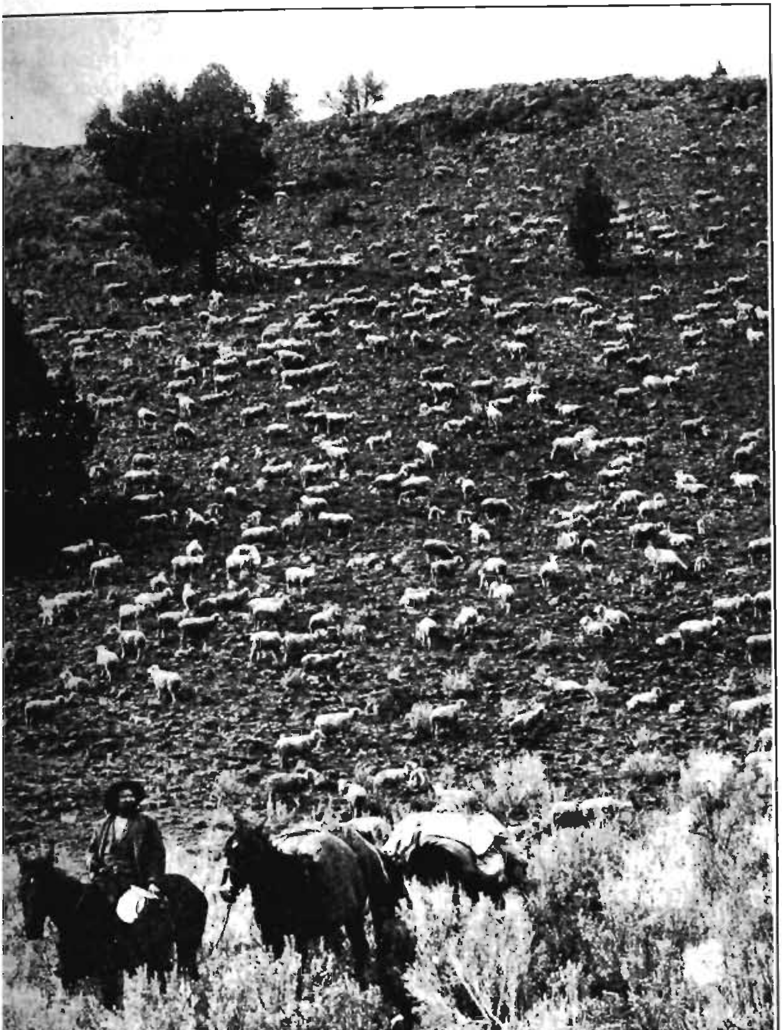


FIG. 17. — Sheep may be pastured where the plow cannot go. Semi-arid west.

There is another very small domesticated animal that helps to supply our clothing; that is the busy little silkworm. Its original home was probably in China, and China has long enjoyed a wide reputation for its fine silks. The early colonists in Virginia, South Carolina, and Georgia engaged in this industry to a limited extent and since then a small amount of silk has been produced in this country. At the present time the United States Department of Agriculture is trying to encourage again the raising of silkworms in the southern states.

For soil fertility. — An old Flemish proverb reads:

"No grass, no cattle,
"No cattle, no manure,
"No manure, no crop."

This ancient proverb is just as true to-day, — there must be grass to feed the cattle, cattle to produce manure, manure to enrich the land so that more grass can grow. Without some kind of fertilizer, crops cannot long be grown successfully. The farmer has learned by experience that if he raises crops year after year without enriching his land, the soil will lose its crop-producing power, and he will secure small returns.

One of the best means of keeping the land fertile is by spreading on it animal manure. Such manure is in a condition to be used quickly by growing plants. The farm boy knows that his father is careful to save all the barnyard manure for the land, and that he spreads it where he wants to raise large crops. Farm animals are reared for the sake of our soils as well as for other purposes.

Relation of animals to kind of farming. — The farmer who keeps live-stock organizes or arranges his work very differently from one who grows fruit or vegetables. He raises crops to be fed to stock, and he sells the stock or its products instead of the bulky crops. He must have large storage barns to hold his winter's feed. He markets his products at *different times and in different ways from* the crop-farmer.

The live-stock farmer can use land that otherwise might be wasted, *that is not suited for growing crops,* — land next to streams, or that is partially covered with trees, or that is too hilly or too stony to cultivate; and he can utilize much wild or native grass land for grazing. Sheep may be pastured where the plow cannot go. Farm animals also use parts of plants that otherwise would be wasted, as straw, corn-stalks, and grasses.

A better rotation of crops, and consequently a better use of the land, can be had when animals are reared. More land can be kept in grass and clover, so that less plowing will need to be done; and the fertility of the soil will be maintained by the return of the manure to the land.

When live-stock is reared, the farm help is busy all the year. This is a mark of good farming. The exclusive wheat-farmer sows his grain in April and May (in the spring-wheat regions), harvests and threshes it in July and August, and has little work for himself, his men, or his teams the remainder of the year from September to April. The stock-farmer raises crops in summer, when the cattle are at pasture, and in the winter is busy caring for his animals *when they must be fed indoors.*

Problem 38. Is there any hunting in your locality? What do the hunters find? What kinds of game are used for food? Are any used *only for clothing purposes?*

Problem 39. How many kinds of animals are raised on your farm for food? How many for work? For clothing? For companionship? Name all of the different kinds of animals, so far as you can, that are *useful in different parts of the world.* Perhaps your geography will help you to name them. Tell which are used for work, which for food, and which for clothing.

Problem 40. Do any of the farmers in your locality keep sheep? Where do they pasture them? What becomes of their products?

Problem 41. When does your father haul out his stable manure? Where does he spread it? Why? *If he does not keep stock,* does he buy any farm manure? Does it pay him to buy it?

CHAPTER VIII

THE FARMER'S AIDS

THE American Indian lived such a simple, free life, subsisting by hunting and a little planting, that he had need for few outside helps in his domestic life. The farmers in colonial days had their school and their church, but did not feel the want of many other aids. The farm was often the home, the store, and the factory, all in one. Farming meant little more than to clear the land and to raise enough to live on, with some surplus for near-at-hand barter. There was little world market to be reached.

Kinds of aids. — With the growth of towns and cities, with a division of labor, and the necessity for providing food-stuffs for the new nation, a need arose for special aids in farming and marketing. The complex life of to-day makes it necessary for the farmer to have many kinds of aids.

As many different aids must be provided for the farmer as there are special needs to be met. There must be schools and churches to encourage education and religion; good roads and railroads to enable the farmer to place his products on the markets; telephone and mail service; opportunities for comparing the farmer's products and skill with others, as in country fairs and exhibitions; and means by which the farmer can coöperate with his neighbors to do work in which all should have a part, and to bring them together for pleasure and visitation, as in farmers' clubs and the grange and the creamery.

The country school. — The school is one of the most valuable aids that the farmer has. His children must be well trained and be able to think and to plan clearly and carefully if they are to make farming as attractive and useful as it is possible to make it, and so that it will equal the best in city life. The schools help to develop the mind; and a trained mind that can meet problems and solve them is equally necessary if one is to be a good business

FIG. 18. — A country school.

man, a lawyer, an inventor, a mechanic, a home-maker, or a farmer.

Country schools are established to give boys and girls who live on farms the privileges of an education. They are now beginning to teach about the farming industry as well as other subjects. We are to study agriculture in our schools as well as history and arithmetic and grammar and geography. We need to study all of these subjects if the people are to be well educated. And we shall study advanced agriculture in the high schools as well as advanced arithmetic and history and language. When we reach the college of agriculture, we shall receive special training in the affairs of agriculture so that we shall be expert in our work. Men have studied agriculture, just as they have studied medicine and mechanics, and there is a great deal that may now be learned about farming by a careful study of the subject. The farmer will find the school of increasing value to him in the future. Although he once lived without special education in farming, he can no longer expect to do so and be successful.

The country church. — Many of the early settlers came to America in order that they might "worship God according to the dictates of their own conscience." The church had an important part in the colonization of America, and, in some neighborhoods at least, the family that never attended church was the great exception. It established itself on the very frontier, a pioneer that amid great trials pointed the way to high standards of living and hopefulness. It has always been an important agency in farming regions, and to-day is found in nearly every community. Good farming is only part of good living, and the church stands to inspire men to their highest character and usefulness.

Transportation. — The farmer is especially dependent on means of transportation, as the products which he raises must frequently be placed on a distant market, and are not usually sold in any large quantity near home. In the early days in America, long-distance transportation was brought about by means of water-routes and stage-lines; the turnpikes were few, the common roads almost impassable, and stage-coach travel was costly and very difficult. With the coming of the railroad about 1830, new opportunities opened before the farmer, for then he could readily dispose of his surplus products. To-day the country is covered by a net-work of railroads and electric trolley lines, and there are great transcontinental railroads that speed the farmer's products from one end of the country to the other and place them on the market at just the right time. All this has made great changes in farming. Good means of reaching the markets are nearly as important as the ability to raise good products.

But railroads, trolley lines, and water-routes cannot reach all farmers, so that good wagon-roads must be provided. The farmer uses the wagon-road every day, going to and from the village, railroad station, or boat landing. If the roads are poor,

FIG. 19. — Water transportation of truck crops.

he can haul less, it will take more time, cost more for teams and wagons, and altogether be expensive transportation. With good well-kept roads, he can do his hauling quickly and easily. He will travel more, see his neighbors oftener, and go to the village more frequently to get what he needs.

The telephone. — About twenty-five years ago the telephone was a curiosity and a plaything. To-day it is an indispensable means of communication. It enables the farmer and his wife to keep in touch with their neighbors, so that they are no longer isolated, and they can become acquainted quickly with whatever is taking place in the community. The doctor can be reached without the long drive to the village; farm hands can be called together; when the thresher is to come, the farmer in a few minutes can arrange with his neighbors for exchange of help, instead of traveling about all day to do so. The telephone can be used in all sorts of weather, at all times of the year, and at all hours of the day.

In some places the daily weather reports are sent to all farmers on the line at noon, and at six o'clock a general report on the conditions of the market. With such information the farmer can more readily plan his work for the next day, as he knows what kind of weather to expect; and if he has a few tons of hay or a load of hogs to sell, he will know when to reach the market to secure the best price.

FIG. 20. — The farm home receives its mail daily.

Mail service. — Until within a few years, the farmer had poor mail or postal service. To secure his mail, he had to drive to the village, often miles away, frequently over poor roads, or else depend on the slow stage-route. He had either to neglect his work on the farm, and go to the village whether it was convenient or not, in all sorts of weather, or else not have his mail. Often he chose the latter, and as a result was out of touch with affairs outside of his community. He wrote few letters, because it was as hard to send them as to go after the replies.

In 1896 the United States government instituted rural free delivery of mails, and to-day most farming districts have this service. In 1911 there were about 41,559 carriers who reached 18,746,550 persons on farms, and the government spent $37,130,000 to render this aid to farmers. Now the farmer has his mail daily, may send and receive letters regularly, has his daily paper, and is in close touch with the affairs of the nation. He is now in need of an extension of mail service by means of a post carrying large parcels as well as letters and journals.

The country fair. — The country fair is intended to be a place where the farmer may bring his best stock and crops for comparison with his neighbor's, where he may learn how to raise better products, see the latest farm machinery, and meet his neighbors for visitation and sociability. The fair was established as the farmer's holiday, when he should meet other farmers and show the results of his own work, and listen to addresses by leading men. To-day the fair in many country districts is not much help to the farmer, because a multitude of amusements and so-called attractions have crowded out his own part; but some day, when there are more grown-up boys and girls who know what a good country fair should be, it will be restored to its original purpose and be a real help to the farmer.

It is interesting to know that as early as 1796 George Washington desired to have agricultural fairs. A fair was held in Washington, D. C., on October 17–19, 1804, and was repeated in the following April, when premiums were offered. Soon after, other fairs and "cattle shows" were held throughout New England and in the middle states, and this kind of farmers' exhibition and social gathering became a regular occurrence.

Farmers' clubs. — The farmers' club, the agricultural society, and the grange represent still another kind of aid for the farmer. They afford him opportunity to meet with his neighbors and and talk over farm and neighborhood questions. Sometimes the clubs establish telephone systems and fire insurance companies;

sometimes they undertake to breed better animals or better crops in the locality, and to secure better machines; sometimes they help the farmer to buy his seeds and fertilizers, and to sell his surplus products; and sometimes they provide large storage houses for his products, as in the case of *coöperative grain elevators.*

The earliest farmers' clubs were formed about the same time that fairs were first held. There are now many thousands of them. Nearly every farming community has at least one. When persons work together they are likely to secure better results than when they work alone.

The creamery.—Agricultural fairs and farmers' clubs are means by which farmers are able to work together. The creamery and the cheese factory are other important means of coöperation. They are useful in many ways. Farmers can send all of their milk there, and not have to manufacture its products themselves; larger quantities are used in the manufacturing, and consequently less expense is necessary; the product is uniform, or just alike, from day to day, and will sell better; it can be shipped in large quantities, and thus at less expense for transportation. Farmers can have their milk tested here, so that they may know which cows are good and which are poor, and so get rid of the poor ones. The creamery should teach cleanliness in handling milk, promptness, good business methods, and the principles of coöperation.

Public agricultural institutions.—The people maintain a Department of Agriculture at Washington as a part of the government of the United States (the chief of which is Secretary of Agriculture in the President's Cabinet), and a college of agriculture and an experiment station in each state; and in most of the states there is a department of agriculture. In Canada, there is a Minister of Agriculture for the Dominion, and departments of agriculture in the provinces. There is a Dominion experiment station at Ottawa, with branch stations in the provinces. There are also several provincial schools and colleges of agriculture.

Problem 42. Are there any boys and girls in your school whose fathers or mothers went to the same school, or to the old one before this was built? Name all the leading and successful men who have studied in your school, so far as you can.

Problem 43. How long has there been a church in your locality? Ask your parents whether they can remember any time when there was not. In what ways is the church useful in the locality?

Problem 44. How many different kinds of transportation does your father use in carrying his products from the farm to the market? Which kind costs the most? Ask your father to tell you how his grandfather marketed his crops.

Problem 45. Why are the roads in your locality laid out where they are — that is, what determined the location of the roads? If you don't know, see whether you can find out.

Problem 46. Why is a good road a good investment? Where is the best section of road in your locality? Why is it better than others? Do some kinds of soil make better roads than others? What kind of road dries soonest after a heavy rain? What kind is heavy or sticky after a rain?

Problem 47. Suppose William's father lives eight miles from the station on a good state road, and John's father lives eight miles from the station on a poor road. If both men have to go to the station three times a week and it takes John's father, on the average, forty-five minutes longer each way to travel through the poor road, how much more will it cost him in six months (26 weeks), if the time of each man is worth 50 cents an hour? If John's father can carry only three-fourths as heavy a load each trip on the poor road, how many extra loads must he take to transport the same amount of stuff to the station as William's father takes in six months? How much more will it cost him to do the same amount of work as William's father will do in six months?

Problem 48. If in buying his farm on the poor road, John's father saved $1000, and put it in the bank at 5 per cent interest, did he make a good investment? How much money in the bank at 5 per cent interest would return the amount that William's father saves each year in hauling? William's father's farm is worth at least that much more to him than the farm on the poor road.

Problem 49. How many families on your route have their mail delivered at the gate? If the first ten of them had driven to the village once a week simply for the mail, how many miles, all together, would they have traveled that week? How far did the carrier have to drive in making one delivery to the first ten?

Problem 50. Write a brief essay on the things you saw at the last country fair that would help the farmer in some way.

Problem 51. Explain what farmers' clubs or business organizations are in the locality, and what they do for the farmers. If you do not have a boys' and girls' agricultural club in your school, write to the Office of Experiment Stations at Washington, D. C., and ask what such clubs do and how they are formed. Perhaps you will want one in your school.

Problem 52. Give the name and post office of the college of agriculture and the experiment station in your state or province. Is there a department of agriculture? Write to each of them and ask what kinds of bulletins they publish that are helpful to farmers. Perhaps they may have some on subjects in which you are specially interested.

PART II

THE SOIL

CHAPTER IX

WHAT THE SOIL IS

THE very thin, soft covering of the earth in which plants grow is called the soil. The farmer tills the soil in order that plants may grow better. It is marvelous that the soil can produce so many different kinds of plants. There is practically no limit to the number of varieties of plants that can be raised.

The nature of soil. — If we take a handful of good garden soil, we find that it is mellow, dark-colored, and moist. If we place it in a dish and heat it, the moisture will be driven off and it will become dry. If we heat it long enough, it will smoke a little, and we can see and smell that something in it is burning. This must be organic, that is, vegetable or animal matter, as mineral matter will not burn. We shall not see much change in size by the burning, which shows that there is little organic matter and that most of the soil is mineral. It is organic matter, or "humus," as it is called, that gives soil its dark, "rich" appearance, that makes it loose and mellow, and that holds much of the moisture.

If now we hold some of this mineral matter between our thumb and first finger and grind it, we shall discover that it contains small particles of sharp grit, which are sometimes hard enough to scratch even glass if rubbed against it. In a soil that is coarse and sandy, we can readily see these hard mineral particles; in a fine loam or clay soil, the particles can be seen under the microscope.

What the soil comes from. — It is evident that in some way mineral has been powdered to form the soil; and since minerals come from rocks, it is rocks that have been ground up. By pounding up a rock we can make the fine, gritty, mineral soil. When we grind the ax we add particles to the soil, the particles being in part from the ax and in part from the grindstone, and they are drained off in the muddy water. The soil specialist, or the geologist, when he has carefully examined the soil particles, can tell the kinds of rocks that have been ground up to make this soil, as sandstone, granite, limestone, or others.

Perhaps the underlying or bed-rock of the earth comes out on the surface of the ground in a field on the farm or near the schoolhouse; or there may be a deep cut somewhere near, which shows the layer of rock under the soil; or maybe a well has been drilled on the farm and there was difficulty in driving through the bed-rock. Everywhere, we find that the soil rests on the rock. In some places the rock shows on the surface, and in others it may be several hundred feet below the surface.

We read in our geographies that at one time the earth was probably a white-hot sphere, like the sun, and that in time the outer part cooled and formed a crust, or case, of solid rock. It is the surface of this rock that has been changed into soil. If we could sweep off all the soil, we should come again to the rock-crust.

If we examine the soil in a woodlot, we shall find it light and loose, and to contain more or less decayed leaves, twigs, roots, and trunks of trees. In the field or garden, we may find parts of plants decaying in the same way and becoming part of the soil. It is evident, therefore, that the organic matter, or humus, comes chiefly from the decaying vegetable matter that falls on the soil, grows in it, or is plowed into it. Some of it is formed also by the death and decay of worms, insects, and animals, which must be returned to the soil when they die.

How the soil is made. — We have seen in the woodlot and in the garden how the organic matter gradually decays to form soil. But how has the hard rock-crust all over this globe been changed into the fine mineral part of the soil? There must have been some powerful means, or agents, and much time must have been required. A close study of different kinds of soils will show that they have been formed by several means, chief of which are the

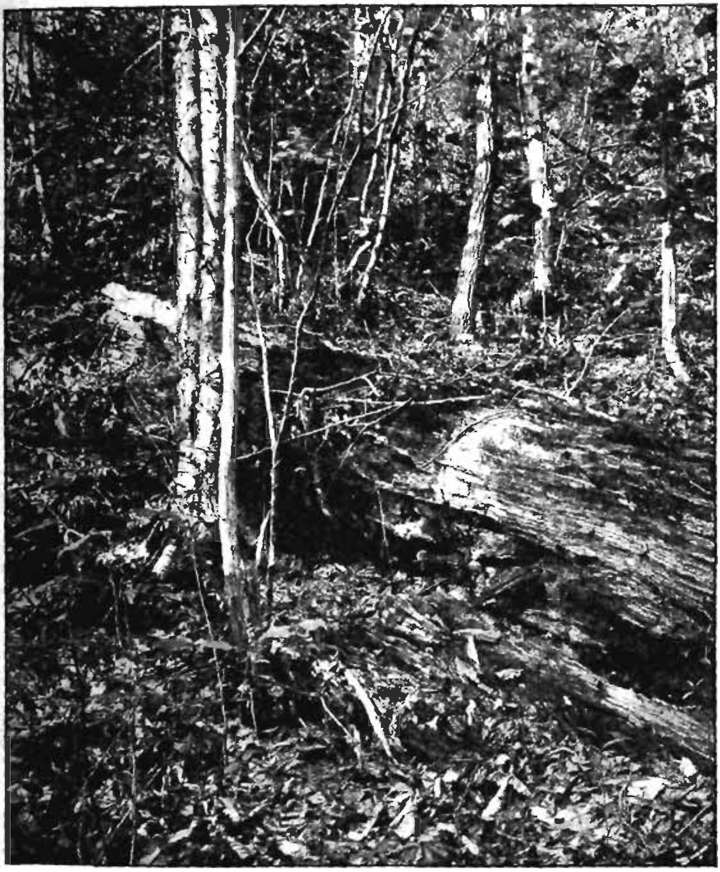


Fig. 21. — Year by year the forest adds its leaves, twigs, and decaying trunks to the soil.

in, the air, water, plants, and animals. We shall study the ork of each of these agents separately.

The work of the sun. — If we will examine several different kinds of rocks we shall discover that most rocks are made up of a mass of fragments or particles of many sizes and kinds. As the sun beats down on a rock during the day, the rock is heated and it expands.[1] As the fragments of minerals are of different materials, they do not all expand equally or in the same directions. Towards evening the air cools rapidly, and the rock also cools. Some of the fragments cool more rapidly than others so that uneven contraction, or shrinkage, is produced. This uneven expansion and contraction, day after day, gradually makes cracks in the rock, and may even chip off pieces.

This method of forming soil is most common in dry climates or where there are great extremes of heat and cold, as in New England and particularly in the mountain ranges in the West.

The work of air. — The air sifts into cracks in rocks wherever it can find an opening. Here it begins a kind of rock-decay which results in the crumbling of the rock. This action of the air is well illustrated by the rust on a stove pipe or plowshare that is left exposed to the air for some time. The rust is a decay of the iron produced by the air.

In arid or very dry regions, or wherever the ground is not covered with grass, the wind lifts particles of soil and hurls them against rocks on hillsides, gradually wearing away the rock and undermining it so that it falls over. This is called disintegration. The rounded and dome-like shapes in the hills and mountains in the western desert regions are largely formed from soil carried by the wind.

The work of water. — The water from rains also finds its way into the little crevices in the rocks, where it may freeze and force the

[1] Metals and minerals expand, or become larger or longer, when they are heated. When a railroad is laid, a short space is left between each two rails to provide for expansion or lengthening when the rails are heated by the sun or by the passage of cars over them. When minerals in a rock are heated they become slightly larger and crowd against one another. Different kinds of minerals expand different amounts.

cracks to open wider.[1] When ice forms in large cracks on rocky hillsides, it may break large pieces from the rocks and send them tumbling down below.

Water also dissolves rock, just as it dissolves sugar, but not so rapidly. The process is slow but it is sure. Think how the

FIG. 22.—The bed of a stream at low water. Notice the pebbles that have been worn smooth by being rolled about. Tiny bits that have been ground off have been added to the soil.

waves of the ocean dash against the rocky shores, and remember that there is "no rock so hard, but a little wave may beat admission in a thousand years."

Water nearly always contains a substance called carbonic acid,

[1] Water expands when it freezes. If we completely fill a glass bottle with water and fasten it with a strong stopper, and then set it where the water can freeze, the bottle will be broken by the expansion of the water in freezing.

and this greatly increases its power to dissolve rock. Very few rocks can resist the effect of such water.

After a rain the creeks and rivers are always muddy because of the soil that the water carries down from the hillsides. In the streams we may see small stones that are being carried along on the bottom, knocking against one another and rubbing off all the sharp edges so that they become smooth, round pebbles. The small particles that are chipped off are carried by the stream, together with the particles of soil from the hillsides, to the mouth, or where the stream overflows its banks, and there, where the water is quiet, are deposited as fine, soft mud. Perhaps we have seen this soft mud in the lowland where the creek has overflowed its banks during the spring freshet. Part of it is new soil ground from the rocks. In this way the deltas of rivulets, brooks, and rivers are formed.

The work of ice. — We have said that when ice forms in crevices in the rocks it forces them apart and may break off pieces. But ice has played a much greater part than this in the making of soils, in the work of glaciers.

FIG. 23. — A part of the edge of the Greenland glacier, showing its load of soil and rock.

A glacier is a slowly moving field or stream of ice, melting or breaking away at the outer edge or lower end where it comes in contact with the sea or reaches a warmer region. The accumulation of snow and ice on top of the glacier or at its sources pushes the mass of ice onward.

At one time the north temperate lands were covered by a great glacier that reached across our continent to the Rocky Mountains. At certain points it extended as far south as Pennsylvania, and in some places was a thousand feet or more in height. As this vast

FIG. 24.—Roots follow crevices in rocks and help to make them larger. Then water enters and freezes and splits the rock.

ice sheet moved gradually southward, it ground the rocks into powder, wore away the sides of mountains, and rounded off the hill-tops. It carried much of the soil and rock with it, and as it gradually melted, deposited its load by the way. With the melting of so much ice, great streams were formed, which carried away much of the finer soil and left the coarser and heavier sand, gravel, and pebbles as sand-banks or gravel-banks. Perhaps near your home there are such banks, left by the glacier, to remind you that it once occupied your region or farm, and that it had part in the making of your land.

There is now a glacier in Greenland covering an area more than ten times as great as that of New York State. It is slowly moving outward in all directions. From the ends that reach out into the sea icebergs break off, which, before they have melted, may float as far south as the path of ocean steamers. Similar glaciers are moving sea-ward from Alaska; and smaller ones are on many mountains.

The work of plants. — The roots of growing plants creep into the crevices in the rocks and there increase in size, forcing the cracks wider open and breaking off fragments of the rock. Decaying plants and roots hold the moisture of rains; and in their decay an acid is formed which slowly dissolves the rock that it touches.

The work of animals. — All classes of burrowing animals, as the gopher, mole, woodchuck, and prairie dog, and of insects, as the ant, and the earthworm, help to form soil. They keep it porous, or open, so that rains can enter, and they bring the deeper soil to the surface. Those that eat soil, as earthworms and certain insects, change its form. They are so numerous in some soils that the part they take in soil-making is very important.

What soil is. — It is apparent, then, that soil is crumbled or ground up rock, containing particles of many shapes and sizes and materials, to which has been added decaying animal and vegetable material, which we call organic matter, or humus. It is not simply one thing or material, but is a great mixture or combination of many kinds of materials; and that is why it is useful in the growing of plants.

Problem 53. Ask your teacher to take the class for an excursion some afternoon, to study soil formation. Go to a creek or river-bank and describe the soil-making that is taking place there. Find a low place where the stream has overflowed, and note the fine, soft mud which is still gritty. Then see whether you can find any crumbling rocks in the field or the fence row, or in a cut in a hillside. Chip off a piece of rock that has been exposed to the sun, and note the change that has taken place on the outside as compared with the inside. Ask your teacher to tell you what she knows about the formation of the hills, if there are any in the locality. See whether you can find a sand-bank or gravel-bank, and notice how it is formed. Write a report on what you learn on this field trip.

Problem 54. Walk over your father's farm, or some other farm in your locality, and note carefully how many kinds of soil there are. Write an essay on what soil conditions you discover on the farm.

Problem 55. What difference is there between the soil in the woodlot and that in the hay or grain field, in color, weight, texture, or feeling, and smell? Why is there this difference? Which contains more moisture? Why?

Problem 56. Grind up three different kinds of rock as fine as you can and bring the fragments and powder to school for comparison. Is there any difference in the soil from the different kinds of rock? Which kinds of rock grind most easily? Which are hardest? Put all of the soil made by the pupils into a pot and set in it a growing plant. Keep it well watered and in a bright place, but not in direct sunlight. Will the plant grow in the soil you have made? What is the chief difference between this soil and that in the field? Does it contain any organic matter?

Problem 57. Heat some garden soil and note the changes. Heat some soil from the woodlot and note the changes. Which burns more? Why? Which changes more in size and color? Why? What has the heat done to each soil?

Problem 58. Why are some stones and pebbles rounded? Do you always find sand where there are pebbles? Why?

CHAPTER X

THE NATURE AND COMPOSITION OF SOIL

WE have learned that there are marked contrasts in the nature of the soil in different sections of our country, as the soil of New England, the alluvial plains of the Mississippi, the broad prairies, the great plains, and the arid regions. These are different one from another, partly because different kinds and amounts

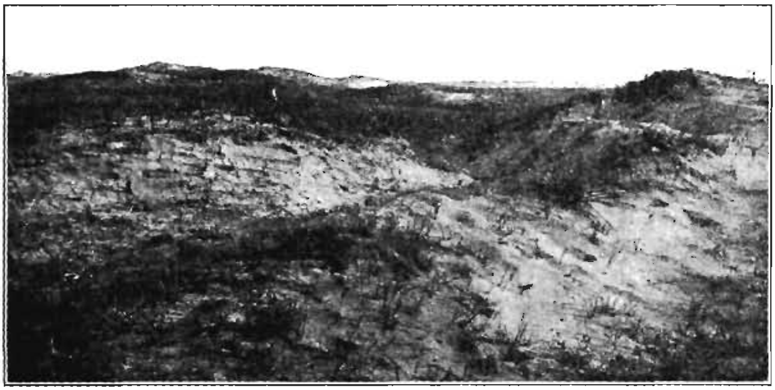


FIG. 25. — Hills formed of sand drifted by the wind.

of rock and vegetable materials have entered into their making, and partly because the particles of soil are of various sizes and kinds.

Different kinds of soils have names, just as different kinds of plants have names. The names help to describe and classify them. Some of the names are peat, muck, clay, loam, sand, and gravel.

Peat. — Peat is made up very largely of vegetable or plant material that is only partially decomposed. It is not decayed enough to be useful for the growing of plants. It is formed chiefly in swamps, where the water is quiet and the mud that it carries settles to the bottom and furnishes a foothold for water plants. When these plants die, they are submerged and others take their places. Year after year this process goes on, and there is built up a peat bog. Such bogs are found in many places in Canada, northern United States, Ireland, Scotland, and Norway.

Muck. — A soil that contains a large amount of organic matter that is more thoroughly decomposed than peat is called muck. It is the next step toward a good garden soil from peat. It will support plant growth, but is not the best garden soil except for a few crops. It is black and loose and holds a great deal of moisture. It must be well drained before any crops can be grown.

Clay. — A clay soil is one that is made up of such fine parts that one particle cannot be distinguished from another without the aid of a microscope. It is the most finely pulverized soil. In the field it is hard and sticky, and difficult to work either when it is very wet or when it is very dry. It makes good mud pies which crack to pieces when they are dry. That is the way the soil behaves in the field also; we have all seen the cracked surface of a clay soil in the dry midsummer. A clay soil is frequently said to be *cold* because it holds much water, that is, does not allow the water to pass through it readily. It is also said to be *heavy*, because it is closely compacted and sticky.

Loam. — A soil composed partly of clay and partly of sand is called a loam. If there is much clay in it, it is a clay loam; if much sand, it is a sandy loam. When clay and sand are in about equal proportions it is a true loam. This is the most common and most desirable kind of general farm soil. It is easy to work, allows moisture to pass through sufficiently fast, and makes a good home for roots.

Sand. — Sand is soil so coarse that it is gritty. Its particles are much larger than those of the clay soil. They can readily be distinguished one from another. The soil is loose, open, and porous, allowing the water to drain out of it easily. Sand is therefore frequently spoken of as a *warm* and a *light* soil, the opposite of a clay soil. We find sand soils along stream beds, along the shores of lakes, in the coastal plain, and in other places where the glacier deposited part of its burden.

Fig. 26. — Where the current is checked the stream deposits its burden.

Gravel. — Some soils are nearly all gravel, or pebbles, and are called gravel soils. Others contain many large pebbles and small stones. A clay soil containing much stone is called a stony clay.

The materials that make up soil. — We now know that the soil is made up of fine particles of rock, vegetable matter, water, plant and animal life. It contains also air and another kind of plant life which perhaps we do not know about, because we cannot see it, but which is very important, — a low form called bacteria. The bacteria plants are so small that they can be seen only under a strong microscope. Yet the soil could not produce crops if they were not there, changing it so as to make it useful for plant-food. Bacteria must have air in order to live, and so there must be air in the soil. We shall study in later chapters about these various materials that make up the soil.

Importance of the condition of the soil. — In order to grow, plants must have food, air, water, and a suitable home. These are what the soil and the atmosphere supply. A suitable home must allow the roots to reach out, must supply the food which they are seeking, help to regulate the moisture and heat conditions for the plant, and give good support to that part which grows above ground. A considerable part of the plant grows below ground to support and nourish the part above ground. When we have tried to pull a pigweed out of a neglected part of the garden, we have discovered that the soil gives strong support and that the root-anchor holds fast. The farmer recognizes the importance of the condition of the soil, and plows and fits his land carefully.

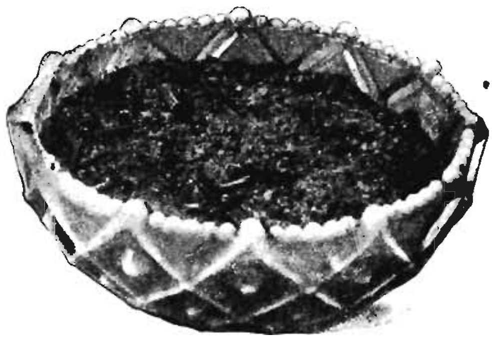


FIG. 27. — Soil that contains much humus and vegetable matter. It remains loose.

Soil as a source of plant-food. — The plant needs a variety of foods, just as the hungry boy does. Many different substances are required for its growth. Some of these substances are obtained from the air and others from the soil. Those that are taken from the soil are spoken of as mineral foods because they are actually some of the mineral matter dissolved in water. As we shall study later, the plant cannot take in solid particles of soil, but only such materials as are dissolved in water in the soil. Through the roots the dissolved materials can pass into the plant, where they are prepared by a sort of digestion for its special needs.

A very large part of the mineral matter in soil is material that cannot be used as food by plants, and is of no use to them except to give them support.

Relation of soil to farming in the locality. — The kind of soil in a locality determines to a considerable extent the type of farming

FIG. 28. — Two soils. On the left, clay that has dried and cracked; on the right, a loose loam.

that shall be carried on. Some crops can be raised on a great variety of soils, while others are not so easy to please. Timothy hay will grow successfully on clay, clay loam, loam, and even fine sandy soils; apples, pears, and grapes prefer heavy loam or clay soils; peaches prefer sandy soils.

When muck soil is well drained, it is excellent for growing onions, celery, cabbage, and peppermint. Large growers of these crops usually choose such land, if they can secure it. Where there are belts or stretches of muck land, the farmers make a specialty of one or two crops; here, the soil determines the kind of farming.

Clay soils will produce good crops of hay, wheat, oats, beets, cabbage, and turnips. They are too cold and wet for corn and too hard to allow potatoes to grow freely. Loam soils produce hay, wheat, and oats nearly as well as clay soils; they produce corn and clover better than clay soils. Potatoes, tomatoes, beans, and peas do very well on loams. Sandy soils produce poor crops of grain and grass, but, because they are warm, they are well adapted for growing berries and early vegetables, as peas, radishes, and lettuce. The intelligent farmer will adapt his crops to his soils, and thus secure the best results from his land.

Problem 59. Ask your teacher to take the class for another soil excursion. Some one supply a spade. In the meadow, dig down about eighteen inches into the soil. Is there any difference between the surface soil and the under soil or subsoil? If there is, which is looser? Which is darker colored? Which has more organic matter? Why? How can you tell? How deep down is the subsoil? How many factors have helped to make the surface soil different from the subsoil? Take a bottle or glass full of both surface soil and subsoil for study and exhibit in the schoolroom. Put a label on the glass to show where and when the soil was secured.

Make a similar study of the soils in the woodlot and down by the creek bed, if there are woods and creeks in your neighborhood. Of all the soils studied, which contains most organic, or vegetable, matter, and which contains least? How do you explain the differences?

Problem 60. Make for the schoolroom an exhibit or museum containing muck, clay, loam, sand, gravel, and stony clay soils so far as you can find them in your neighborhood. Mark the bottles to show where each was found. Get the same amount of each kind of soil, weigh the samples, and mark the weights on the bottles. After a few weeks, note which have changed most. Weigh them again. Explain the changes. Do these differences make some soils better for crop-growing than others? Why?

Problem 61. What kind of soil is most common in your locality? Do all of the farmers grow, in general, the same kinds of crops? Are there any special crops? Are the special crops grown on certain kinds of soil? Does your father try to adapt his crops to the different kinds of soil on his farm, if there are differences?

Problem 62. Write a short essay about the part that the soil plays in the growing of plants — what it does for the plant, and how.

CHAPTER XI

THE WATER AND AIR IN THE SOIL

If a soil is perfectly dry — or as dry as you have ever seen it — plants cannot grow in it. When we add water, we see that plants will grow or they will revive if they are wilted. We know that in some way the water in the soil is useful to plants.

Relation of water to plant growth. — A living plant contains a large proportion of water — generally more than 75 per cent of its weight. Practically all this water is taken from the soil by the roots. All growing plants need water, first, because they can take their food from the soil only in liquid form, and second, in order to keep fresh — that is, to keep their cells expanded so that the plant will not become wilted. The moisture that is in the soil is the immediate source of the food-supply of plants; it is a plant-food itself, and it carries other plant-foods. Much water must pass up through the plant in order to carry the food to the leaves where it is digested.[1] From there the surplus water evaporates, or passes off into the air.

How the water gets into the soil. — If we go out immediately after a heavy shower, we find little muddy streams running by the roadside. Out in the cornfield, where the land slopes down toward the hollow, some of the soil has been washed away and the water has cut deep channels toward the bottom of the slope. The little rills rise rapidly and rush away, loaded with fine soil from

[1] It has been found that crops take 300 to 500 tons of water from the soil to make one ton of dry plant material, by which is meant all of the plant except the water. Timothy hay takes 300 tons of water to make one ton of dry hay. Oats require 500 tons, barley 464 tons, clover 576 tons, potatoes 385 tons, to produce one ton of dry matter.

the plowed *fields*. *The water that runs off in this way* instead of sinking into the ground is spoken of as surface water.

FIG. 29. — Disastrous soil erosion, or washing, in an orchard.

But not all of the water robs and furrows the land and retreats with haste to the nearest creek or pond. Much of it does not stop when it strikes the surface of the ground, but sinks into the

FIG. 30. — This soil needs drainage. After rain puddles were formed. Then, when the sun shone, the earth "baked," or dried, until it cracked.

land through the cracks, crevices, earthworm burrows, channels left by the decay of roots, and whatever other openings there may be. As it is urged on by other water from above, it will sink down to the lower layers of soil. Finally, if the rain is heavy enough, it will reach the level of the "free" or ground water, from which wells and springs are supplied. Very heavy and long-continued rains may fill all the spaces in the upper layers of soil with water. Dashing showers will run off the surface, if it slopes, as time is required for water to soak into the soil. When the land is dry, the farmer likes a slow, steady rain that continues for several hours — a soaking rain.

How the water is held. — As the water passes downward, each particle of soil is surrounded with a thin film or coating of water, much as is a marble when dipped into water.

All through the soil are holes or pore spaces which vary in size with the kind of soil. In a fine-grained soil, as clay, which packs closely, the spaces are small, and the water cannot pass through quickly. Much water is held back in the little cavities. In a loose, coarse-grained soil, as sand, the spaces are large and the water passes through very rapidly. We might compare the two types of soil with two pieces of cloth — one of fine linen and the other of cheese cloth. The former, with its fine spaces, will almost hold water, while the latter, with its large openings, allows water to drain through rapidly.

Perhaps we shall now understand why clay is frequently a sticky, wet soil, and forms puddles on the surface after a rain, while sand is a dry soil and almost never forms puddles.

How soil water moves. — We can readily understand how water will move downward through the soil wherever there are openings or pores. It is interesting to know also that the water that is about the particles in the form of thin films can pass from one particle to another whenever two particles touch each other closely. As the particles in the soil are in close contact, this movement of water is constantly taking place. It is the dry particle that takes the moisture from the wet one, so that the movement is toward the drying area. This is of great importance to the plant, as there is a constant movement of water towards its roots as fast as the roots take up the water from the particles of soil that they are touching. It is

FIG. 31. — These scoke plants have wilted because of too much water, causing a lack of soil air.

in this way that the plant receives the benefit of most of the moisture in a good soil.

Drainage. — In regions that have considerable rainfall, enough water falls to more than fill the pore spaces in the soil. If most soils did not provide some means of carrying off the surplus that has entered the soil, all lands, even the most rolling, would be swampy. More water must be removed from the soil than runs off the surface. Therefore, all lands that do not of themselves drain away the excess, or have natural underdrainage as we say, must be artificially underdrained. This is because the surplus water occupies the open spaces in the soil and thereby prevents the entrance of air. The roots of plants must have air, and they will go down only as far as the air can penetrate. By removing the over-abundance of water and allowing the air to enter, we provide for the roots a wider and deeper feeding ground.

Drainage has other uses than this, however. Much water makes the ground cold. When the surplus is removed, the ground warms up earlier in the spring and crops can be planted earlier.[1] If the ground heaves in winter, breaking the plant roots, it is an indication that there is too much moisture present and that drainage is needed. Drainage will largely prevent heaving. It will also largely prevent the "baking" or cracking of soils in midsummer. It really provides more moisture, not less, for plants, because it removes only the harmful excess and allows the roots to go deeper and so to be in contact with a larger surface from which to draw the films of water.

The best means of artificially draining most lands is by laying tile drains in the soil three to five feet deep, and close enough to take care of all surplus water. When it is necessary to remove only excess surface water, open surface ditches may be used.

[1] Growth will not begin in most cultivated crops when the temperature is below 40° F. Above this temperature, growing conditions improve up to a given temperature, beyond which they fall again from too great heat. Corn will not begin to grow below 48° or 49° F. It grows best at 93° F.

Irrigation.—Sometimes soils do not receive enough moisture, or the rain is not well enough distributed throughout the year to meet the needs of growing plants. In such cases water must be supplied artificially by what is known as irrigation. In many large areas in the western part of the United States no farm crops can be grown unless the land is irrigated. In other regions, the rainfall is not sufficient for the best growth of crops. Fifty years ago less than 100,000 acres in the United States were artificially watered. To-day more than 10,000,000 acres are being so watered. Many more millions will be valuable farm lands when they are irrigated.

In the east, irrigation is also being practiced by farmers who grow vegetables or truck-crops for market. Their crops may be ruined by drought if they depend wholly on natural rainfall, and sometimes they establish systems of watering in their vegetable gardens. Usually they use an overhead sprinkling device instead of running the water through ditches in the gardens.

In the great western irrigation systems, immense dams are built to form reservoirs or artificial lakes to hold back all the water from rains and winter snows. From these reservoirs, canals carry the water through the region to be watered. Ditches opening from the canals distribute it to the fields. In some places canals and ditches run out from large creeks and rivers, and reservoirs do not have to be built.

The air in the soil. — All plants require air around their growing parts, about the roots as well as about the stems and leaves. The roots cannot do their part unless there is air about them. Without air seeds will not germinate, that is, will not begin growth, but will rot. And the great host of soil bacteria, whose work it is to change certain plant-foods so that they can be used by the plants, will perish if they cannot have air. In other words, all the activities in the soil that have to do with the growth of plants will cease if air is not present, and plants will not grow.

Fig. 32. — Young apple orchard prepared for irrigation.

We have already learned that air occupies the open spaces in the soil; and that it enters the pores, cracks, earthworm burrows, holes left by decaying roots, and any other openings. When rain water seeps into the soil, it carries air with it. The farmer introduces air into his soil by plowing, turning the soil over, exposing it to the air, loosening it, and making new pore spaces.

Problem 63. Fill a four-ounce medicine bottle with well water. Cut a small slip of geranium and put the lower end into the water. Hang the bottle containing the slip in the window. Empty the water every other day and fill the bottle with fresh well water. Does the slip grow? Does it have food? Where does it get its food? Is there dissolved mineral matter, plant-food, in the well water? Do you suppose that your well is simply a deep hole to catch the excess soil water, which contains plant-food?

Problem 64. Take three long-necked lamp chimneys or glass tubes, and tie a piece of coarse muslin over one end of each. Fill one with coarse sand, one with sand and loam mixed, and one with clay, to within one and one half inches of the top. Jar carefully to compact the soil while filling. Stand the tubes in trays filled about two inches deep with very coarse sand or fine gravel. Fill each tube to the top with water. As the water sinks, add equal amounts to each tube. In which tube does the water sink fastest? In which one does it drain away from the bottom first? When each has begun to drain, fill each tube level full of water at the top and see how long it takes each to lose its one and one half inches of water. Keep the tubes for a few days and note which one dries first and which last. Which would be the best garden soil so far as the moisture is concerned? Why?

Problem 65. Are there any surface drains on your father's farm, or on any farm in the locality? Are there any underdrains? Are there wet places on your father's farm? What kind of soil is there in the wet places? How does it behave when it is dry? Do plants grow well on the wet places?

Problem 66. Write a short essay about what becomes of the rain that falls on your father's farm.

Problem 67. Where is the great Roosevelt dam? Why is it there? How much land is irrigated from it?

Problem 68. Put clay soil into a pot and plant seeds. Wet the surface of the soil and puddle or pack the clay while wet. Watch for the seeds to germinate and grow. Keep the clay soaked. At the same time put seeds into another pot filled with loose, mellow, moist soil. In which do the plants first appear? Why do not the plants grow in the first soil? Are there any wet clay soils like the one in the first pot, in your locality? Do they grow good farm crops?

Problem 69. If there is a bare place on your father's farm, or on a neighboring farm, try to find out why it does not produce plants. Might one reason be that it is so hard that air cannot enter? Does it contain much humus?

Problem 70. Why does very little grass grow on the playground by the school-house, especially near "home plate" of the baseball field, during the summer vacation?

Problem 71. Why do seeds rot in a water-soaked soil?

Problem 72. Do you suppose that you could cause seeds to germinate even in a water-logged soil if you thrust straws down to them?

CHAPTER XII

THE PLANT LIFE IN THE SOIL

We have already used the word bacteria (Chapter X); and we have learned that bacteria are very small, invisible plants that live in the soil and help in the growth of other plants. Some kinds live in other places than in the soil, but we shall study now only the kinds that are found in the soil.

These tiny plants live in the soil in countless millions. In the barnyard and the manure heap, where conditions are especially favorable for their growth, they exist in very great numbers, even as great as 100,000,000 in one gram of soil (a gram is .002 of a pound). We cannot see them without the aid of a powerful microscope, but we know that they exist and that they are very important to the farmer. They do not require sunlight, as do most of the plants we know about; but they do require air, moisture, moderate warmth, and food. When the farmer knows how much he depends on these unseen allies, and what they require for their life and work, he tries to make the condition of the soil favorable for them.

What the bacteria do. — All plants and animals require food; and much of it is limited in quantity. At any one time, there is little food in the soil in the right condition for plants, yet plants and animals have used food constantly for unknown centuries; and our soils are still producing vegetation. This is possible because the same food is used over and over again. One kind of living things uses it, and in so doing changes it into a form to be used by another kind of living things; these, in turn, change it into other forms for use by still other living things.

The food substances pass through a circle, or cycle, passing round from one kind of life to another, and finally returning to the form in which they started.

Plants are grown to feed animals. All tillage of the soil is to help plants to grow — to make the food in the soil useful for plants. When plants consume this food, they change it into new forms that cannot immediately be used as food for other plants. But it is then in just the right form for animal food, and so animals consume the green plants. In the animal body the food substances are again changed. Some of the materials are returned to the soil in the manure. All of the others are returned when the animal dies and is buried.

When the food materials, which came originally from the soil, have passed through these several changes and are returned once more to the soil, they are not then in a form to be used again by plants. This is where the bacteria do their part. Such dead plant and animal matter is just the kind of food they need, and they set to work on it vigorously. When they are done with it, it has been changed into simple forms again that are in the right condition to be used as food by plants; and here the materials start again on their round, or cycle. If it were not for the bacteria the soil would soon become clogged with the dead bodies of plants and animals, and would be useless for producing vegetation.

This circle or cycle or round of life, in which all living things have their part and receive their nourishment, helps us to understand why the soil can produce crops for countless centuries without becoming exhausted. It is only when the farmer takes much food from the soil in crops and returns nothing to it, that the cycle is broken and soils become poor and unproductive.

Another activity of bacteria. — Every farm boy knows that the fields are richest where clover or cowpeas or alfalfa has been grown. Certain crops, which we call legumes, or leguminous plants, such as clover, alfalfa, beans, peas, cowpeas, and vetches, leave the soil in a specially rich or fertile condition. The soil bacteria must be given credit for this unusual richness. Nature has provided a kind of bacteria that penetrate the small rootlets and set up factories, which we call root nodules, for the preparing and storing of one of the most valuable of the plant-foods known as *nitrogen*. In these factories, which are established on the leguminous plants, nitrogen is stored for the use of the plant itself and for other plants that will be grown on the soil after the legume is harvested. The crop that is grown after the legume is benefited because the roots of the legume, bearing the nodules, are left in the ground.

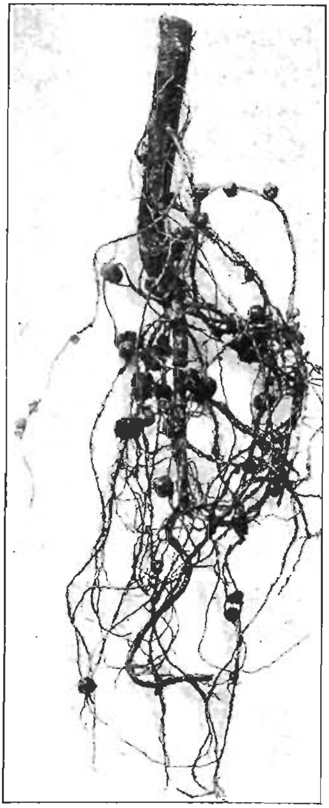


FIG. 33. — The roots of the cowpea, showing the nodules in which live the bacteria that gather nitrogen.

Soil inoculation. — Sometimes it is desirable to place these tiny plant organisms in soil in which they are lacking. This operation we call soil inoculation; that is, we inoculate, or infect, the soil with bacteria. Soil inoculation may be practiced when a kind of legume is to be grown on the land that has not been grown there in recent years. It is most easily done by spreading on the land soil from a field where the same kind of legume has been grown successfully. The soil carries the bacteria, and thus they get into or inoculate the new soil. If clover does not do well on one field, but thrives on another, it may be made to grow better on the first by sprinkling on it some soil from the second.

Soil diseases. — There are some kinds of bacteria in the soil which are not desirable. They are known as plant disease germs; that is, they cause diseases of plants, and carry diseases from one plant to another. They are just as active in the soil as are the helpful kinds of germs, and may cause the farmer great loss. Clubroot of cabbage is a soil disease.

Problem 73. Go into a field in which a heavy sod or stubble was plowed under last spring or last fall. With a spade dig up some of the soil and note what changes are taking place in the vegetable parts that were plowed under. If possible, find next a field in which vegetable matter was plowed under the year before. What has become of the vegetable materials in this field? Then go over to the woodlot, and where the trees are thickest dig down about fifteen inches. Describe the changes in the condition of the soil as you go down from the surface. From what is most of this soil made?

Problem 74. Can you find any mushrooms or toadstools in the woods or about the barn? Why do they grow there?

Problem 75. Carefully pull up a clover, sweet clover, alfalfa, or some other leguminous plant, and look for the little nodules or swellings on the roots. They may be as small as pin heads, or much larger. Try to find them on the roots of two or three different kinds of legumes for comparison. Wash the roots carefully and keep them for a while in a glass jar in the schoolroom for observation.

Problem 76. Legumes are the true pod-bearing plants. The pea-pod is the kind of fruit that botanists call a "legume," and from this the name has been given to all the plants of this family. It is a large family. Most of the members have pea-shaped or butterfly-like flowers. How many kinds of leguminous plants can you name?

Problem 77. Write a story about the life cycle of a corn plant — what becomes of the plant and how the materials that are in it are carried round to go into another corn plant. Explain what happens to the soil if the corn is shipped away or is fed to cattle that are to be sold, and little is returned to the soil.

CHAPTER XIII

THE TILLAGE OF THE LAND

TILLAGE is the stirring or turning over of the land to fit it for the growing of plants. Plowing and spading and harrowing and hoeing are forms of tillage. Land is tilled in order that crops may be planted and harvested, and to improve the condition of the soil so that it will yield the largest and best crops.

When man first tilled the soil, centuries ago, he doubtless did it only to get his seed into the soil, or, in the case of root-crops, to get

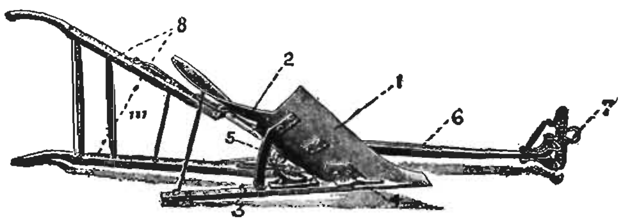


FIG. 34. — Bottom view of a modern plow, showing the parts. 1, share; 2, mold-board; 3, landslide; 4, frog; 5, brace; 6, beam; 7, clevis; 8, handle.

the crops out of the soil. Gradually it was learned that tillage had other uses — that it destroyed weeds, and that stirring the soil to remove weeds seemed to make the plants grow better. When the land did not produce good crops, the workman of former time thought that it needed to have a rest instead of having more thorough tillage. So he rested his land for a year, or "fallowed" it, as we say to-day; that is, he allowed it to remain idle.

History of tillage. — In the early part of the eighteenth century, Jethro Tull, an English landlord, taught that tillage was the most important farm operation. He declared that by tillage, which would pulverize the soil for the use of plants, soils could be kept forever in a productive condition. He thought that the plants themselves took the fine particles of soil into the roots and digested them within the plant. He did not know, as we do to-day, that plants cannot take in solid materials, but must get their food from the soil in liquid form. He had observed, however, that thorough tillage made plants thrive, even though he did not know the real reason. Tull's teachings and writings completely changed the methods of farming of his day. Thereafter tillage occupied a more important place in farm operations.

We shall learn in this chapter some of the reasons why the farmers of the present day till their soils.

Why soils are tilled. — We have already learned that plants will not grow unless their roots have a suitable home and feeding ground. Tillage is one of the best means of preparing this suitable home. The following are some of the reasons why soils are improved by tillage:

(1) Tillage makes the soil finer and deeper, so that roots can reach farther.

(2) It brings up the moist soil in spring and enables the surface to dry enough to make a good, early seed-bed.

(3) It helps the soil to hold a larger amount of useful moisture by fining or pulverizing it so that there are more particles to be coated with the films of water.

(4) It saves moisture in the hot midsummer, for reasons which we shall learn.

(5) It stirs the soil and allows air to enter.

(6) It prevents the growth of weeds, which take plant-food and moisture from the soil.

(7) By tillage, vegetable matter is plowed into the soil to make it more productive.

Tillage makes plant-food available. — We know that, at any one time, there is only a relatively small amount of food in the soil in condition for plants to use. But there is a great deal of material that will serve as food for plants when it is changed into

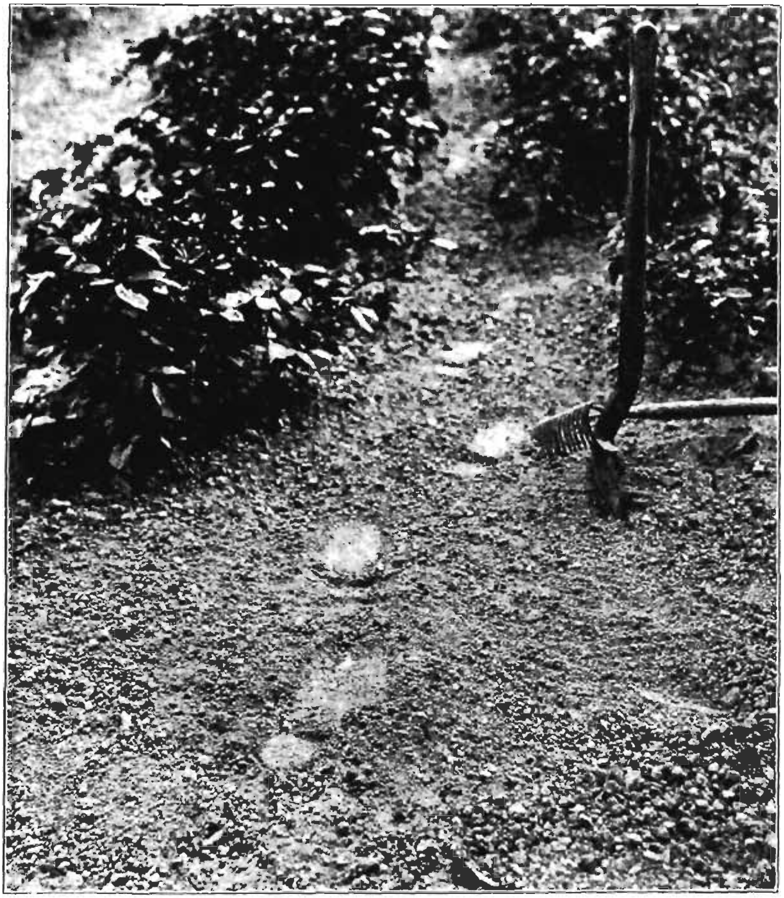


FIG. 35.—Good tillage saves moisture.

another form. The food in the soil is available only when it is in a condition in which plants can use it. One purpose of tillage is to help change this material into the form in which it can be used.

As we have learned in the preceding chapters, moisture, heat, and air are necessary in the soil if the mineral material is to be dissolved, the organic matter decayed, and the bacteria to do their work. All of these activities must take place in order to prepare the soil as food for plants. Tillage opens up the soil to receive moisture, heat, and air. It is therefore of first importance in creating the right conditions for the growth of plants.

Tillage saves moisture. — Tillage, if it is well done, breaks the soil into very fine particles; and a soil made up of fine particles will hold much more moisture than a coarse one — as clay soil

Fig. 36. — Tillage improves the orchard soil.

will hold more moisture than sandy soil, even though it does not take up the moisture so rapidly as does sand.

But tillage saves moisture for the plant in another way. Our fathers cultivate their corn and cabbages and potatoes, not only to keep weeds out, but also to keep the soil loose on top. Have we ever asked them why they keep two or three inches of loose soil on the surface, which dries out as soon as it is stirred?

Let us go out behind the barn or woodshed, and lift a board or large stone that has lain there throughout the spring and early summer. We find that the soil is moist under it, while the ground about is dry. The stone has prevented the moisture from evapo-

FIG. 37.—Footprints compact the soil, and this brings the water to the surface. That is why footprints are dark and moist. (See Figs. 35 and 38.)

rating into the air. The loose layer of surface soil, which we call a mulch, acts in much the same way as the stone. It serves as a blanket, covering all the field, to protect the soil beneath from the strong summer heat and to prevent the evaporation of the moisture. By stirring and drying the surface mulch, its moisture is evaporated. As the mulch is kept loose, the films

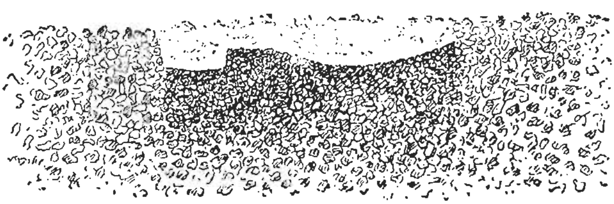


FIG. 38.—A footprint, showing how the soil is compacted.

of moisture from below do not pass from the moist particles to the dry ones, as we learned in Chapter XI, because the dry particles are not in close enough contact with the moist ones. If the mulch is allowed to settle of its own weight and pack again, or becomes packed by rolling, tramping, or a beating shower, its particles will become pressed against the moist ones beneath; and then the moisture will pass upward again and be evaporated. It is in order to prevent this packing that the surface must be stirred frequently to keep the mulch loose.

Dry-farming. — Many of us have heard or read about "dry-farming." It is a special kind of tillage used in very dry regions to save enough moisture so that crops may be grown every two years instead of every year. The land is made deep and fine to catch and hold all the rainfall, and then the surface is kept loose throughout the year to prevent the moisture from escaping.

The purpose is to store up enough moisture one year, when crops are not grown, to supplement the rainfall of the next year so that a crop can be grown during that year. The third year the land is bare again, to store up moisture for a crop to be grown during the fourth year.

Where the rainfall is normally 20 inches or less in the year, dry-farming or irrigation must be practiced.

History of tillage tools. — The first tools for stirring the soil were for hand use. They were built after the fashion of the hoe. Later, crooked sticks, so shaped as to enter and loosen the soil, were used to draw behind the workman. This seems to have led to the development of the plow. The first plows were either pushed or drawn by man. The ancient Egyptians built and used a plow that had a beam, a shank, and a handle, and they used their animals to draw it. From this the next step was to provide the parts that received the wear with a shoe of iron.

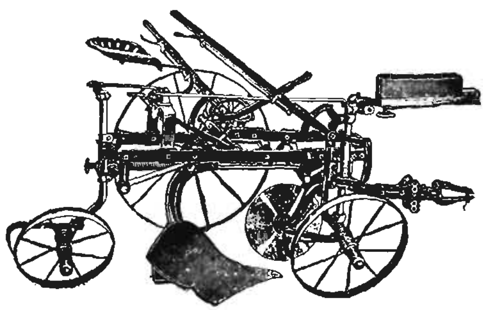


FIG. 39. — Sulky plow.

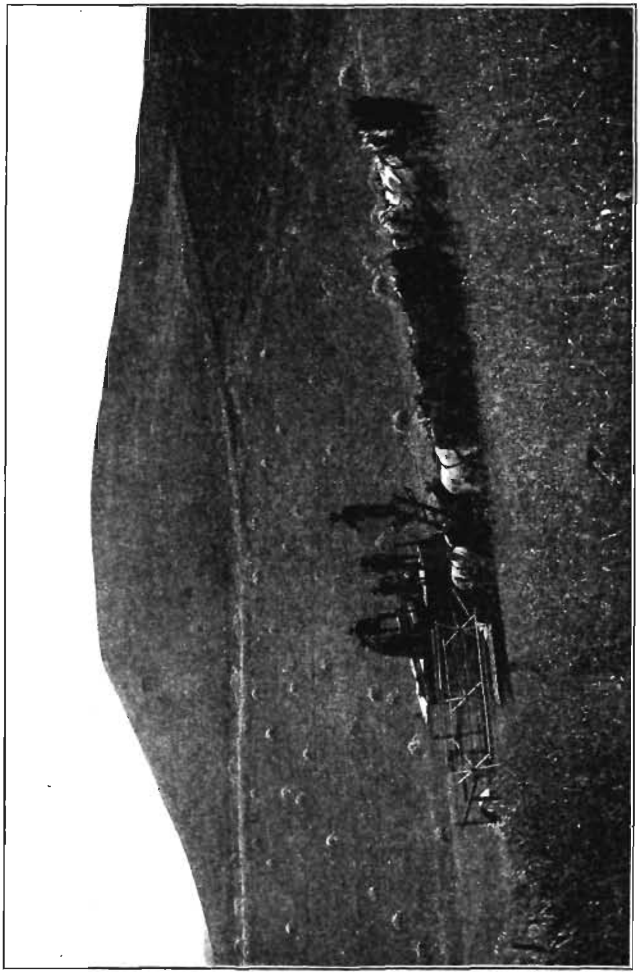


Fig. 40. — Harvesting wheat raised by dry-farming in the State of Washington.

This was done very early, for it is written, 1100 years B.C., that the Israelites, who had little skill in the working of iron, "went down to the Philistines to sharpen, every man, his share and his coulter."

From the first appearance of the plow to the present day, many changes and improvements have been made, and several thousand

FIG. 41. — Gang plow, drawn by traction engine. Used for farming large areas.

different models have been designed at various times. At present there are very many kinds in use, from the single walking plow to the large steam plows that carry gangs of sixteen to twenty plows. These large gangs will plow, harrow, and occasionally seed, in one operation, 40 to 60 acres in a day. The development of the plow has a long history, and in one form or another it has had a part in the progress of all nations and races.

Next to the plow, the harrow is perhaps the oldest tillage tool. The first harrow was doubtless the limb of a tree with extending branches. From this developed the first type of harrow, a forked stick with spikes in each arm. Later a cross-arm was added and we had the "A" harrow. The Romans used a square or oblong

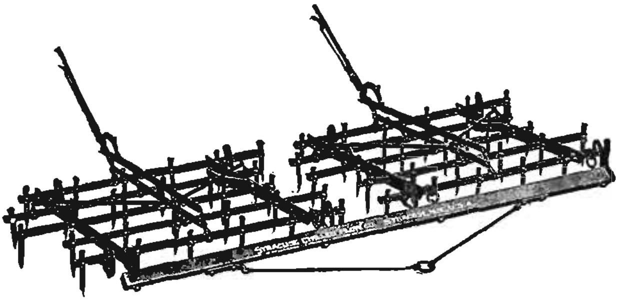


Fig. 42. — Spike-tooth harrow.

harrow with cross-bars carrying many teeth. Our modern harrows all follow these same general principles.

The first rollers were carefully chosen logs. Spikes or bars were driven into the ends and a yoke provided for drawing. This style

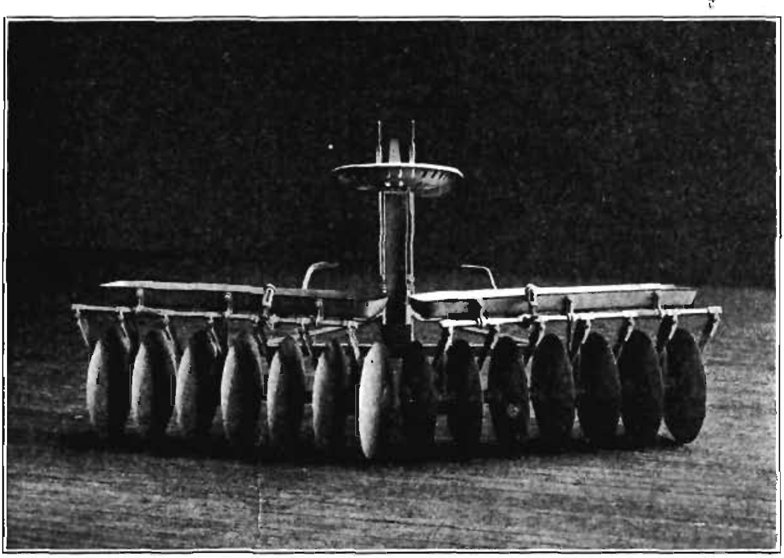


Fig. 43. — Disk harrow.

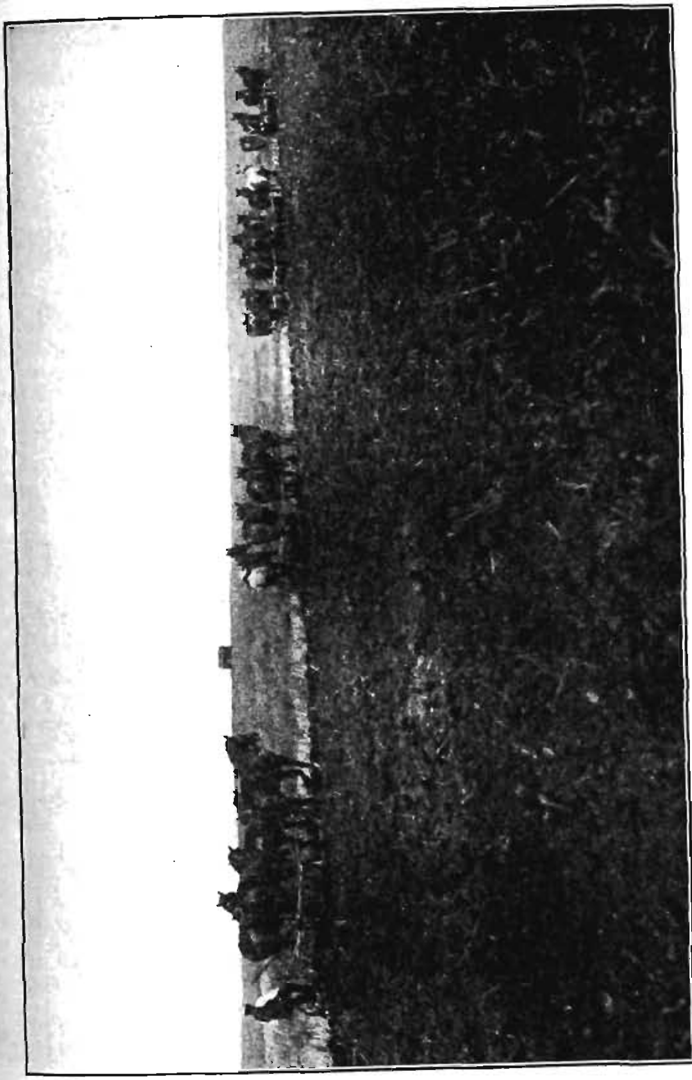


FIG. 44. — Plowing in the Great Northwest.

of roller was in use until within recent years. Because of difficulty in turning the log, the two-piece or two-section roller was devised.

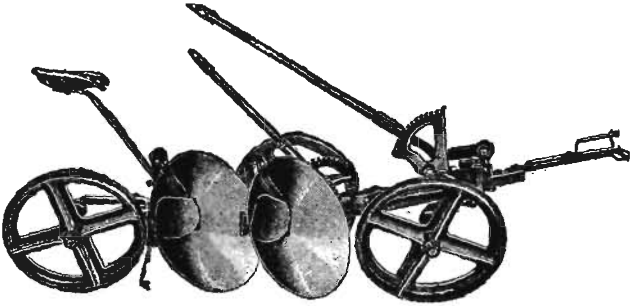


FIG. 45. — Disk plow.

The use of tillage tools. — The farmer needs many different kinds of tillage tools for different purposes. Some, as the plow, are to stir the soil deeply and to cover the sod or stubble that is on the surface of the ground. Others, as the cultivator, tear up the soil to less depth than the plow, and lift and turn it. Others, as the harrow, prepare and pulverize the surface of the soil and make the soil mulch. Others, as the roller, compact the soil and are specially useful on light, sandy, or gravelly soils that are naturally too loose.

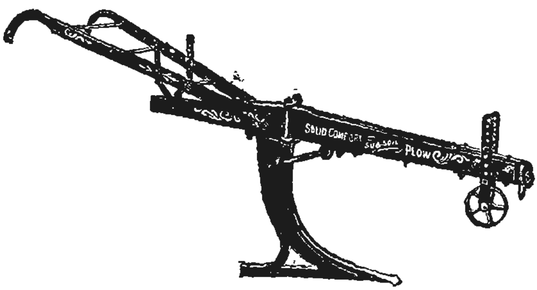


FIG. 46. — Subsoil plow.

There are many styles of each of these different tillage tools for special purposes. Each has its own use, and the careful farmer will choose his tools so as to get the ones that will do his various kinds of work best.

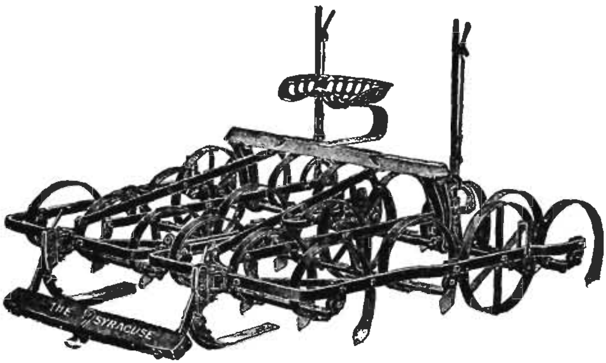


FIG. 47.—Spring-tooth harrow.

Problem 78. Place some small marbles or pebbles in one tumbler. Put an equal weight of loose soil in another tumbler. We shall then have in the second tumbler the same amount of material as though the marbles or pebbles were ground into fine powder. Pour water into each tumbler until it stands on the top of the soil in one tumbler and just covers the pebbles in the other. Which takes the larger quantity of water? If we measure the amount of water as it is added, we shall find that the soil has two to four times as much as the marbles. Tip the tumblers and let the water run out. Which loses more water? Which holds more? Why? What does this teach in regard to tillage? Is there a film or coating of water left on the pebbles after the water has been allowed to run out of the tumbler? Is there any evidence that there is a similar film about the particles of soil, or that there is water in the spaces between the particles? Where else could the water be in the soil?

Problem 79. Describe the different kinds of plows on your father's farm or on a neighboring farm. What is each used for? Have you any old ones that your father does not use now? How are they different from the ones he is using?

Problem 80. Ask the teacher to write on the blackboard a list of all the different kinds of tillage tools, including those used by hand, on the farms in the neighborhood. You should tell the teacher what to write. Then recite (or write) from this list what each is used for.

Problem 81. Do the farmers in your locality plow in the fall or the spring? Why? Do they roll their land? Why? Why do they drag it? Why do they cultivate the crops while they are growing?

Problem 82. What crops are grown in your locality for which the soil must be tilled in order that they may be planted? For what ones is it again stirred or turned in order that they may be harvested? Is this stirring of any benefit to the soil, aside from the planting or the digging of the crop?

Problem 83. If you live in a dry-farming region, describe how the work is performed. If you live in a humid region, ask your parents or teacher to read you something about dry-farming. Where are the dry-farming regions? On the map that you made for Chapter II, outline the dry-farming regions.

Problem 84. What is the amount of the annual rainfall of your region? When does most of the rain come? From what direction does it usually come?

CHAPTER XIV

THE IMPROVEMENT OF THE SOIL

The first thing the farmer must do is to make his land productive; then he must strive to keep it productive so that it will serve him well year after year.

Plant-food in the soil. — When studying the character of the soil in Chapter X, we learned that plants take from it certain substances which we call plant-foods. These substances are called sodium, potassium, silicon, calcium, magnesium, phosphorus, iron, chlorine, and others. From the air the plant gets still other materials called carbon, hydrogen, oxygen, and nitrogen. The nitrogen is not taken in from the air above ground as are the carbon, hydrogen, and oxygen, but by the roots from the air in the soil. We shall learn more about all of these materials when we study chemistry in high school; but just now we need to know their names so that we can talk about the food of plants intelligently.

A plant must have every one of these different plant-foods. Each contributes its part to the growth of the plant, and one cannot be substituted for another. If a soil contained all of them except potassium, it could not grow plants. If it contained enough of everything but phosphorus to produce thirty-five bushels of wheat, and contained enough phosphorus for only fifteen bushels of wheat, then fifteen bushels is all it could possibly produce. In order to be fertile it must contain a sufficient amount of each of the food materials to meet the needs of the crop to be grown.

Plant-food must be available. — Not every soil that contains an abundance of plant-food substances will grow large crops, however. Gravel-stones may contain all the necessary mineral foods, but gravel-stones will not make a fertile soil. If the stones

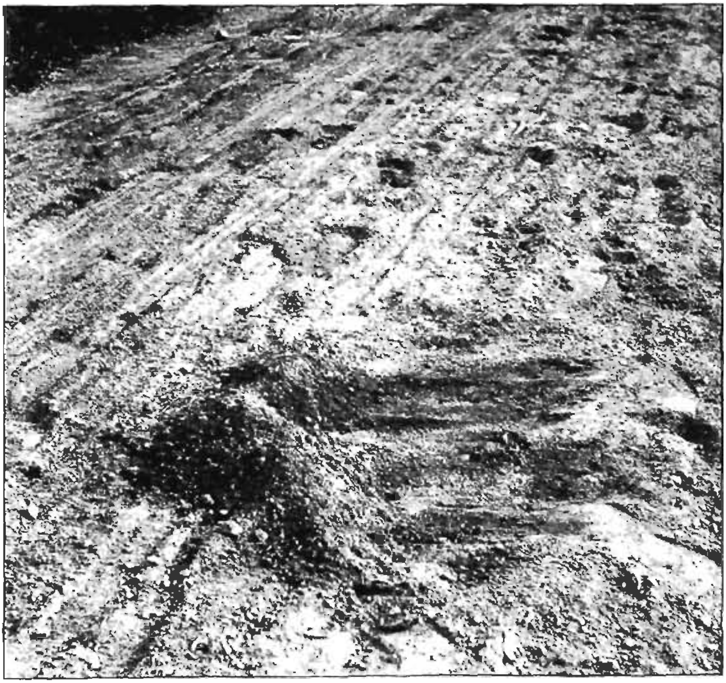


Fig. 48. — Good tillage is a first step in soil improvement.

should be pulverized into soil and have some humus added, much usable plant-food might result. In order to be usable the food material must be in such condition that it can be dissolved by the soil water; for plants can take their food only when it is dissolved in water, or is in liquid form.

Amount of plant-food in the soil. — The farm soil nearly always contains all of the plant-food substances; but some of them may be present in very small quantities, or may be in such form that the plant cannot use them. Or the farmer may raise crops year after year and not return anything to the soil, and in this way greatly reduce the supply of plant-food. Of all the substances that make up the food of plants, however, only three, or occasionally four, are likely to be lacking; and they may not all be lacking in the same soil. They are nitrogen, phosphoric acid (from phosphorus), and potash (from potassium), and sometimes lime (from calcium).

When any one of these substances is lacking, it must be provided. Usually this is done in one of two ways: either by better tillage, which, as we know, helps to change the minerals into a form to be used by plants, or by adding the plant-food directly to the soil in the form of fertilizer.

Fertilizers. — Fertilizers are substances added to the soil to make it more fertile, or to contain a larger amount of available plant-food. They are of two general classes: one, which is produced on the farm, we call farm manure; the other, which is generally bought on the market, is called commercial fertilizer. Phosphoric acid, potash, and nitrogen may be added to the soil by the use of either of these kinds of fertilizers. We shall study the second of these classes first, and learn something about phosphoric acid, potash, and nitrogen.

Phosphoric acid. — We have all seen phosphoric acid. When a match is struck, the little curl of white smoke which first appears is phosphoric acid. The old sulphur matches show this best. In the blue-black or red tip of one of these matches there is a small amount of the substance we call phosphorus. When this phosphorus is warmed by rubbing it against something, as in striking the match, it unites with oxygen from the air. The white substance of the smoke is the result of the union of the phosphorus and the oxygen, and is phosphoric acid.

In a fertilizer purchased for its phosphorus, the phosphoric acid is usually united or combined with lime. The fertilizer is then called phosphate of lime.

Fertilizer containing phosphoric acid is made chiefly from bones. In certain places in the southern part of the United States there are large deposits of bone which are called "phosphate rock."

Potash. — Potash, which is a form of potassium, exists in the soil, locked tight in a substance that will not dissolve readily in water; consequently, much of the potash is not in a form to be used by plants. It may slowly be unlocked and made usable by tillage.

When vegetable matter decays, acids are formed which attack the locked-up potash and set some of it free for the use of plants. A soil that contains plenty of humus (decayed vegetable matter) is likely to have potash in a usable form.

Potash can be bought as commercial fertilizer to apply to the soil. There are large deposits in Germany, from which our supply comes. Wood ashes contain potash and are a good fertilizer.

Nitrogen. — Nitrogen, in the particular condition for the use of plants, is found principally near the surface of the soil. It is made into the right form in the decay of the humus, in which process the nitrogen is taken from the air and united with other materials. Four-fifths of the air about the earth is nitrogen, and all nitrogen comes originally from the air. There is no nitrogen in common rocks.

Nitrogen may be added to the soil by plowing in vegetable matter, or by applying barnyard manure, both of which decay to form humus; or it may be added in certain combinations of commercial fertilizer such as sodium nitrate, dried blood, and tankage.

Barnyard manure. — Soils often need to be improved not only by the addition of certain plant-food substances, but also in their texture or general condition. They may be infertile because they cannot be brought into good condition by tillage or because they

FIG. 49. — A leguminous cover-crop (clover) grown to improve an orchard. It protects the soil while growing, and when plowed in adds vegetable matter and nitrogen.

lack sufficient moisture. Barnyard manure is one of the best fertilizers to meet these conditions not only because it supplies plant-food materials but because it also carries useful bacteria and contains much vegetable matter for the formation of humus.

The manure from all farm animals is useful in improving the soil. Horse manure is richer in nitrogen, phosphoric acid, and potash than is the manure from cattle or from hogs. Sheep manure is very rich in these substances, and poultry manure is the richest of them all.

Green manures. — Sometimes the farmer will raise a crop merely to plow into the soil to add vegetable matter to make humus. Such a crop is called a green manure, because the plants are generally plowed under when they are still green. The most useful plants for green manures are the legumes, as clover, alfalfa, peas, vetches, soybeans, and cowpeas, because they add nitrogen as well as vegetable matter. They are sometimes called nitrogen-gathering crops, because they gather nitrogen in the nodules on their roots. They are sometimes called cover-crops also, because they frequently cover or occupy the land when it otherwise would be bare.

Storing an account for the future. — The soil is the farmer's bank account on which he must draw for his living for all the years to come. If he uses up his account, he will suffer. If he mistreats his soil, takes plant-food out in the form of crops and puts nothing back in, he will reduce his soil fertility until he cannot raise crops. If he adds to his fertility from year to year, putting back what is needed by good tillage, farm manures, green manures, or commercial fertilizers, he will store an account in the soil that will pay him well in abundant crops.

When a farmer dies, or moves away, that does not end the usefulness of his farm. Some one else must make a living from it. A good farmer thinks of those who are to come after him. Some day all farmers will be of the kind that make the soil more useful rather than less useful by their farming.

Problem 85. Does your father use barnyard manure on his farm for fertilizer? Where does he spread it? Why does he spread it there? Does he use commercial fertilizers with any of his crops? What does he use? Why does he use them with these particular crops?

Problem 86. Does your father grow any cover-crops to plow in? What kinds does he grow? Why? Does he sow them so that they will not interfere with other crops? When are they plowed in? Does he get good crops from the fields on which cover-crops have been grown?

Problem 87. Ask your father to explain to you all about his method of improving his soil. Write a short essay about soil improvement on your farm.

Problem 88. If one ton of clover hay contains 40 pounds of nitrogen, 10 pounds of phosphoric acid, and 40 pounds of potash, how many pounds of each would be taken from the soil in thirty-five tons of clover? If a farmer raises two tons of clover to the acre, how many pounds of each of these plant-foods will he remove from twenty-five acres? If clover was raised on your farm last summer, ask your father how many tons he cut, and then find out how much plant-food was removed. Find out also what was done to replace this loss in the soil.

Problem 89. If one bushel of shelled corn contains 14 ounces of nitrogen, 5 ounces of phosphoric acid, and 3 ounces of potash, how much of each is removed in a crop of 45 bushels to the acre? If one ton of barnyard manure contains 10 pounds of nitrogen, 6 pounds of phosphoric acid, and 9 pounds of potash, how many tons will be required to replace the plant-food removed by a corn crop from 20 acres at the rate of 45 bushels to the acre?

PART III

FARM PLANTS

CHAPTER XV

THE NATURE OF PLANTS

PLANTS, like animals, must have food, water, and air. They must also have warmth and light. It is easy to see what animals eat and drink, but not so with plants. And yet, if we will, we may know in a general way how the plant gets its food and its air, how it digests and circulates its food, and how it grows and bears fruit. To understand these processes, we must know about the nature of plants, — what their different parts are and what they do.

Parts of the plant. — We know that a plant has three parts — roots, stem, and leaves. These perform for the plant three kinds of service; each has its own work to do. These parts work together in perfect harmony, just as do the parts of our own body; and together they form a living, growing plant.

FIG. 50. — Radish, showing large, fleshy root, small, tapering root (*a*), and rootlets (*b*).

The root system. — To study the root system in a way to understand it, we should have a plant before us to examine. Let us bring in from our gardens a radish or a beet or a turnip. We must dig it up carefully so as to save all the fine roots. Your radish will look somewhat like the one shown by the picture in Fig. 50. The upper part of the root is large and round, and is stored full of food. Running out from the lower end of this large part is a common root about the size of a lead-pencil, which tapers to a point several inches below. Fine rootlets are attached to the sides of it. Similar rootlets are attached also to the thickened upper part of the root.

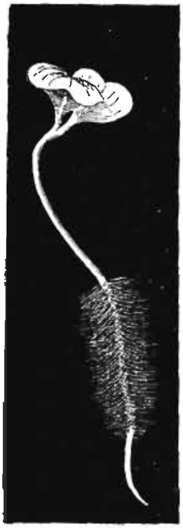


FIG. 51. — A very young radish plant, showing the root-hairs.

Root-hairs. — To understand how these rootlets obtain food from the soil, we must see the fine root-hairs that clothe them near the lower end. These hairs can be seen best if we germinate, or sprout, a few radish seeds, so that no parts of the roots will be injured. The root-hairs are very delicate, and we have broken most of them off in pulling the radish out of the soil. Let us sow a few seeds in packing-moss or between the folds of black cloth and keep them moist. In a few days the seeds will have germinated, and the roots will be an inch or two long. Lift one side of the cloth carefully and study the seedlings. Notice that at a distance of about one fourth of an inch from the tip the root is covered with a delicate fringe of hairs. Dip one of the plants into water; when it is removed the hairs cannot be seen. The water has matted them against the root so that they are invisible. They are so delicate that it is no wonder we break them in pulling the radish from the earth.

These root-hairs clothe all the young, growing rootlets on the radish. But they are not young roots. They never grow larger. They differ from the remainder of the root. Each root-hair is a single cell, shaped like a tube, and contains the life-giving matter of the plant, as do the cells in the other parts.

The plant-food dissolved in the soil water passes through the walls of these root-hairs into the root system. There are no holes, or pores, for it to enter, as we might suppose. It must pass directly through the walls, or surfaces, of the cells. It is able to do this because the cells contain sap, which is a stronger liquid than the soil water. The sap therefore draws the soil water through the walls. As the hairs are slender and very numerous, they are in contact with a large area of soil and consequently take in much soil water. The surfaces of rootlets themselves also take in some soil water.

Fig. 52. — The root-hairs cling to the soil.

The root-hairs help to secure the plant-food in another way. They are provided with an acid, which, when it comes in contact with the soil particles, dissolves a little of the food-elements that are needed. These are taken up by the soil water and so enter the plant. The soil water carries the necessary food materials into the plant.

Once inside, the soil water, containing its plant-food, passes into the rootlets, then through the roots, and up into the stem, the same process by which it entered the root-hairs. It finally reaches the leaves, where, by the aid of sunshine, and in combination with materials taken in from the air, it is made a part of the substances to be used by the plant, as we shall learn later.

Perhaps we shall now understand why the roots cannot use solid soil particles. There is no place for solid particles to enter the fine root-hairs. It may be said that roots absorb their food rather than eat it.

The stem. — As the plant has a root system to gather the needed water and minerals, so it has a leaf system to take from the air

FIG. 53.—The years' growths. The large branches started at the ends of the different years' growths of the main shoot. Red maple.

substances which it needs. The stem (or, in the case of trees, the trunk), branches, and twigs, connect the working centers, the roots and the leaves, so that they can exchange products with each other. In the stem are "ducts," or conducting channels, in which the water, bearing the food materials, travels upward rapidly to the leaves. There are other channels, made by chains of cells, through which the food manufactured in the leaves is carried to the roots and to the other parts of the plant to be stored or to be used in growth. The stem supports the leaves, and is an important part of the conducting system of the plant.

The leaf system.—Air is a mixture of gases;[1] and the materials that plants take from the air are said to be in gaseous form.

[1] A gas is matter that is neither liquid like water nor solid like ice. It is like steam; steam is a gas.

We need to know what are the substances the plant takes from the air, how it gets them, and what it does with them, in order to understand how the plant develops.

Carbon. — A considerable part of every plant is made up of a substance called carbon. At least half of the bulk of a tree, aside from the water it contains, is carbon. Charcoal is carbon in a solid form. The "lead" of a lead-pencil is still another form. The diamond is a pure crystaline form of carbon. As a gas, it is combined with oxygen, and exists as a small constituent in the atmosphere.

The plant gets its carbon from the air. Strange as it may seem, much of the solid part of the plant comes from the air in the form of gas. If we burn the corn plant, nine tenths of the solid matter [1] will pass back again into the air in the form of a gas that we call "carbon dioxid." This is exactly the form in which the carbon was taken from the air, as the atmosphere everywhere contains some carbon dioxid.

How the air enters the leaf. — The leaf is delicate and occasionally the air can enter directly into it through its walls. However, nature has provided special openings (called in botany stomates or stomata) for the entrance of air into the plant. These openings, or pores, are usually more numerous on the under side of the leaf. They are so small that they cannot be seen by the unaided eye. The under side of an apple leaf has about 100,000 of them to each square inch. The air passes into the leaf through these pores.

Leaf-green.— The substance which gives plants their green color is called "leaf-green" or "chlorophyll." It is produced only in plants or parts of plants exposed to the light. Plants grown in the dark do not produce it and are therefore white instead of green. Its special use is to aid in the formation of starch, which it does

[1] The solid matter or dry matter is all of the plant except the water. Nearly all plants contain much water. A corn plant in the roasting ear stage is nearly 80 per cent water and about 20 per cent dry matter.

by using the carbon dioxid from the air and the water brought up from the soil. From these materials sugar is first formed, and then starch. The starch is composed of carbon, hydrogen, and oxygen, and is known as a *carbohydrate.*

Starch is formed in very small grains, which will not dissolve in water. It is therefore not in a form for immediate use by the plant in growth, and must first be "digested." In the process of digestion it is changed again into sugar; and we know that sugar readily dissolves in water. In this form it is transferred to all parts of the plant where growth is taking place. In woody plants, as trees, it passes downward through the inner bark, just under the surface. In spring the maple sap is sweet, because it contains this dissolved sugar.

FIG. 54. — The effect of transpiration. The slip on the left has lost its moisture by transpiration and has wilted. On the right, the upper tumbler has prevented much of the transpiration, and the slip is still fresh.

Not all of the starch is needed for immediate use by the plant, and the surplus is stored for use in the early spring. The fleshy tuber of a potato contains stored-up starch. Fruit-trees usually blossom in the spring before they are able to make any plant-food that season. The young leaves and the blossoms are supported by the food that has been stored in the branches, twigs, and buds during the previous season.

Protoplasm. — We may now ask, what has become of the mineral foods carried into the plant and up to the leaves in the soil water? In the leaves some of the mineral matter from the soil water unites with some of the carbon taken in from the air to form what later becomes a product called protoplasm. Protoplasm is the real living, or life-giving, matter in plants. It exists in the cells in the plants, where it stimulates all the activities of the plant.

Transpiration. — In Chapter XI we learned that crops take from the earth 300 to 500 tons of water to make one ton of dry plant substance. Some of this water is used in the plants in dissolving and circulating the foods, and in keeping the plants "fresh" and strong. But much more water is taken into the plant than is needed. The surplus is given off from the leaves into the atmosphere by evaporation. This process is known as "transpiration"; that is, the leaves transpire, or give off, moisture. If the leaves give off more moisture than the roots supply, the plant wilts. The water is then taken out of the cells, and out of the conducting system, and the cells collapse. This teaches us again the necessity of an abundance of moisture in the soil.

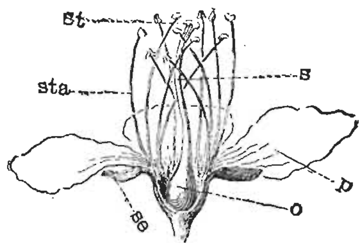


FIG. 55. — Parts of the plum flower: *se*, sepal; *p*, petal (three are shown); *sta*, stamens; *os*, pistil (in three parts); *o*, the ovary; *s*, the style; *st*, the stigma.

The flower and the fruit. — When roots, stem, and leaves have stored a sufficient surplus of food, the plant begins to flower. The flower springs from a bud on the stem or on a twig. Sometimes the flower is prominent and beautiful to look at, as on the apple tree, and sometimes it is not so readily distinguished, as in wheat or oats.

Very much has been intrusted to the flower. It contains the organs, or parts, which create the fruit. The fruit contains the seeds, from which new plants are to be grown. The flower is therefore the reproductive part of the plant. If it fails to do its part, there will be no fruit and no new plant, unless a new plant can be started from a slip, or cutting, from the old plant.

Parts of the flower. — If you were to open a flower of the peach, you would find a very small peach in the center. This is the lower part of what is called the "pistil," and is known as the "ovary." In the apple flower, the pistil has five parts or branches; in the plum it is not branched or divided. Around the pistil in the peach, the plum, and the apple blossom are the "stamens" that bear the "pollen." When the pollen falls on the pistil, it causes the pistil to set seed, and fruit. Bees and the wind carry the pollen. Peach, plum, and apple flowers are inclosed in showy leaves or parts called "petals," which help to attract the bees. Below the petals are small leaf-like parts called "sepals."

Problem 90. Dissolve one ounce of saltpeter, purchased at a drug store, in one pint of water. Mark it Solution I. Dissolve a small piece of saltpetre, not larger than a peach pit (about one seventh ounce), in one gallon of water. Mark the latter Solution II. Cut several slices of potato tuber about one eighth of an inch in thickness and let them lie in the air for a half hour. Then put a few of the slices into some of Solution I and others into some of Solution II. In about one half hour compare the slices in the two solutions. The pieces in the weak solution (No. II) will be rigid and stiff. Those in the strong solution (No. I) will be limp and flexible. This indicates that those in the strong solution have lost some water from their cells, while those in the weak solution have taken some water into their cells.

This experiment illustrates the way in which water is taken into the roots. As long as the water in the soil is weaker than the living matter in the root, water is taken into the root. When the soil water becomes stronger than the liquid in the root, the moisture from the root is drawn into the soil. The passage is always toward the stronger solution. It is possible to make soils so rich that plants cannot grow. The root-hairs can absorb only water which contains but a small quantity of plant-food materials.

Problem 91. Remove a small plant from the ground carefully, by lifting it out with a shovel, spade, or trowel. Then slowly wash away the earth till all the roots or rootlets are exposed. Note how extensive the roots are, the size and shape, the mode of branching. See whether you can find any difference between the roots of oats and of wheat.

Problem 92. To show that the root-hairs excrete an acid that dissolves minerals, place a half inch of sawdust on a polished marble block. Plant seeds in the sawdust and moisten it. After the small plants have produced a few leaves, turn the mass of sawdust over and observe the faint prints of the roots on the marble. The lines on the marble show where the mineral has been dissolved.

Problem 93. Can a farmer apply too much fertilizer to his land? Why?

Problem 94. What plants grown on your father's farm store up starch for future use? Where is it stored?

Problem 95. When potatoes sprout in a dark cellar, why are the sprouts white instead of green? How can they sprout, without being planted in the ground? Why do the sprouts reach toward a window or other opening through which a small stream of light comes?

Problem 96. Find the pistils and stamens in some flower that you know.

Determine the ovary or part that is to bear the seeds. In some plants, the stamens and pistils are in different flowers, and the different flowers may even be on different plants. (Examine squash, pumpkin, melon, cucumber, begonias, willows, poplars, hickories.)

CHAPTER XVI

CLASSIFICATION OF PLANTS

THERE are many different kinds of plants in any locality. A five-minute walk through the fields or the woods will reveal a great variety to a wide-awake observing boy or girl. There are trees of many kinds, shapes, and sizes; some are open and wide-spreading, others are dense and compact; some are evergreen, others are bare in the winter; some bear soft fruits, some nuts, some cones. There are erect, sturdy bushes and low, sprawling bushes. There are vines that creep on the ground, others that creep over rocks, others that climb trees. There are delicate flowering plants, and mushrooms and puff-balls. In the earth are countless hosts of invisible plants; in the water, *algæ* and other water plants (the ocean kinds of algæ are known as sea-weeds); in the marshes, sedges, lilies, and cat-tails.

The farm plants. — On the farm there is also great variety among cultivated plants. There are tree fruits and bush fruits; slender, upright grasses, and low, trailing clovers; thick, heavy root crops, and light, waving grains; loose, leafy lettuce and solid, round cabbages. Some plants live for many years, others for but one year; some produce many bushels of fruit, others a single fruit; some lift their fruit into the air, some bear it on the surface of the ground, and some (as the peanut) hide it in the earth. Some grow in thick, tangled masses, others grow alone. Each has a habit of life of its own, and will grow where it can live its own life best.

Why there are differences. — Plants have become adapted to all places on the earth where life is possible. The great variety of conditions in nature has called for many kinds of plants. Some locations are wet, others dry; some are sunny, others shaded; some are exposed to the wind and the storm, others are secluded, quiet, and protected; some are rocky slopes, others are deep, fertile valleys; some are sandy, others stiff clay. In the many centuries of the past, certain kinds of plants have been adapted or produced to meet these numberless conditions, and the result is shown in the variety we have to-day.

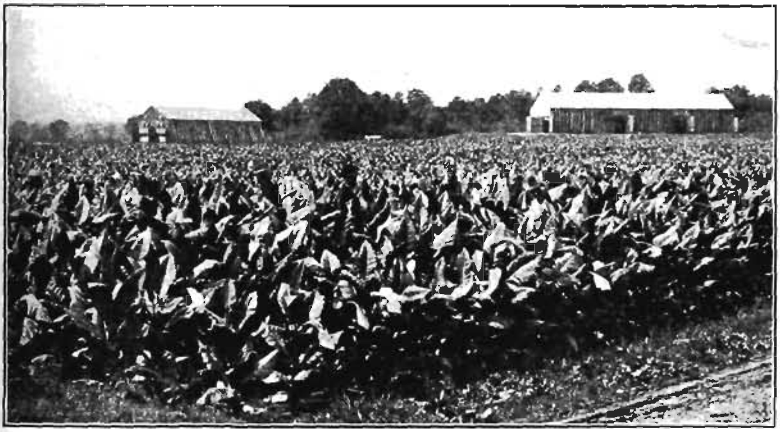


Fig. 56. — A field of tobacco, with curing sheds in the distance.

There is yet another reason why plants are not all alike. Most plants produce large quantities of seeds. It is not possible for nearly all of these seeds to grow into mature plants, because of lack of space on the surface of the earth. This results in a struggle for place, a struggle that never ceases. When certain plants win the chief places, others must adapt themselves to what is left or perish. Thus, in the meadow there are tall, stout grasses, and weaker grasses of the same kind. In the fence row are strong bushes and poor bushes of hawthorn or blackberry or choke-cherry. Rivalry necessitates variety.

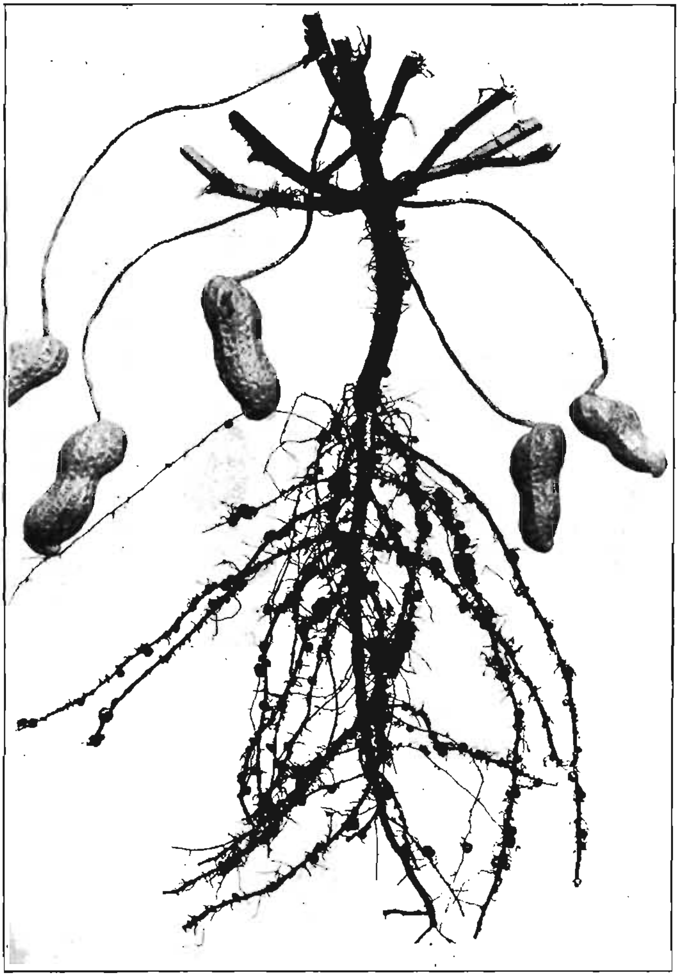


FIG. 57.—Part of a peanut plant, showing roots, root nodules, and nuts. The nuts are borne underground.

The farmer has taken advantage of the power of plants to change and has modified cultivated plants to suit his wishes. He has thus added to the variety in plant life. The many varieties of tomatoes in our gardens to-day are very different from the wild tomato from which they have been developed. The wild apple has little use; yet from it men have derived

From Duggar

FIG. 58.—A cotton plant bearing a large crop.

an almost endless number of useful varieties. And the farmer knows that the differences between any two stalks of corn or heads of cabbage may be due, in part at least, to the soil or competition or other conditions in which they are placed.

How plants are classified. — The differences in form, habits, length of life, and other qualities have been taken advantage of in grouping or classifying plants for purposes of study and comparison.

Classification by length of life. — We may classify plants according to their length of life; we then have a group of annual plants, which live not more than one year from the planting of seed to the production of new seed, as wheat, oats, barley, peas, beans, and tomatoes; a group of biennial plants, which live two years from seed to seed, as cabbages, parsnips, and common mullein; a group of perennial plants, which live more than two years, as asparagus, alfalfa, strawberries, bushes, and trees.

Classification by use. — Another very common classification of plants, based on the use that is made of them, together with their habits of growth, is as follows: —

(1) Forage and fodder crops, as timothy, alfalfa, sorghum, cowpea, corn fodder.

(2) Grain crops, as corn, wheat, oats, rye, barley, and rice.

(3) Root crops, as carrot, parsnip, turnip, mangel, beet, and sugar-beet.

(4) Fiber crops, as flax, hemp, and cotton.

(5) Fruit crops, as apple, peach, pear, plum, quince, currant, blackberry, grape, orange, banana.

(6) Vegetable crops, as tomato, pea, bean, cucumber, and celery.

(7) Ornamental plants, as rose, lilac, geranium, sweet pea, and nasturtium.

(8) Timber crops, as oak, chestnut, maple, cypress, and pine.

There are other special groups that might be added, as sugar plants, oil plants, perfumery plants, spice plants, dye-stuff plants, and medicinal plants.

When we speak of forage crops, or root crops, or grain crops, the person to whom we are talking knows at once what kind of plants we are speaking about, because these groups are well established. As nearly all the plants in each group have certain characteristics in common, especially in their cultivation, such a grouping is useful in describing them.

The botanist's classification. — The farmer is satisfied to classify his plants as forage crops, root crops, vegetable crops, and the like. These general groups are sufficient for his discussions. Some of these classes, however, include plants of very unlike characteristics and habits, and sometimes it is desirable to group them according to likeness of characters. The botanist, the person who makes a very close study of plants to find the important resemblances among them, groups them into families. He places in a plant family all those plants that seem to be related in their general nature. He gives these families Latin names. Thus, in the grass family (Latin name, *Gramineæ*) he places timothy, blue-grass, orchard-grass, redtop, wheat, oats, rye, barley, corn, sugar-cane, and others. In the rose family (*Rosaceæ*) he places apples, peaches, plums, raspberries, blackberries, strawberries, and others. In the pulse family (*Leguminosæ*), peas, beans, clovers, vetches, and alfalfa. In the mustard family (*Cru-*

FIG. 59. — Oats.

ciferæ), mustard, cabbage, kale, rape, turnip, rutabagas, and radishes. In the nightshade family (*Solanaceæ*), potatoes, tomatoes, egg-plants, peppers, and tobacco. In the lily family (*Liliaceæ*) all the true lilies, onions, hyacinth, and tulip. There are many other plants in all of these families, some of which are not of importance to the farmer. There are many other plant families besides these.

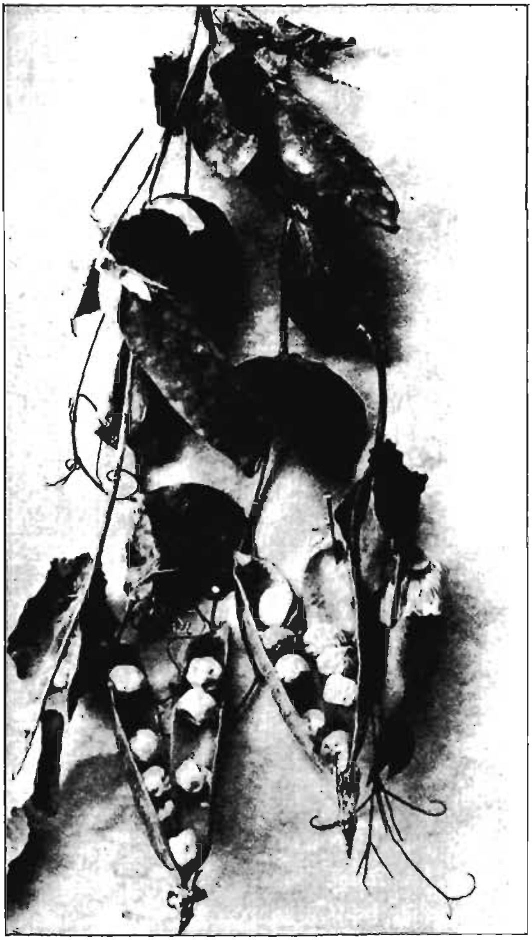


FIG. 60. — Pea. "Leguminous" plants bear their seeds in a certain kind of pod called a "legume." Peas, beans, clover, alfalfa, cowpeas, and vetch are examples.

It is of interest to know in what family group each of our farm plants is placed, and what other plants are its relatives. Perhaps we should learn, first, whether a plant is a fruit, vegetable, root, cereal, or forage plant; then whether it is an annual, biennial, or perennial; and finally, to what natural family it belongs.

Problem 97. How many different kinds of plants are grown in your garden? Which produce underground the part that is to be eaten? Which produce their product on the surface of the ground? Which are vines?

Problem 98. Do you think that the squash, the pumpkin, the cucumber, and the muskmelon belong to the same family? Why?

Problem 99. What resemblance is there between the potato and the tomato? Do the plants look alike in any respect? Are the leaves similar? The flowers? The fruits (who has seen the fruit of the potato)?

Problem 100. Name some of the annual plants on your father's farm; the biennial; the perennial.

Problem 101. Write a list of all the plants on your father's farm that belong in each of the following groups: forage and fodder crops, cereal or grain crops, fruit crops, vegetable crops, flower crops, and root crops.

CHAPTER XVII

DISSEMINATION AND MULTIPLICATION OF PLANTS

Long before man came to live on the earth, plants had established themselves on its surface. They grew, produced other plants, and perished. They did not need the interference of man to plant their seeds or their roots, or to carry them from one place to another. Nature provided them with all the means of multiplying and spreading that were needed.

Fig. 61. — One of the ways in which seeds are scattered.

Nature's method of distributing plants. — Some of the plants, as the cocoanut, are encased in snug, water-proof jackets, so that they can float on the surface of streams to new regions. Others, as the maple seeds, are given wings to carry them on the wind. The dandelions are provided with parachutes so light that they can sail away in the breeze to distant fields. The burdock and the stick-tight are given little coiled arms to clutch the fur or hair of a passing animal and ride away to a new home.

The tumble-weed excels many others in cleverness. In the autumn, when its seeds are ripe, it breaks off at the surface of the ground, and by the wind is swept tumbling across the field, leaving a trail of seed wherever it passes. The wild carrot, not to be outdone, sends its seeds skidding across the country on the smooth snow in winter. The touch-me-not provides itself with a spring which, when the ripened pod bursts, throws the seeds far away from the parent.

Other plants are given bright, attractive seeds that taste good to birds, which eat them and scatter the seeds in their flight. The white clover and the strawberry reach out their branches as far as they can from the parent plant, send down roots, begin to make their own living as independent plants, and separate from their parents. The blue-grass reaches out in the same way underground, and sends up, all about the parent, new plants which soon become independent.

With so many means of multiplying, it is little wonder that the earth is covered with a great variety and tangle of plants, all struggling for place and opportunity to live.

Man's method. — *When man began to live a settled life*, he discovered that he could not depend on Nature to plant his garden, for she had a way of mixing and moving her plants. He desired to choose his crops, plant them in rows instead of tangles, and control them to suit himself. So he collected seeds and roots, carried them to the place where he wanted them to grow, and planted them.

The *means of multiplying plants which man used* varied with the kinds of plants. Some were multiplied, or propagated, most readily by the use of seeds, others by the use of roots or other parts. The farmer to-day propagates his plants mainly by the use of seeds, roots, tubers, cuttings, buds, and grafts. He has found that he must employ many methods to get the best results from different kinds of plants.

Propagation by seeds. — A seed is a body produced by a plant, which contains a small or tiny undeveloped plant called an "embryo." The embryo is surrounded by food, stored for its use when it shall begin to grow, or else contains food within itself. The purpose or use of the seed is to produce a new plant like the one from which it came. When placed in the proper conditions

Fig. 62. — Squash seeds.

of moisture, temperature, plant-food, and air, the seed will sprout and a plant be produced.

Nearly all farm crops are grown from seeds, especially those that are annuals. Wheat, oats, barley, beans, peas, corn, lettuce, radishes, and beets are always raised from seeds. This is the simplest method of multiplying plants, as seeds are usually produced in great numbers, are easily collected and stored, and may be planted with little difficulty. They may be sown broadcast over the field, or may be dropped into holes or trenches; and they may be planted by machines or by hand.

Propagation by other means. — Some plants, as sweet-potatoes and sugar-cane, produce few seeds; others, as grapes and strawberries, grow faster and better by the use of other parts than seeds; in still others, as apples and potatoes, the seed cannot be depended upon to produce a new plant similar to the parent, and the farmer cannot be sure what he will get if he plants seed. In all of these cases he finds it better to use parts, or sections, of the parent plant for starting his new crop. The part that he uses is not the same for all plants, for some plants reproduce better from one part than from another. We shall study how these different parts are used.

Roots. — The sweet-potato is a good example of a plant in which the root is used for starting the new crop. The part of the sweet-potato that is eaten is the root. When this is planted, it throws up many sprouts that have roots of their own. When these sprouts are pulled and planted, they will produce sweet-potato plants.

FIG. 63. — The potato is a storehouse of food. When it is set in water, shoots grow out from its eyes, or buds.

Tubers. — A tuber is a greatly enlarged part of a plant, particularly of an underground stem. Usually we think that the stem of a plant is all above ground. In the case of the white, or Irish, potato, part of the stem is below ground. This part bears large tubers that we call potatoes. The potato, then, is not really a root, as we may have thought. The potato plant has other true roots.

The potato is the most familiar farm crop that is multiplied by the use of tubers. The tubers may be planted whole, but usually it is more economical to cut them and plant pieces having about two eyes. These eyes are buds from which new plants will spring.

Cuttings. — A cutting is a part of a plant, cut from the parent, which is used to produce a new plant. Some plants grow much better from cuttings than from seeds. Most house-plants and many woody plants raised on the farm are started from cuttings, or "slips" as they are also called.

Cuttings may be made from the stem, from a branch or twig, or from a leaf. In starting new grape vines, a short section having three buds is cut from the growth of the preceding season. Two of the buds are placed below ground for the formation of roots, leaving one above ground for the growth of the new vine. With sugar-cane, the short sections of the stalk carrying one or more buds are laid horizontally in the soil and lightly covered with earth. Currants and willows are readily started from cuttings. All of these form roots and become perfect plants.

Buds and grafts. — There are other plants that do not "come true" to seeds and that do not readily develop roots from the stem. In some way they must be established on the roots of other plants. This is accomplished by transferring a bud from the plant it is desired to increase to the stem of another plant, and inserting it there. Here it will attach itself and begin growth as part of the new plant.

Sometimes, instead of using a single bud, the farmer will take short sections of a branch bearing more than one bud. Such a section is called a graft, or *cion*. It is attached to the plant of which it is to be a part by cutting off the stem or branch of the latter and inserting the cion like a wedge in the cut end.

Buds and grafts always produce the same kind of tree or plant as that from which they were taken. Varieties of apples, peaches, plums, pears, and cherries are nearly always perpetuated from buds or grafts. They grow on the roots of other similar plants, these other or *stock* plants having been grown from seeds. The budding or grafting is usually done in the nursery row, while the stock is very small and only one to three years old.

Thus, peach stones of 1911 may be planted in the fall, or in the spring of 1912; in August or September, 1912, the buds of chosen varieties may be inserted in them, one near the ground in each little tree. These buds remain dormant, or quiet, all winter, and begin to grow in the spring of 1913. In the fall of 1913, the tree is ready for sale. Apple trees require two to four years longer than this.

Problem 102. If there is a fruit-grower in your neighborhood, ask him to show you how to bud and to graft. Watch him cut the bud and the cion, and ask him questions.

Problem 103. In winter or spring, cut a section having three buds from last year's growth of the grape vine. Place it in a pot of moist sand with two buds below ground. When the young plant has well started, take it out of the pot and see where the roots come from. Set it out near the fence in your school-yard to grow.

Problem 104. If there is a strawberry bed on your father's farm, find a plant that has reached out and started another plant. Bring it to school to show to the class.

Problem 105. Write a list of fifteen useful plants on your farm or in the neighborhood, and tell how each is multiplied.

Problem 106. How is the common garden geranium multiplied? The fuchsia? The onion?

Problem 107. Dig up a potato plant and find the real roots.

Problem 108. For your schoolroom exhibit, collect seeds that are scattered by the wind from as many plants as possible — as dandelion, thistle, milkweed, maple, ash, poplar, box-elder, and others. Collect also those that are scattered by attaching themselves to the coats of animals or the clothes of persons — as burdock, Spanish needles, sand burs, beggar ticks, and the like. Put the seeds from each plant in a bottle by themselves and label the bottle with the name of the plant and a statement telling how the seeds are scattered. From year to year add to the collection until you have seeds of all the plants grown in the neighborhood. When you go out into the fields, carry a few small bottles or envelopes with you in which to collect seeds.

Problem 109. Take a small box of sand, say 10 inches square and four inches deep, and a leaf from a Rex begonia plant. Moisten the sand and lay the leaf on it, right side up. Fasten it to the sand by running toothpicks through the ribs in several places. Set the box for a few days where it will be warm, but not in direct sunlight. Do roots grow from the places where the toothpicks go through? How many new begonia plants can you start from one leaf?

CHAPTER XVIII

ROTATION OF CROPS

On every farm several different kinds of crops are grown. When the farmer has a definite plan by which he changes his crops from one field to another from year to year, so that one crop always follows a certain other crop, we say he is rotating his crops, or is practicing crop rotation; that is, he is growing his crops in a circle or rotation, one after another, returning to the same field with a certain crop every four or five or six or other number of years.

What crop rotation is. — Suppose a man has a dairy farm and is raising his own hay, corn, and small grain. Let us say that each year he raises the same number of acres of corn and small grain, and twice as many acres of hay. He desires to rotate his crops, so he divides his farm into four fields of equal size. We may call his fields *A*, *B*, *C*, and *D*. He has decided that he will plant corn on land that produced grass the last two years, follow the corn with small grain, sow grass seed in the grain, then let the grass grow for two years before he plows it for corn. How will he rotate his crops on his fields? Let us study the following chart and see: —

	Field *A*	Field *B*	Field *C*	Field *D*
1912	Corn	Hay	Hay	Grain
1913	Grain	Corn	Hay	Hay
1914	Hay	Grain	Corn	Hay
1915	Hay	Hay	Grain	Corn
1916	Corn	Hay	Hay	Grain
1917	Grain	Corn	Hay	Hay

On Field *A*, in 1912, he will plant corn; on Field *B*, he will have hay; Field *C*, hay; Field *D*, grain. That gives him equal areas of corn and grain and twice as much hay. In 1913, he follows corn with grain on Field *A*, plants his corn on Field *B* which last year raised hay. He leaves Field *C* in hay for the second year and follows grain on Field *D* with hay. In 1914, he moves his crops all forward to the next field, following grain with hay on Field *A*, following corn with grain on Field *B*, plowing sod for corn on Field *C*, and allowing the hay to remain for the second year on Field *D*. In 1915, the crops move forward again. In 1916, the beginning of the fifth year, his rotation has reached its starting point, and each crop has returned to the field on which it was grown in 1912.

It requires four years to complete this rotation. It is a four-year or four-course rotation. The fifth year it begins a new round. It is a definite plan, or system, which gives the farmer each year just what he wants without growing the same crop on the same field oftener than once in four years, except in the case of hay, which is left purposely for two years.

Each year half the hay land is plowed. If the grass seed is sown with the small grain, it will not grow enough to interfere with the grain. It takes possession of the ground after the grain has been harvested. It will therefore not be necessary to plow the grain land after the harvest to plant the grass; and as only one hay field is plowed each year, the farmer will plow half of his farm each year instead of all of it. This makes less work.

This is a simple rotation that is in common use. Other rotations may be planned for more fields, more crops, or for a greater or less number of years. The farmer may work out nearly anything he desires. But he should always have a regular plan, or system, of crop growing.

Why crops are rotated. — Let us see what benefit will come from using the four-year corn, small grain, and hay rotation given on page 128. Corn is tilled or cultivated between the rows when it is growing. This loosens the soil, helps to improve its general condition, and by admitting air aids in making plant-food available. It also destroys weeds. When the grain is sown it occupies all of the land closely and helps to choke out many weeds. When grass is planted, clover may be sown with the timothy. Clover is a leguminous plant, and therefore, as we have learned, makes the soil richer. Then when the sod is plowed under, the grass adds a great deal of vegetable matter to the soil to be made into humus. Stirring the soil for the corn that follows helps to decay this vegetable matter.

We learned in Chapter XIV the many benefits that come from plowing vegetable matter into the soil. If corn only, or wheat only, were grown, there would be very little vegetable matter added, and the soil would suffer from need of it.

Chess and cockle are weeds that grow with wheat and become very destructive when land is constantly in wheat. They are destroyed by the grass crop followed by clean or constant tillage such as is given for the corn.

When one crop is grown constantly on the same field, it seems to injure the soil in some way. This injury is avoided when crops are regularly changed. Furthermore, some plants have short roots and take all of their plant-food from near the surface of the soil, while others have long roots that reach deep into the soil in search of food and moisture. Wheat, radishes, and onions are short-rooted and take their food from the first six inches of soil. Alfalfa may send its roots as far down as thirty feet. This distributes the demand for plant-food over a much larger area of soil, which we can readily see is an advantage.

Planning a rotation system. — The farmer will choose a rotation that meets the particular needs on his farm. His next door neighbor may have a very different rotation. If he is raising stock, his rotation will be planned to include the crops needed for feeding. If he is a grain-farmer, and desires to grow as much grain

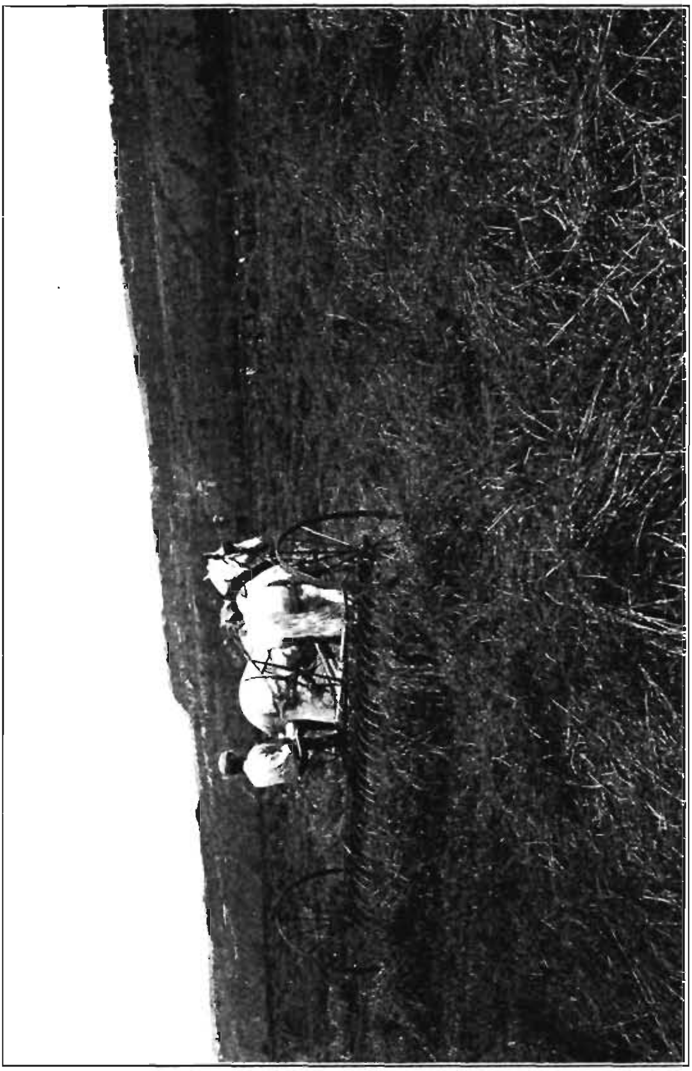


FIG. 64. — The hayfield.

as possible, he will have a different rotation. If the soil is poor, the rotation will include the frequent use of leguminous crops and the plowing under of green manures to improve it. If the farm has sandy soil, a different system must be planned from that used for clay soil. One rotation is useful in a cool, moist climate, another in a hot, dry climate.

In all of these cases, the farmer will plan his rotation so that each crop will leave the land in the best condition for the one that is to follow. Wheat and rye leave the land in good, smooth condition for hay, and consequently hay often follows wheat or rye in the rotation.

The farmer will also plan his rotation so that his farm help will be used to the best advantage throughout the year. He will plan to distribute his planting and his harvesting so that all this work will not come at one time and be more than his men can do.

When all of these conditions have been carefully considered, the farmer will try to plan a rotation that will include a "money crop," that is, one that will go directly to market; a clean-tilled crop, or one that is tilled between the rows during the growing season; a hay or straw crop; a leguminous or soil-improving crop. Such a rotation will keep the land from becoming poor and will not allow many weeds to grow. In the rotation on page 128, the small grain may be the "money crop," the corn is the clean-tilled crop, and clover, in the hay, is the leguminous crop. The hay and corn, and perhaps some of the small grain, may be fed to stock on the farm.

If the farmer is raising a special crop, as a gardener near a large city is likely to do, and keeps his land in constant use so that the humus is used up, he must buy commercial fertilizer and stable manure to keep his land in good condition.

History of crop rotation. — When settlers come into a new country and find the land rich, they are not likely to rotate their crops with any special care. As long as the land is fertile, they are not concerned as to how they shall keep it so. As soon as one piece becomes poor from unwise farming it is deserted and another piece is taken up to be ruined in the same way. It is only when nearly all the land becomes poor that they begin to think of the importance of a careful system of farming.

This is just what took place in America. George Washington, who was a thoughtful farmer as well as a great statesman, became alarmed at the carelessness of the farmers about him. He saw that they were robbing their land of fertility by their lack of careful system. In 1787, he wrote the following letter to his friend Arthur Young in England: —

"Before I undertake to give the information you request, respecting the arrangements of farms in this neighbourhood, &c., I must observe that there is, perhaps, scarcely any part of America, where farming has been less attended to than in this State (Virginia). The cultivation of tobacco has been almost the sole object with men of landed property, and consequently a regular course of crops has never been in view. The general custom has been, first to raise a crop of Indian corn (maize), which, according to the mode of cultivation, is a good preparation for wheat; then a crop of wheat; after which the ground is respited (except from weeds, and every trash that can contribute to its foulness) for about eighteen months; and so on, alternately, without any dressing, till the land is exhausted; when it is turned out, without being sown with grass-seeds, or reeds, or any method taken to restore it; and another piece is ruined in the same manner. No more cattle is raised than can be supported by lowland meadows, swamps, &c., and the tops and blades of Indian corn; as very few persons have attended to sowing grasses, and connecting cattle with their crops. The Indian corn is the chief support of the labourers and horses. Our lands, as I mentioned in my first letter to you, were originally very good; but use, and abuse, have made them quite otherwise.

" The above is the mode of cultivation which has been generally pursued here, but the system of husbandry which has been found so beneficial in England, and which must be greatly promoted by your valuable Annals, is now gaining ground. There are several (among which I may class myself), who are endeavouring to get into your regular and systematic course of cropping, as fast as the nature of the business will admit; so that I hope in the course of a few years, we shall make a more respectable figure as farmers than we have hitherto done."

In Washington's time the land was "respited," or rested, or allowed to remain idle after it had been injured by careless farming. To-day the best farmers do not "rest" land to improve it; they practice crop rotation, good tillage, and the use of fertilizers and manures, and keep the land in good condition.

Crop rotation has become a regular practice on farms all over this country, and hundreds of different rotations are in use. Americans are becoming better farmers.

Problem 110. Do all the farmers in your neighborhood raise large crops? If one raises specially large crops, ask him to tell how he does it, what fertilizers he uses, and what is his rotation of crops.

Problem 111. Explain what kind of rotation is used on your father's farm, or a neighbor's farm, and why it is used. Which is the money crop? Which is the clean-tilled crop? Which is the leguminous crop? Are all of the fields included in the rotation? If not, are the crops as good on those not in the rotation?

Problem 112. How often are the meadows plowed on your father's farm? What is planted after the meadow? Why? Do the farmers that keep their land in hay for two or three years get larger crops than those who keep it in hay for five or six years? At haying time, compare a field that is in hay for the second year with one that has been in hay for several years. Decide whether it pays to rotate the hay crop.

Problem 113. If your father does not rotate his crops, see whether you can plan a rotation for him. Write out a rotation, explaining why you place the crops in certain order. Ask your teacher to tell you whether or not it is a good rotation, and why.

Problem 114. Suppose a farmer raises potatoes, rye, and hay to sell, and needs twice as much hay as rye or potatoes. What should be his rotation? Why?

Problem 115. If a six-acre field yields a ton and a half of hay to the acre the first year and each subsequent year yields 400 pounds less to the acre, how much will it yield at the end of five years? If hay is worth $16 a ton, how much less will the hay crop be worth at the end of three years and of five years? Would it pay to rotate the hay crop so as to get a new crop every two years?

CHAPTER XIX

INDIAN CORN

As far back as we can go in the history of man, we find that he depended on grain for much of his food supply. In many places in the Bible we read about the cornfields. In the book of Genesis it is said that " Joseph gathered corn as the sand of the sea, very much, until he left numbering; for it was without number." Many centuries later it is written that Jesus and His disciples passed " through the cornfields."

Maize. — But this was not the same kind of corn that is called by that name in America to-day, and which was not known to white men until after the discovery of America. The name " corn " has been given to several different grains by different peoples in various parts of the world. In the book of Ruth we read that Ruth asked " to go to the field and glean ears of corn . . . so she gleaned in the field until even, and beat out what she had gleaned; and it was about an ephah (a little more than a bushel) of barley." In the northern part of Europe, corn is the name given to rye; in England, corn means wheat; in Scotland and Ireland, a field of corn is understood to be a field of oats. Thus we see that the name corn is applied to all of the grains. The original meaning of corn was a grain or hard seed, and all of these plants have been called corn just as we now call them all grains.

We speak of these grains also as cereal grains, or cereals. The word *cereal* comes from Ceres, the name of the goddess of agriculture, worshipped by the Romans over two thousand years ago. They thought that Ceres watched especially over the grains.

The corn of America probably originated in southern Mexico and was extensively grown there centuries before the discovery. As the Romans brought to Ceres the first-fruits of their grain harvest, so the native Nahuas of old Mexico sacrificed the first-fruits of their cornfields to Centoatl, their goddess of maize, or corn. Long before Columbus landed in America, the plant had been carried by the Indians into the temperate regions of both North and South America. When Columbus reached the West Indies, he was given by the natives a bread made from a grain called mahiz. He used this name in his letters to Spain, and from it has come our word *maize*, commonly applied to corn. In a letter to Ferdinand and Isabella, dated May 30, 1498, speaking of his brother, Columbus says, "During a journey in the interior he found a dense population entirely agricultural, and at one place passed through eighteen miles of cornfields." The Indians were farmers.

Place of maize in American agriculture. — The cultivation of corn, Indian corn as it was called, was the chief reliance of the early colonists as it had been of the Indians before them. It was already well established and grew luxuriantly. The settlers learned from the Indians how to prepare the corn for food. Roger Williams, in speaking of the forms in which corn was used for food in New England, says, "Samp (from the Indian name for the dish, *nasaump*) is the Indian corne, beaten and boiled, and eaten hot or cold with milke or butter, which are mercies beyond the native's plaine water, and is a dish exceeding wholesome for English bodies."

From colonial days to the present, corn has held an important place in American agriculture. To-day it is the most important American crop. It can be grown in nearly every part of the continent. It has become adapted to all the various climates from Canada to the tropics. For the short seasons of the north there are varieties that ripen in 70 or 80 days and grow but three or four feet tall. In the southern part of the United States, Mexico, Central America, and South America, there are varieties that grow to a height of twenty feet or more and require six months in which to complete their growth. Corn fits well into crop rotation systems, and this has led to its being grown in regions where a few years ago it was not an important crop.

The corn or maize plant. — Let us go out into a field of standing corn, or bring a corn plant into the schoolroom and study it. We should know that the worst foe of the corn plant is wind, and it has been obliged to develop certain forms of stalk, leaf, and root to enable it to withstand this foe. If we cut a corn-stalk across, we find that it is a strong cylinder with a pithy center. It is strengthened at short intervals by hard nodes, or joints. If all of the stalk were as compact and rigid as the nodes, it would break in the wind instead of bending. As it is, the stalk is elastic, and will bend far over without breaking. The nodes are near together at the bottom, thus giving strength to the base; they are farther apart at the top, where the wind strikes and where the stalk must bow rather than break.

The corn leaf comes from the stalk at a node. Its base clasps the stalk completely for some distance, thus making the latter stronger. Just where the leaf bends away from the stem is a small growth, which fits tightly around the stalk and is called the rain-guard because it prevents rain from seeping down between the stalk and the clasping leaf, where dampness would allow disease to set in.

The true roots of the corn plant, which begin their development from the planted seed, penetrate the soil rather deeply, but they are hardly able to hold firm a stalk so slender and tall as that of the corn plant when the wind blows fiercely against it. Hence, all about the base of the stalk are certain roots, which we call brace-roots, the office of which is to hold the stalk erect.

Blossoms. — Each corn-stalk has two kinds of blossoms. Those that bear the pollen appear at the tip of the stalk; they are borne in the "tassels." The other flowers are those that develop the seed and are the pistillate (bearing the pistils) flowers, borne in the ears of corn. These pistillate flowers are set on a central stalk or cob. From each one a long thread, which we call the corn silk, runs out. This silk reaches out to receive the pollen that falls upon it from the tassels of its own stalk or is blown upon it from the tassels of the same or other corn plants.

Fig. 65.—A well-shaped ear of yellow dent corn.

If one of these pistils fails to receive pollen at the tip of its long silk, it does not develop into a kernel of corn, and the ear will then be imperfect. Such undeveloped kernels we say are "blasted." These kernels are set on the stem or "cob" in twin rows; that is, each row is double, being made up of pairs of kernels. If different varieties of corn are planted one near another, the pollen from one kind may be carried by the wind over to the ears of the other kinds, and the result will be a mixture of two or more varieties on the same cob.

Ears. — The ears are borne at the joints or nodes; and on the side next the ear, the stalk is grooved. The husks show plainly that they are modified leaves, in the following ways: The husk has the same structure as the leaf; the outside husks are green and, therefore, do the work of leaves. The husk often changes to leaf-shape at the tip of the ear, thus showing that the husk itself is that part of the leaf which normally clasps the stalk. As a matter of fact, the ear of corn is on a branch stalk which has been much shortened so that the nodes are very close together, and the leaves, therefore, come off close together.

Kinds of corn. — There are eight distinct kinds, or "species," of corn. They differ one from another in certain important respects. They are:

1) A wild form, sometimes found in Mexico.
2) Pod corn, in which each kernel is inclosed in a separate pod husk.
3) Popcorn.

From Duggar

66. — The husks often produce leaf-shapes, indicating that they are modified leaves.

4) Flint corn, a hard smooth corn, generally yellow in color, wn in New England and other northern states.
5) Dent corn, which has a dent or depression in the large end, ellow or white in color, and is grown in both the north and south.
6) Soft corn, not often grown in North America.
7) Sweet corn, having a horny and more or less crinkled ap-rance, used for table purposes.
8) Starchy sweet corn.
here are many varieties of most of these kinds, so that

there are great differences in the types of corn grown in different places.

The culture of corn. — The seed for planting should be chosen the fall before from the standing corn, for it is important that the

FIG. 67. — Corn. *From Duggar*

seed come from thrifty stalks that yield the largest amount of corn. The ears should be of good length, strong, and well filled at tip and butt. A few kernels from each ear of the seed corn should be tested to be sure it will sprout vigorously. We shall learn how to test seed in Chapter XXX.

The soil should be the most fertile on the farm. Sod land which grew clover the preceding year, and which received a dressing of barnyard manure during the winter or early spring, is ideal. It should be plowed early and harrowed repeatedly until the seed-bed is fine and smooth.

Planting should be delayed until the weather is warm all day long. If it is to be done by hand, furrows should be made across the field, generally in its longest direction, about three and one half feet apart. The corn may be planted in hills, three kernels in a hill. In the East, where corn is thinned after the plants are up, as many as five seeds to the hill may be planted. For large varieties the hills should be three and one half feet apart in the row, and for small varieties a shorter distance. The seed is covered with fine soil one or one and a half inches deep. If a horse-drawn corn planter is used, it will not be necessary to make the furrows.

A few days after planting, the weeder should be run over the field to stir the surface and destroy the sprouting weeds. About a week after the corn shoots can be plainly seen in the rows, the first cultivation should be given. This should be fairly deep. The later ones may be less deep.

FIG. 68.—Cutting corn with a harvester that has an attachment to carry the stalks until a bundle is formed.

Frequent cultivation benefits corn, and four or more cultivations should be given during the growing season. The surface should be left fine and nearly level. The hoe must be used to keep the weeds out of the rows.

Harvesting.—Harvest time is at hand when the lower leaves on the stalks begin to die and many of the husks are becoming dry. The stalks may be cut by hand or with a corn harvester. About sixty hills may be gathered into one shock and the tops bound together to make the shock stand. If the corn is heavy, smaller shocks should be made. If they are too large, the corn on the inside will not cure well. If the weather is good, the corn will be cured in six weeks.

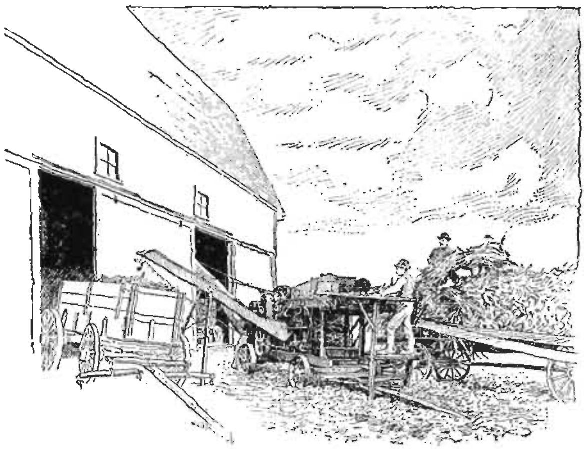


Fig. 69.—A machine for husking and shredding corn. Why are the stalks shredded?

After the ears have been husked, the stalks should again be bound together and stored under cover for winter use. If the fodder is to be fed to stock, it should not be left in the field during the late fall and winter. If the fodder is not to be fed, husking may be done in the field and the stalks left standing. The ears, after husking, should be stored where air can circulate about them, and where they will be free from rats and mice.

The silo.—The silo is a building in which certain kinds of green plants are stored in quantity in such a way that they will remain green and juicy and wholesome. It is much used on stock farms to preserve green corn, clover, alfalfa, and other forage plants, so that in winter the cattle may have fresh food. Corn is the principal crop preserved in this way.

The first silo in Europe was a stack of wet grass covered with earth. In America, the first ones were pits in the earth. Most of those in use to-day are wood or cement structures built above ground, adjoining or part of the cattle barns. They are usually built in the shape of a cylinder, but may be square.

When the corn is grown for the silo, it need not be planted in hills, but the seed may be sown so as to have a stalk about every seven inches in each row, the rows being three and one half feet apart. It is harvested for the silo when the lower leaves are turning yellow and when the kernels begin to be hard and no milk comes out of them when they are mashed.

Enemies. — Crows and blackbirds are the enemies of the young corn plant. They must be frightened away from the field until the corn is too large for them to pull it up. Cutworms lurk about the hills and cut off the stalks. Coating the kernels of seed corn with coal tar before planting will drive away some of the enemies after it has been placed in the ground.

Uses. — Although corn is produced in America much more extensively than other grains, very little is exported. It is nearly all used on the farms where it is produced to fatten cattle and hogs for market.

Aside from the use of the fodder, grain, and meal for feeding, there are many other corn products of commercial value. The silks are used in the making of filters; the husks for the making of mattresses; the pith for the packing of coffer-dams of battleships; the outer parts of the stalk for the making of varnish and for paper; the cobs for corn-cob pipes. An oil used in the arts is extracted from the seed germs. Starch and alcohol are made from corn. There are many other products that might be mentioned, for corn is one of the most useful of our farm crops. There is one factory that makes forty-two different corn products.

Problem 116. Do the roots of the corn plant penetrate deep into the soil? Why? Describe the brace-roots. How do they help the plant to stand firm against the force of the wind? How far up the stem do the brace-roots come off?

Problem 117. Where on the stalk are the ears borne? How many ears on a stalk? After removing the husks carefully, note whether there is a thread of corn silk for every kernel. How many rows of kernels are there on the ear?

Problem 118. What varieties of corn are grown in your locality? What is each kind grown for? Are all of the varieties planted in the same way? Describe the differences. Collect good ears of the different varieties for your school exhibit. Attach the name of the varieties to each one, and place them where you can study them until you easily recognize the different varieties without looking at the names.

Problem 119. For what is the corn raised on your father's farm used? Is any of it shipped away? If so, where does it go? What becomes of it?

Problem 120. Who grows the best corn in the locality? How does he prepare his land? What crop precedes corn in his rotation? How does he secure his seed? How often does he cultivate the growing crop?

Problem 121. Make a list of as many things as you can find are made from some part of the corn plant. It will be very interesting to collect as many of these as possible and arrange or mount them on a chart. This may be done with other grains also.

Problem 122. How many hills are there in a one-acre cornfield if the hills are three and one half feet apart each way? If each hill bears three ears, how many ears are there on the acre? If it takes 105 ears to make a bushel, how many bushels are there? At $ .40 a bushel, what is the crop worth?

Problem 123. Suppose that the field described in Problem 122 represents your father's cornfield. Will he get more corn if he has five stalks in a hill, each bearing an ear of which 200 are required to make a bushel, or three stalks in a hill bearing ears that require 105 to make a bushel?

CHAPTER XX

WHEAT

WHEAT has held a leading place in the food-supply of all the greatest nations of the world since the beginning of history. It has been grown so long and in so many different countries that there is difficulty in determining where it originated. Monuments much more ancient than the Hebrew Scriptures show that it was an important plant at the time they were built. The earliest Lake Dwellers in western Switzerland cultivated a small-grained variety of wheat. The ancient Egyptians and Greeks believed that it had been originated by some of their deities, among them Demeter (Latin, Ceres), the goddess of agriculture. It was grown by the Chinese at least 2700 years B.C., and was considered by them a direct gift from Heaven.

Western Asia, especially the valley of the Euphrates, is supposed to have been the original home of this plant. A wild grass native to the Mediterranean region at the present time bears a resemblance to the wheat plant.

Wheat in America. — It is believed that wheat was not known in America before the discovery by Columbus. Within two weeks after the arrival of the first colonists at Jamestown, in 1607, this crop was sown on land that had been cleared by felling timber for the fort. In the year following, additional land was cleared and planted. The first attempts were not especially successful, but the colonists persisted and from year to year planted wheat in increasing quantities. The crop was harvested with the reap hook and the sickle and was trodden out by horses and oxen instead of being threshed with a flail.

As early as 1626 wheat was cultivated by the Dutch in New York. It held a leading place in the middle colonies and was among the very few crops exported. The Pennsylvania millers gained a wide reputation for the excellence of their flour.

Wheat was sown at Plymouth in 1621. It did not become an important crop in New England during colonial times.

Production. — Wheat is now grown in nearly all civilized countries. Vast areas are planted in Russia, India, France, Austria-Hungary, Argentina, Canada, and the United States. Europe produces more wheat than any other continent, raising nearly twice as much as North and South America together.

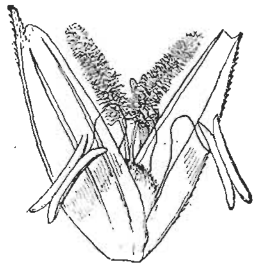


FIG. 70.—The wheat flower, showing two stigmas and two of its three anthers.

The wheat plant. — Let us bring a few wheat plants to school or, better still, go out to a field of ripening wheat, and study the habits of this plant. We shall find that, unlike the corn-stalk, the wheat-stalk is hollow, although occasionally it may contain more or less pith. We may wonder how the hollow stem is able to support the heavy head as it is swayed in the wind. It can do so because a hollow tube is very much stronger than a solid cylinder made from the same amount of material. The nodes, which are solid joints, support the sides of the tube and keep it from collapsing.

We see that the nodes are nearer together at the base. This is because there is greater strain here. The walls of the stem become thicker toward the base for the same reason. Wheat grows rapidly because each section of the stem, between the nodes, lengthens at the same time; and the stem elongates at the tip, also, so that there is growth throughout its entire length at one time.

When the seed germinates, it throws out three temporary roots which gather moisture for the young plant. As the stalk grows, nodes are formed close together on it. Additional roots spring from each node. The permanent roots are formed near the surface of the ground. They branch outward and downward and may sometimes reach a depth of four feet or more.

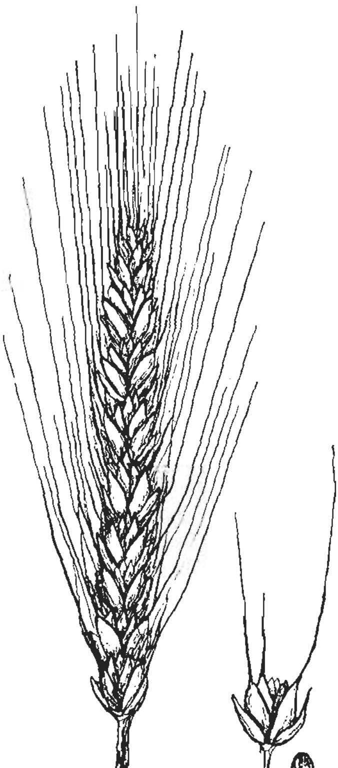


FIG. 71.—*A head, a spikelet, and a grain of wheat, having long beards.*

If wheat is planted in the fall, the stalks do not rise above the crown of leaves produced at the surface of the ground until after winter is past. The leaves, or blades, that cover the winter wheat-field like a mat, are snugly protecting the roots from the cold.

The head or " spike " gradually develops as the plant grows tall. It is the flowering part, and the place where the fruit or grain is to be produced. When it ripens, the leaves at the surface of the ground, together with those at each node, wither and fall, and the whole plant turns a golden yellow color. It is then ready to harvest.

A habit of importance to the farmer is the tendency of the wheat plant to "tiller" or "stool"; that is, to throw up additional stalks from the same seed plant. From twenty to as many as one hundred stalks may spring from one seed. Each stalk develops its own roots, so that it is soon independent of those with which it is associated. Seed that tillers heavily, therefore, will make the growth in the field *much more dense; it will give a heavy* "stand" of wheat.

Kinds of wheat. — The different kinds of wheat in America may be divided into classes according to where they are grown and whether they produce hard or soft grains. Thus we have: —

(1) The soft winter wheat, grown chiefly in New England and the middle states.

(2) The semi-hard winter wheat, grown in the north central states.

(3) Hard winter wheat, grown in parts of the middle plains states.

(4) Soft spring wheat, grown on the Pacific coast.

(5) Hard spring wheat, grown in the upper Mississippi River basin.

(6) The durum, or macaroni wheat, grown in the Great Plains states.

Often we call them all either winter wheat or spring wheat, meaning by winter wheat that which is sown in the fall and is in the ground over winter, and by spring wheat that which is sown in the spring and harvested in the fall.

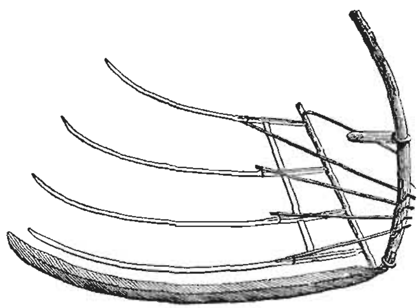


FIG. 72. — The grain cradle.

Culture. — Wheat will grow on a great variety of soils, but seems to do best on a light clay. The land that is to be used for winter wheat should be plowed as early in the season as possible so that it may be made fine and be able to absorb moisture. The land that is to be used for spring wheat should be plowed the fall preceding or early in the spring. In either case the surface must be made fine and loose to receive the small seeds.

If wheat is to follow corn in the rotation, the land should receive barnyard manure before it is plowed for the corn. A fertilizer containing nitrogen, phosphoric acid, and potash is valuable on some land, particularly in the east, and may be applied after the land has been prepared for sowing the seed.

FIG. 73. — The old way of harvesting grain crops, still occasionally in use on small areas.

Wheat should never be grown on the same land year after year, or the soil will become too poor to grow good crops. It should always be grown in a rotation if possible. It commonly follows corn, oats, potatoes, or beans.

Winter wheat should be planted early enough in the fall for

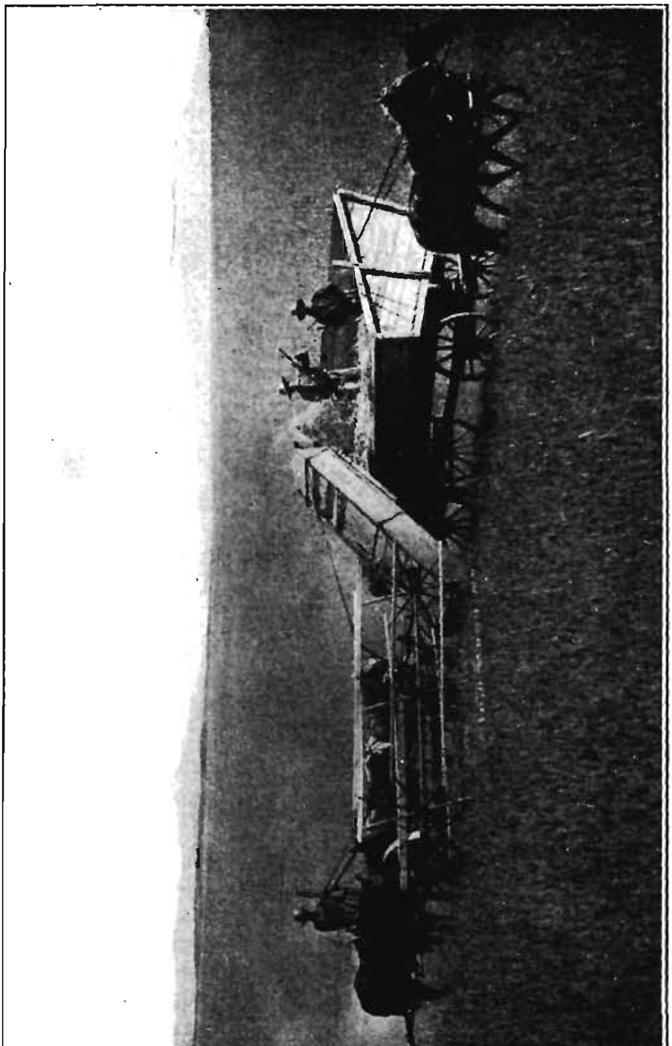


FIG. 74. — One way of harvesting wheat on large areas. The "header" at work.

the young plants to make sufficient growth to be able to withstand the cold of winter. Spring wheat may be planted early, as wheat seed will germinate and grow in cool temperatures.

The grower should be very careful to choose good seed. Six to eight pecks should be sown to the acre, and the seed should be planted one to three inches deep, depending on the condition of the soil. The lighter and looser the soil the greater the depth. Wheat is not ordinarily cultivated after the seed has been planted.

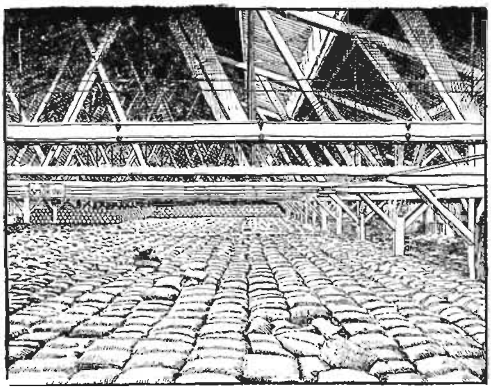


FIG. 75. — View of the interior of a grain warehouse on the Pacific coast, showing the bags of grain.

Harvesting. — The wheat harvest in the United States extends over five months. It begins in May in Texas, moves gradually northward through the summer months, and may continue as late as September or October in North Dakota and Washington. If we consider every country in the world we may say that the wheat harvest lasts for twelve months, or every month in the year.

For centuries wheat was harvested with the sickle and the cradle, and these tools are still used in some countries. To harvest the great American wheat crop, machines have been devised to do all of the work on a large scale. It is scarcely necessary for the hand to touch the grain in the entire harvesting process. The self-binder is used extensively. It cuts and binds the wheat into bundles. On some of the large grain farms in the western part of the United States there are as many as fifty self-binding harvesters, and as many as six hundred acres of grain are cut in a single day.

The greatest labor-saving machine is the combined harvester and thresher used in the Pacific coast states. It is drawn by 20 to 30 horses, or by a steam traction engine, and will cut 60 to 100 acres of wheat in a single day. This machine cuts the wheat, threshes, cleans, and bags the grain, and carries the sacks until it has enough to make a pile before they are dumped.

Uses. — Most of the wheat grown in America is made into flour for bread-making or is used in the manufacture of breakfast foods. The grain, either whole or ground, is a stock food. Wheat bran and wheat middlings, which are common cattle foods, are obtained from the manufacture of flour. Macaroni is made from durum wheat. Starch made from the wheat kernel is much used as a material for paste or sizing.

The straw is used for feeding or for bedding cattle. When traction engines are employed to harvest the crop, the straw is sometimes burned to make the steam. Wheat straw is also used to make fine straw hats and bonnets.

Problem 124. Is the culture of wheat important in your locality? Why?

Problem 125. How many acres of wheat are grown on your father's farm? What is the largest acreage on a farm in your locality? What is the average yield per acre? What is the average yield per acre for the United States? Do the farmers in your locality help to raise or lower the average?

Problem 126. What does wheat follow in the rotation on the farms in your locality? What follows wheat? Is the rotation a good one? Why?

Problem 127. What is done with the wheat raised in your locality? If it is shipped away, what becomes of it?

Problem 128. Make a list of the kinds of foods used on our tables that are made from wheat or its products.

Problem 129. Compare a wheat plant and a corn plant, and explain in what ways they are similar. Is there any similarity in the roots? In the stems? In the way the leaves clasp the stems? In the arrangements of the nodes on the stem? In the shape of the leaves? In the flower parts?

Problem 130. Write a short essay, telling how wheat is grown in your locality: when it is planted, how the soil is prepared, how it is fertilized, how the seed is sown, how the crop is harvested, and what becomes of it.

Problem 131. How many kinds of wheat do you know? How do you tell them apart?

Problem 132. Can you tell the difference in May between a field of oats, of wheat, and of rye? How?

Problem 133. In what ways is wheat used on the farm? What is done with the straw?

Problem 134. If one bushel of wheat contains 20 ounces of nitrogen, 8 ounces of phosphoric acid, and 5 ounces of potash, how many pounds of each are removed in a crop of 24 bushels to the acre? Does the wheat crop take more or less than a 50 bushel oat crop containing 10 ounces of nitrogen, 3 ounces of phosphoric acid, and 2 ounces of potash to the bushel?

Problem 135. What is the value per bushel for wheat in your locality? Suppose that by growing wheat in a rotation the farmers in your locality should obtain an average yield of 25 bushels to the acre. If one of them ceases to rotate his wheat and grows it on the same land for five years, and the second year gets 20 bushels, the third year 17 bushels, the fourth year 15 bushels, and the fifth year 12 bushels to the acre, how much money will he have lost by the end of the fifth year on a ten-acre field?

CHAPTER XXI

GRASSES — MEADOWS AND PASTURES

In the story of the Creation we read that God commanded the earth to "bring forth grass." Grasses have helped to cover the face of the earth since a very remote time.

There is an almost endless variety of grasses, and they are grown from the hottest tropical regions to the frozen north and south. They vary in size from delicate moss-like plants less than an inch high to the gigantic bamboos 100 feet or more in height. They are adapted to many sorts of conditions — to dry, infertile soils, rich, moist soils, marshes, stagnant pools, slow-running streams, rocky hillsides, or sandy sea-shores.

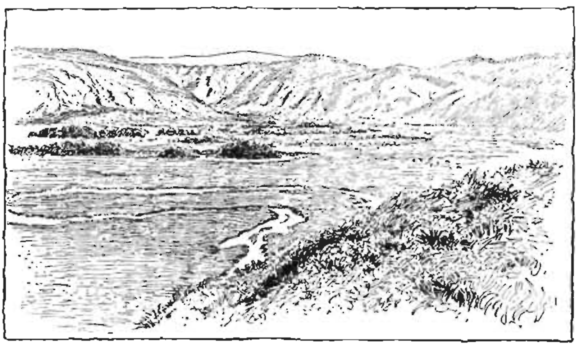


Fig. 76. — A stretch of native, or wild, pasture land in Nevada.

Native grasses. — Nearly every country has great areas of native or unsown grasses, which occupy unbroken or wild land, and which serve as forage to animals. Perhaps you can find small areas of "volunteer" or unsown grass-land in your own locality. The native grasses are of great importance, for they not only supply pasture and forage in many cases, but also keep the land from washing and blowing. While a large part of the native grasses are not useful to the farmer, yet many of them are exceedingly important, as we shall see.

In the Great Plains region there still remain immense tracts of open prairie from which are cut large quantities of native hay. In the Rocky Mountain states millions of cattle, sheep, and horses live on the native grasses. It is said that 300,000 to 500,000 sheep pass the winter on the Red Desert of Wyoming.

In the Great Basin, extending from Oregon and Idaho to northern Arizona and westward to the Sierra Nevada Mountains, the stock roam in the hills during the summer, and in the autumn are turned into the meadows after the native hay has been stacked. On the Pacific slope are other extensive native feeding grounds bearing a large number of varieties of wild grasses.

Cultivated grasses. — Throughout most of America farmers cannot depend largely on native grasses. They must grow greater quantities to the acre, and must include the grass-land in their rotation systems. Also, they desire to choose varieties that will be most valuable to them. We have therefore a long list of cultivated grasses that are adapted to various climates and soils. Some of them are most useful in meadows for cutting as hay, and others in pastures for grazing.

Many of the hay plants are not true grasses, that is, do not belong to the grass family. Clover, alfalfa, and cowpeas, as we have already learned, are legumes. They are used for hay and forage, just as are the real grasses, but they belong to a different family of plants (see pages 119, 120).

In northeastern United States, extending as far south as Virginia and westward to Kansas and North Dakota, timothy and red clover furnish most of the hay, and Kentucky blue-grass (also called June-grass) a large part of the pasture.

Farther south, in the cotton-belt, a most important hay plant is the cowpea. Bermuda-grass is the best pasture plant. Johnson-grass and Bermuda-grass are grown for hay and pasture throughout this section. Both spread rapidly and are hard to get rid of after they have once been grown, so that they are often looked upon as weeds.

On the Gulf coast, crab-grass, beggarweed, Mexican clover, and carpet-grass supply most of the hay and pasture. In the Plains

FIG. 77. — Drawing hay on solid-wheel wagon.

region, alfalfa is the most important hay plant, and millet, sorghum and kafir-corn are valuable for rough forage. In the Rocky Mountain states, alfalfa has first place, with timothy, orchard-grass, and clover of less importance. On the Pacific coast, alfalfa outranks all other real hay plants; but great quantities of hay are made from oats cut when immature.

In each section of the country, therefore, some hay plants are of much more value than others. An almost endless number of other grasses are grown, however. Taking the country as a whole, timothy is the leading hay plant and blue-grass the leading pasture plant.

Meadows. — By the word meadow we mean land on which grass is grown to be cut for hay. The land may be kept permanently in grass, or it may be plowed every two, three, or four years and a new meadow seeded on another piece of land.

Since the grass in the meadow is to be cut for hay, all of the plants should be at their best at the same time. The plants should also grow to maturity quickly. The farmer has to consider these points in choosing seed for his meadows. If the meadows are to be plowed frequently, the seed must not be very costly. One reason why timothy is so widely grown as a hay plant is that its seed is cheap, and it germinates quickly.

Pastures. — By the word pasture we mean land on which grass is grown for grazing by live-stock. Pasture may be either perma-

Fig. 78. — A hillside pasture that has been grazed very little.

nent or temporary. When it is temporary, it is usually a meadow from which two or more crops of hay have been cut.

Since pasture is used for many months in the year, the grasses in it should not all mature at the same time. For this reason, usually a mixture of several kinds of grass seed is planted. Different plants occupy the ground in different ways, and when more than

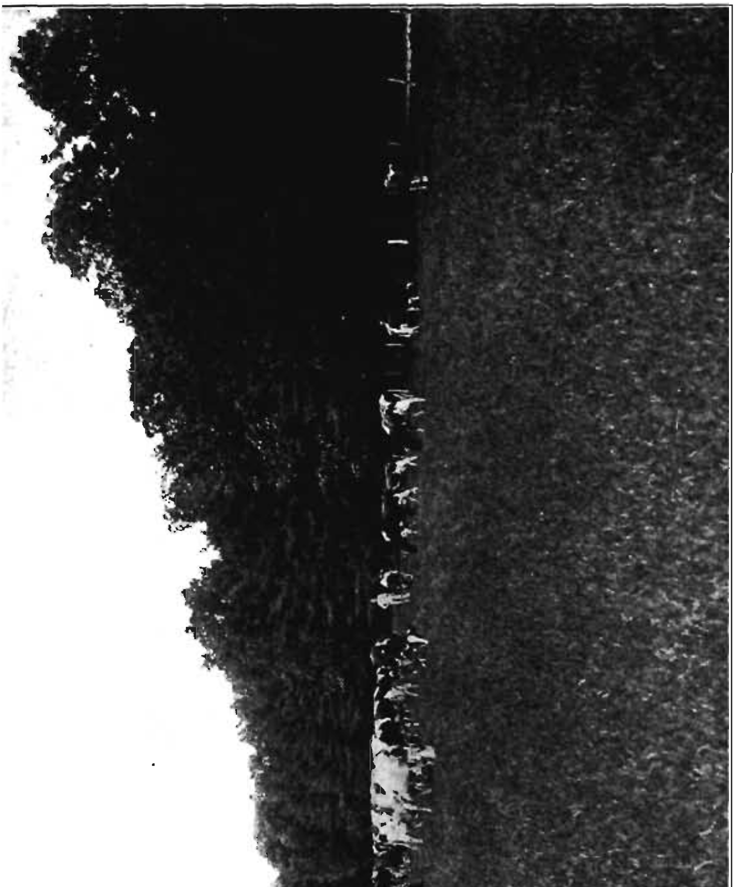


FIG. 79. - - A bountiful pasture.

one kind is planted the land is used to better advantage. Then, too, if the season is unfavorable for one kind, it may be more favorable for some other kind. The farmer will choose the grasses that yield the largest crops in his locality and which his animals like.

Timothy. — Timothy is the best known grass in the United States. It gets its name from Timothy Hansen, who took the grass from New York to the Carolinas about 1720. It was cultivated by him in Virginia, also. In 1760, Peter Wynch, President of the Agricultural Society of England, secured some of the seed from Virginia. It soon came into general use in England. It is a native of Europe, and is now grown extensively in western Asia and Africa, as well as in Europe and America.

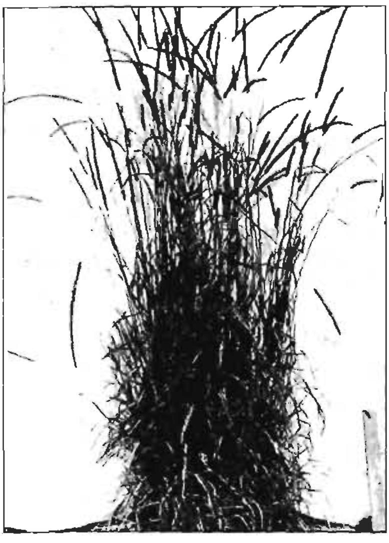


FIG. 80. — Timothy hay plant, nine months old. Many stems rise from the same root.

Timothy is a perennial plant. It has short, flat leaves. On good land it grows two to four feet high. Each stem bears a stiff, erect, rough spike or head as thick and generally as long as a lead pencil. The grass stands up well and the hay is easily cured. It has a good appearance, and sells readily.

Timothy may be sown alone or in mixtures for meadows, but is of little use as a pasture plant. It may be sown in the fall with wheat or rye, or may be planted early in the spring. About eleven pounds of seed are used to the acre. It will grow on a great variety of soils, but does best on clay loam.

Blue-grass. — This is one of the most common and most useful grasses in the north temperate zone. It is found in Great Britain, Asia, Australia, and America. In North America it is especially valuable for lawns and for permanent pastures in the northern states, but it does not do well in the South. It makes good pasture from early spring to early summer, and again in the fall after the heat of summer is past.

Blue-grass varies in height from a few inches to a foot or more. Its head is light and spreading, and the seed is borne on little branches bearing three to five flowers. It spreads rapidly by underground branches or "rootstocks," so that it gradually takes possession of the ground wherever it is planted.

Blue-grass is usually sown in the spring, and it may be planted early. Three to ten pounds of good seed to the acre is sufficient in pasture mixtures. As much of the seed on the market is poor, it may take more than this to secure a good seeding.

Problem 136. Bring to school as many different kinds of grasses as you can find in your locality. Ask the teacher to help you dry them and mount them on card-board for your museum or collection. Find some one who can name those that you do not know. Place the name of each one on its card. Study the different kinds until you know them all.

Problem 137. Name the different kinds of grasses sown by farmers in your locality. What is each used for? Do they all ripen at the same time? Which do the animals like best? Which kinds sell best?

Problem 138. Count the number of plants on a piece of pasture sod six inches square. If there are 43,560 square feet in an acre, how many plants are there to the acre? How many different kinds of plants are present on the piece of sod?

Problem 139. If a meadow yields two tons of hay which, by weight, is one fourth clover, one fifth weeds, and the remainder timothy, how many pounds of each are harvested?

Problem 140. What land on your farm is used for pasture? Why? Is it ever plowed and planted with some other crop? How often are the meadows plowed? What do they precede and follow in the rotation? Why?

Problem 141. Examine a load or mow or forkful of hay to see whether you can tell what kinds of grass and other plants it contains.

Problem 142. Can you tell what kinds of grass make up the pasture nearest the school-house? On your father's farm?

CHAPTER XXII

CLOVERS AND THEIR KIN

MANY leguminous plants are of great importance to the farmer, not only for their stock-feeding value, but also because they enrich the soil in which they grow. For centuries the most careful farmers have grown clover or a clover-like plant because it seemed to make the soil more fruitful. Long before it was discovered how such plants enriched the soil, it was known that they did so. Now that we know that clovers and their kin restore to the soil nitrogen which other crops have exhausted, farmers include a leguminous crop in their regular rotation systems. In the northern states, several species of clover are grown; in the western states and California, alfalfa is grown; in the central and southern states, soybeans, cowpeas, and crimson clover are grown; in the South, velvet beans, beggarweed, and sweet clover, or melilotus, are common; in both the North and the South, vetch is grown.

Uses. — Clover-like plants are sometimes used to occupy the land for the short periods between the growing of other crops, to protect the soil, to make it richer by adding nitrogen, and to furnish vegetable matter when plowed under. For example, crimson clover may be sown in corn at the last cultivation. After the corn is harvested, the clover occupies the land, protects it during the winter, and in the spring is plowed in when the ground is prepared for the grain that is to follow.

Most of the clover-like plants are valuable for feeding to stock, because they are rich in protein, a substance containing nitrogen.


Fig. 81. — The common red clover.

Clover. — The American colonists cultivated the native grasses long before they began to grow clover. Red clover was not carried to England from the continent of Europe until 1633, and white or Dutch clover till 1700. These plants did not reach America until a much later period. Now they are widely grown, and are numbered among our most important forage plants.

Red clover came to us from Europe. It is native also to Asia. It is used more largely in hay mixtures in this country than any other of the clovers. It is really a perennial plant, although it may die after the second or third year. It is a spreading, hairy plant, bearing purplish heads or flowers on the ends of branching, leafy stems. The leaves have a prominent whitish spot.

This clover is easy to grow. It may be planted with oats or barley, but is commonly sown in the spring on winter-wheat fields. About ten pounds of seed to the acre are sown broadcast or with the same drill that plants the oats or barley.

For hay, red clover is cut when the heads are in full bloom and before many of them have turned brown. Clover pasture is much relished by hogs, and cattle thrive on it if not allowed too much at a time.

Mammoth red clover is a perennial plant. It is less likely to die after the second or third year than is red clover. It grows taller and stouter than the common red, ripens later, and bears larger and darker heads. It yields more heavily than the common red clover, but stock do not like it so well.

Alsike clover was brought to America from Europe, and is now grown in low meadows and less fertile places from Nova Scotia to Idaho. It is a perennial with trailing, slender stems, and small whitish or rose-colored heads. The leaves are borne on long, forked stalks that rise from the low-growing main stem. It grows well on cool, moist soils and is valuable in wet meadows where red clover would be drowned. It is useful both for hay and for pasture. It makes a fine, soft hay. It is a valuable honey or bee plant also.

White clover was introduced from Europe, but it is probably native to northern America also. It is now grown in almost all regions in the temperate zones. Some persons think that it was the original shamrock. It is a low, creeping, perennial plant, that bears its small fragrant white blossoms on long, slender stalks. The leaves, which usually are made up of three leaflets, are also supported on long, slender stalks. The leaves and the flowers rise from the stem that creeps along the surface of the ground. White clover will grow in cool climates and on moist soils. It grows so low that it is not useful for hay, but is a good pasture plant. It is much used for lawns, also.

Crimson clover had its original home in the Mediterranean region in Europe. It is an annual plant, erect, two to three feet tall, and is covered with soft hairs. The heads are oblong and dense, and are composed of brilliant crimson flowers. The leaves are borne on long stalks. It grows best in warm climates, on loose, sandy soils. It is used both for hay and for pasture, as well as for green manure purposes.

FIG. 82. — A branch of the alfalfa plant.

Alfalfa. — Alfalfa is native to the valleys of southwestern Asia. It was in use centuries before the Christian era. It spread from Persia to Greece about 480 B.C., then to Italy, Spain, Mexico, and South America. It reached Mexico and South America during the Spanish invasion in the sixteenth century. It was brought to New York from Europe as early as 1791. It was carried to California from Chile in 1854, and crossed from Mexico into Texas in the early part of the nineteenth century. Alfalfa has spread rapidly in the West and Southwest, and is gradually becoming a valuable hay plant in the East and other sections. It has long been grown as a farm crop in New York.

Alfalfa is a long-lived perennial plant. It roots very deeply, usually from 6 to 12 feet. Its stems grow 1 to 4 feet high, and

FIG. 83. — Stacking alfalfa in the western country, where large areas are grown.

in bunches or clumps. The stems are covered with small leaves made up of three leaflets. The flowers are purple, or occasionally white, and are clover-shaped.

To grow alfalfa, a deep, well-drained soil containing lime is necessary. If lime is lacking, so that the soil is "sour," applying sufficient lime to it will remedy the sour (acid) condition. Well-rotted barnyard manure makes an excellent fertilizer.

The seed-bed must be made fine. The alfalfa seedling is not a strong plant, and it cannot compete with weeds until after it has become well established. It demands plenty of moisture, but will not thrive in wet soils; it should therefore be planted on a well-drained soil. There must be the right kind of bacteria in the soil to store nitrogen in the nodules on the alfalfa roots. Frequently it is necessary to secure some soil from a field where alfalfa has grown luxuriantly in order to establish the bacteria in the new land.

In the West, 12 to 20 pounds, and in the East, 20 to 30 pounds, of seed are sown to the acre. Alfalfa grows rapidly and may be cut two or three times each season in the North, and four to seven times in the South. It will yield four to five tons to the acre. Alfalfa may be grown on the same land without injuring it greatly longer than most other crops. However, in a good rotation it should not be allowed to occupy the same field for longer than four to seven years at a time.

Alfalfa is a valuable hay plant, because it is rich in protein. It should be cut when it opens into flower. It makes good pasture if the stock are allowed to graze only a little at a time.

Cowpea. — The cowpea is originally from India and the region to the north. It has been cultivated for two thousand years or more. Varieties have been distributed throughout the world, but only in China, India, and the southern part of the United States has it become an important farm crop. It reached the West Indies in the latter half of the seventeenth century, and was brought to the United States some time later.

The cowpea is a summer-growing annual plant, closely related to the bean. Some varieties are erect and bush-like, others are trailing. It is a climbing plant, and its slender runners twine around near-by objects. The leaves have each three leaflets, and in appearance are much like those of the garden bean. The flowers are whitish or whitish purple, and may have a yellow tint.

From Duggar

Fig. 84. — Cowpeas growing between rows of corn.

The pods are usually straw-colored, and are five to ten inches long.

Cowpea will grow on almost any kind of soil except that which remains wet during the summer. It likes a warm climate and is easily killed by frost. The soil should be well prepared by plowing and harrowing. The seed may be sown broadcast or in rows. When sown broadcast, four to six pecks of seed per acre are used, and when planted in rows two to three pecks.

The leaves of cowpea fall off easily when being cured, so that sometimes a grass crop, as German millet, is grown with it. The millet makes the curing quicker and entangles the leaves so that they are saved. Cowpea hay is allowed to lie where it is cut for 24 to 36 hours, after which it is raked and piled into cocks. If the weather is fair, the curing will be completed in the cocks in two or three days. Then the cocks may be opened for a few hours before being hauled to the barn.

Cowpea is grown for hay, green forage, and to enrich the land.

Other clover-like plants. — The *soybean* is closely related to the cowpea. It is grown more or less throughout the eastern and southern parts of the United States. It is used for human food, for stock food, and to improve soils.

Vetches are grown both in the North and in the South as pasture plants for horses, cattle, sheep, and swine. They are frequently grown also merely to enrich the soil.

Melilotus, the common "sweet clover" that grows by the roadside, is sometimes planted in the South to be used as a green manure, forage, and honey plant. Generally it is looked upon as a weed. There are two common kinds, — the white and the yellow.

Problem 143. Name all the legumes that you know.

Problem 144. Bring to school a plant of each of the clovers and other legumes that you can find. Mount them on cards for your museum. Compare them carefully and explain how they resemble one other, and how they differ. Compare the flowers especially. How do the stems of white clover differ from the stems of other clovers?

Problem 145. Are any of these plants grown on your farm merely to enrich the soil? What is a cover-crop and what are its uses?

Problem 146. Which is the best stock feed: timothy hay, clover, or alfalfa?

Problem 147. What kinds of leguminous plants run wild in your neighborhood? What kinds are cultivated?

Problem 148. Write a short essay about the use that is made of clover on the farm, and where it should come in the rotation system.

CHAPTER XXIII

POTATO

It is thought that the potato was cultivated in Peru at least 2000 years ago. When the Spaniards came as conquerors to South America, they found the Indians cultivating the plant in all the valleys of the Andes from Chile to New Granada (now Colombia). They carried it back to Spain with them, and passed it on into Italy and the Netherlands before it was known in England. Both Sir

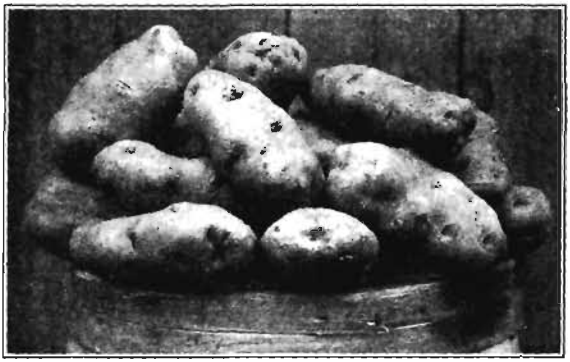


FIG. 85. — Potatoes.

Francis Drake and Sir Walter Raleigh are credited with its introduction into England. It was probably taken to Ireland in 1586 by Thomas Herriot, who was a member of the expedition sent to America by Sir Walter Raleigh. Raleigh cultivated it on his farm near Cork in Ireland. He called it Battata.

The potato has greatly affected the fortunes of English-speaking peoples. Its destruction by blight in 1846 was the cause of the

"Great Famine," which drove over the seas so many thousands of Ireland's best and sturdiest workers to help in building up America.

It is a common opinion that the aborigines of Virginia cultivated the potato at the time of the discovery of America, but this is in doubt. The crop was early grown by the Virginia colony. It was not grown in New England until the arrival of the Presbyterian immigrants from Ireland in 1718. The potato has been developed to a greater extent in Europe than in America, and it is now a staple crop throughout both continents.

Place of the potato in agriculture. — Next to rice, the potato is probably the most extensively grown and most valuable crop in the world. The annual yield of the world is nearly 5,000,000,000 bushels.

As potatoes are a cultivated crop they fit well into rotation systems, to follow the grass and to precede the small grain.

The potato plant. — The potato plant has a weak stem. Its branches may grow long and trail on the ground. The stem is round and smooth, and all parts of the green plant are juicy. The leaves grow alternately and are compound, a pair of very small leaflets growing between pairs of much larger size.

In some varieties the slightly fragrant flowers are light purple or lilac; in others they are white. The fruit, or seed-ball, is round and about the size of a small plum, and of a yellowish color when ripe. It is packed full of seeds, which are shaped very much like tomato seeds but are smaller.

The part of the potato that we eat is an enlarged underground stem called a tuber. We might think from its appearance and from the fact that it is produced beneath the surface of the ground, that it is a root; but when we study it, we shall find it is not. In the first place, although the tubers differ greatly in size, shape, and color, they are all alike in having "eyes" on their surfaces. These are fewest near the stem end, where the tubers are attached to the plant, and are more numerous at the opposite or "bud" end. When the potato is allowed to sprout, we discover that each eye is a bud or group of buds from which a branch springs. We know that leaves grow from stems only, and not from roots; therefore, the potato tuber cannot be a root. It is part of the stem underground, enlarged for the

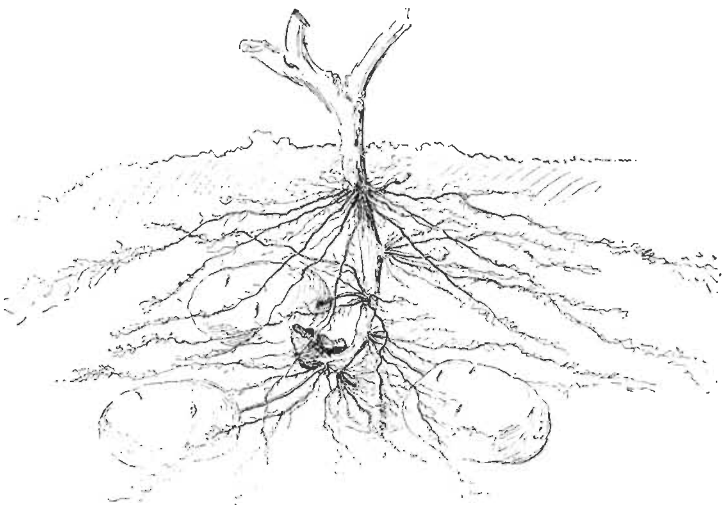


FIG. 86. — The underground parts of the potato plant in a loose, mellow soil, showing the tubers and the true roots.

storage of surplus starch. In the second place, rootlets are never attached to the tubers of the potato, but to the main root-stem of the plant itself.

Culture. — In its wild state the potato reproduces itself through the seeds, which are borne in the seed-ball at the end of the stalk, and by its tubers. The seeds from any one plant, however, may produce several varieties of potatoes, so that the farmer cannot depend on the seed for his new crop. The tubers will produce plants bearing other tubers just like themselves, so the farmer plants tubers or parts of tubers for his new crop.

From each eye of the potato a new plant will develop. If a piece large enough to nourish the young plant until it becomes established is used, a stronger plant will result. Potatoes which have sprouted in the cellar or pit, sending out long, colorless shoots, should not be used for planting, as the tubers have lost some of their plant-food in the growth of the sprouts.

Ideal conditions for the growth of the seed-pieces are a moderately moist and deep fertile soil, and a relatively cool climate. The seed-pieces are planted two to five inches deep. The most successful potato-growers do not hill up their plants, at least not until late in the season, but keep the field level. Level culture wastes less moisture by evaporation than does hilling.

A few days after planting, the spike-toothed harrow or the weeder should be run over the field to destroy all weeds before they are well started. Then the weeder may be used once a week until the plants are seven to ten inches tall. Thereafter, about five cultivations should be given at intervals of seven to ten days. The early cultivations should be deeper than the later ones.

Early potatoes are dug as soon as they are large enough to sell. Late varieties are left until the vines are dead. The potatoes should be harvested when the land is dry, and the tubers picked up at once and kept in a cool dark place.

The average yield of potatoes in the United States is about 85 bushels per acre, but under ideal conditions 300 to 500 bushels per acre are not uncommon.

Fig. 87. — The potato beetle.

Enemies. — The first enemies of the potato plant to appear are flea-beetles. They arrive as soon as the plants are above ground. They gnaw small holes in the leaves. Repeated spraying of the vines with Bordeaux mixture combined with Paris green will check this destroyer. The same remedy should be applied also for the black-and-yellow-coated Colorado potato beetle.

The diseases of the potato may be more destructive than its insect pests. The early blight, which usually appears in June, may destroy some of the foliage and check the growth. The late blight is much more serious. The vines may be so badly injured that no tubers will be formed. Spraying with Bordeaux mixture is the remedy.

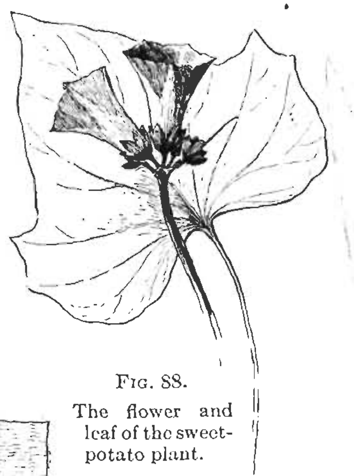


Fig. 88. The flower and leaf of the sweet-potato plant.

Scab and rot are diseases that attack the tubers underground. They also may be very destructive.

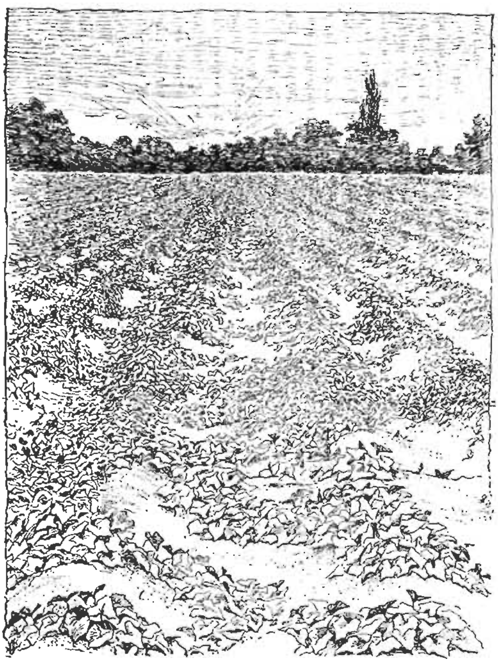


Fig. 89. — A field of sweet-potatoes.

Uses.—Potatoes are used most largely for human food. They are also valuable for stock food, either raw or cooked. From the tubers, starch and alcohol are made.

Sweet-potatoes.—The sweet-potato, which is a staple food crop in the South, differs from the Irish or white potato in that it is a true root and not an enlarged underground stem or tuber.

It has no eyes, no leaf-buds. Small rootlets run out from it. It belongs to the same family of plants as the morning-glory, and the flowers resemble those of the morning-glory.

The sweet-potato probably came originally from tropical America. It is now in cultivation in many of the islands of the Pacific. For the new crop all or part of the sweet-potato itself may be planted. Usually, however, the sweet-potatoes are started in a hotbed and the young plants are removed and set in the field when they are of the right size. Some persons make a business of growing the small plants to sell to farmers for planting their crops.

The sweet-potato does best in a warm, sandy soil that is well drained and that contains humus. The land is plowed four to six inches deep. The seed-bed is made fine so as to be a good home for the transplanted plants. The plants may be transplanted by hand or with a machine. They are usually set eighteen inches apart in the row. Three or four cultivations, supplemented by hand hoeing, are necessary to keep the growing crop in good condition.

Problem 149. Dig up an entire potato plant without breaking off the tubers, and examine it in the field or bring it into the schoolroom. Where are the true roots? What is the difference between them and the stems on which the potatoes are borne? How many potatoes grow on each stem? Do the true roots go much deeper than the tubers? Are any rootlets attached to the potato as there are to beets, turnips, or sweet-potatoes? What does this indicate?

Problem 150. In a box in the schoolroom, plant one whole potato, one piece having two eyes, and one piece having no eyes. Mark the place where each is planted. Do they all grow? If not, why? Which develops the best plant?

Problem 151. In another box, plant a large piece of potato having only one eye. As soon as the rootlets begin to appear divide the eye and piece into two parts and re-plant. In a few days after the rootlets have again started, divide the two pieces into four and re-plant. See how many times this can be repeated, and how many potato plants may be grown from one eye. When large enough, set these little plants in the school-garden, if the weather is suitable.

Problem 152. Purchase at the drug store five cents' worth of iodine (*a poison*). Dilute it one half with water. Cut a few slices of potato and apply a few drops of iodine to the freshly cut surfaces. The color will change to a blue-black. This shows that the potato is composed of stored-up starch. When iodine touches grains of starch, they turn to a blue-black.

Problem 153. Describe the difference between the common or white potato and the sweet-potato.

Problem 154. How many varieties of potatoes do you know? How do you distinguish them?

Problem 155. How does your father keep or store his potatoes?

Problem 156. How much are potatoes worth in the market at present?

CHAPTER XXIV

THE ORCHARD

NATURE has generously provided many kinds of fruit, and many varieties of each, so that some variety will grow in nearly every section of America. Nearly all farms have some fruit. There may be only a few trees for family use, or there may be orchards that cover many acres. In the latter case, fruit-growing is an important part of the farm business. It may be the largest part of the business.

Location of the orchard. — Fruit may be grown for a few years on almost any kind of soil. But if we would grow long-lived trees and fruit of superior quality, then the climate, site, and soil must be favorable.

There may be more than one site on the farm for the orchard, the main difference between them being the slope of the land. South and west slopes are hottest in summer and are subject to more sudden weather changes than north or east slopes. On south slopes, peach trees may be brought into blossom earlier than on north and east slopes; consequently they are more liable to injury by early frost when planted on south slopes. On the western plains, the best growth of native timber is usually on north slopes. In general, we may say that for apple, pear, and plum trees, a location that slopes to the southwest, west, or northwest is best; for peach and cherry trees, a northwest or west slope seems to be best. But the slope or exposure may be otherwise and the fruit plantation still be successful, if other conditions are good.

The choice of the soil is as important as the choice of slope. A rich, deep, moist clay loam is ideal for apples, pears, and plums, and a light, sandy loam is preferable for peaches and cherries. If the prospective grower has no choice of soil, and must take a less desirable kind, he may still grow fruit for home use.

The soil should be prepared as carefully for the fruit crop as for the corn crop, so that the roots may grow far and wide for food and water. Frequently it will be necessary to drain the land, as fruit land must not be wet. For the best results the soil must be pulverized, drained, and plowed deeply.

Planting the trees. — On a well-fitted soil, the first essentials for success are the trees. They should be purchased from a reliable nursery as near home as possible so that they will be accustomed to the climate of the region in which they are to be grown.

The trees may be planted either in the fall or in the spring. The rows should be straight, not only for the sake of appearance but also because tillage will be easier. The trees must be set far enough apart so as to favor the best growth. The distance will vary in different regions. It is a common practice to plant apple trees 40 feet apart each way, pears 20 to 25 feet each way, quinces 16 feet, plums 20 feet, sour cherries 20 feet, sweet cherries 30 feet, peaches 20 feet.

When the trees are dug from the nursery, many of the roots are destroyed. If all of the top is left, there will be a greater demand for plant-food than the roots can supply. Usually the top is cut back severely, so that only a "leader" and three or four short side branches are left.

A hole is dug sufficiently large to accommodate the roots comfortably in their natural positions. Fine, rich soil must be worked firmly about the roots so that they can begin their activities at once. A shallow layer of loose soil is left on the surface as a mulch. Coarse, fresh stable manure should not be placed in contact with the roots.

Tilling and fertilizing. — Orchard trees grow large and are expected to bear heavy crops of fruit year after year. To do this, they must receive good care and abundant food.

We know that tillage improves the soil, saves moisture, and sets free plant-food. It is therefore a very important operation in the orchard. More than 90 per cent of most fruits is water. To obtain a large crop there must be a great abundance of moisture in the soil. In dry seasons, the moisture must be prevented from escaping from the soil. The apples on sod land are likely to be much smaller and poorer in a dry summer than those grown on tilled land.

The orchard may be plowed early in the spring to break up the soil. During the summer the harrow and the cultivator should be used to preserve the surface mulch.

Fig. 90. — The Baldwin apple.

Trees make heavy demands on the plant-food in the soil, so that it is seldom wise to grow any other crop, even grass, in the orchard. The soil will need to have humus added to it from time to time. This may be done by applying barnyard manure or by growing a cover-crop. It may be necessary to add commercial fertilizers containing nitrogen, phosphoric acid, and potash. Stunted growth indicates the need of nitrogen or water, or both. Fruit lacking in flavor and color may lack phosphoric acid and potash.

Pruning and spraying. — Tilling and fertilizing are only part of the necessary care of the growing and bearing orchard. They make the tree grow. Pruning and spraying direct the growth and protect the tree from injury by insects and diseases.

A wild, uncared for tree seldom produces good fruit, although it may produce a large quantity of small fruits. The fruit-grower desires large, well-shaped and well-colored fruit that will be attractive in the market. To obtain it, he keeps his trees vigorous, and removes unproductive and interfering branches.

Pruning helps to make a tree vigorous; it also changes the shape of the tree to suit the wishes of the grower. Winter pruning en-

FIG. 91. — Picking apples. The fruit-grower has his busiest season at the harvest.

courages the growth of wood, while summer pruning encourages the production of fruit.

Young trees that were properly pruned when set out will require little pruning until they begin to bear. Shoots that would make a poorly shaped head, or that cross and interfere with other branches, should be removed. In pruning old fruit trees, the aim should be to prevent crossing and crowding of branches and to thin out old wood, so that young, vigorous wood may take its place.

FIG. 92. — Packing fruit for market. In rainfall regions, it is usually sorted and packed under cover.

When the ends and highest branches are cut back, growth is formed in the lower branches.

All fruit trees have enemies, both insects and diseases. These enemies must be controlled if good *fruit is to be grown.* This is done partly by spraying. Some kinds of sprays are used for insects, and other kinds for diseases. We shall learn more about spraying in Chapters XXVIII and XXIX.

Harvesting. — If the grower is to secure part or all of his income from his fruit, the harvesting and marketing become very important. The fruit should be picked, not pulled, and handled carefully to prevent bruising. It should be graded according to size and quality before it is packed, so that each barrel or box will be uniform throughout. When this is done, it is attractive to the buyer. Neat packages and careful packing add to the selling price.

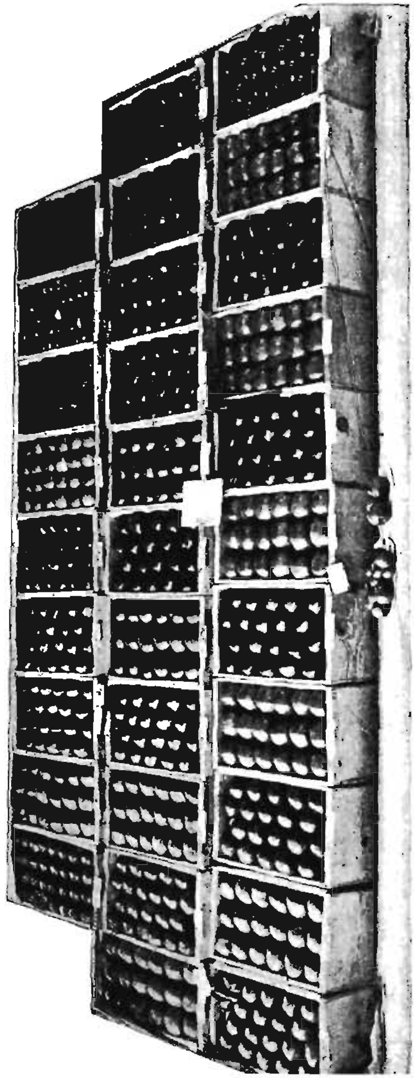


FIG. 93. — Apples packed for market. The box is taking the place of the barrel for some purposes.

Kinds of fruit. — The more important orchard fruits in America are apples, peaches, pears, plums, cherries, oranges, and lemons. The apple is the king of all fruits in this country.

Apples. — From time immemorial the apple tree has been cultivated. Its original home was in southwestern Asia and southeastern Europe. It is now grown in every temperate climate and is the most important tree fruit.

Apple orchards were common in the *American colonies*, and shiploads of apples were exported to the West Indies. The first trees in New England were planted on Governor's Island, Boston Harbor, from which "ten fair pippins" were picked on October 10, 1639. An apple nursery was planted on the farm of Governor Endicott, at Salem, in 1640. In 1641, apple trees were planted on Governor Berkeley's farm in *Virginia*.

A great natural apple region is a stretch of country beginning with Nova Scotia and extending west and southwest to Lake Michigan. Many other sections are well adapted for this fruit, as the highland regions farther south, and many parts of the western and Pacific States.

North America is the leading apple-growing country in the world. A full crop of all kinds and grades for the United States and Canada is probably not less than 100,000,000 barrels.

Apple stocks are grown from seeds. At the end of a year, or a little longer, the desired variety is budded on to the stock in the nursery row or is root grafted. The trees are set in the orchard when two or three years old.

Peaches. — The peach probably had its original home in China. It has been in cultivation from the earliest times. It came into Europe by way of Persia, and from there reached America. As early as 1629 peaches were grown in Virginia, and before the Revolutionary War New Jersey and Delaware were famous for their peaches.

The peach is easily injured by frost, and it is not so easy to grow as the apple. It grows best in mild climates, near bodies of water. There are "belts" where peach growing is specially successful, along the Great Lakes, in Connecticut, in the South Atlantic States; also in Illinois westward to Missouri, in southeastern Texas, and in western Colorado and California.

The peach is propagated by means of seeds. The first year the seedlings are budded in the nursery with the desired variety. A year later they are ready to plant in the orchard.

Pears. — The pear is a native of Europe and was introduced into America by the colonists. It is now grown in many parts of the temperate zone, but the largest production is in France and the United States. In America, the best pear regions are in the northeastern states, from New England west to Ontario and the Great Lakes, and in California and parts of Oregon and Washington.

Pear seedlings are grown in the same manner as those of the apple. The young trees are ready for the orchard two or three years after they have been budded in the nursery row.

Plums. — Many kinds of plums are grown in America, which came from different original ancestors. Some of them had their first home in southeastern Asia, some in western Asia, some in southeastern Europe, some in America, and others elsewhere.

The seedlings, grown from the seeds, are budded at the end of one or two years' growth. Plums may also be grown from "suckers," or shoots, which spring from the roots.

Cherries. — Most of the cherries grown in America have come from plants that are native to Europe. Sweet cherries are not grown as an important farm crop east of the Rocky Mountains; but the sour varieties are grown for canning in many parts of the East.

Cherries are raised from seeds, and the seedlings are budded or grafted to the desired variety, much the same as with apples.

Problem 157. Can you tell the difference between apple, peach, pear, plum, and cherry trees in summer? How? In winter?

Problem 158. How many different kinds of fruit that are sold in your locality are brought from other sections of the state or country? Where do they come from?

Problem 159. If yours is a fruit-growing region, what is done with the fruit that is grown? Is any of it dried? Is any preserved in any way? Is any made into cider? Where is the cider sold, and for what purpose?

Problem 160. Name three fall apples, and three winter apples. Describe them.

Problem 161. Describe in detail how apples are picked, packed, and stored.

Problem 162. Are there orchards in your locality that are cultivated? Do they seem to yield better crops than those in sod? Is there any difference in the health of the trees?

Problem 163. What difference is there between the orchards that are sprayed and those that are not sprayed? What is the purpose of the spraying?

Problem 164. When is pruning done? What parts of the tree are removed? Why?

Problem 165. What is the best cooking apple raised in your locality? The best apple for eating? The best selling apple? The best winter apple?

Problem 166. If apple trees are planted 40 feet apart each way, how many trees can be planted on an acre of ground? How many pear trees at 25 feet each way? How many quince trees at 16 feet each way?

CHAPTER XXV

THE FARM GARDEN

EVERY farm should have its garden-spot. Many of our schools have gardens, and it would be well if all country schools had

FIG. 94. — Staking out the school garden.

areas in which boys and girls could study how vegetables and flowers grow. But every boy and girl should have a garden at home where he can learn how to prepare the soil, how to plant and care for the seeds and plants, what the needs of plants are, and how to supply them. The garden is simply a miniature farm, in which plants receive individual attention. It should be the most productive area on the farm. Usually it is the least productive.

Location of the garden. — The farm garden should be placed near the house, because it is truly the "kitchen" garden and should be easily reached from the kitchen. It should be large enough for the crops to have an abundance of room, and so that horse-cultivation may be given instead of hand-cultivation. With long rows, or an oblong garden instead of a square one, horse-cultivation will be easier. The vegetable garden may be a part of a field crop, as corn or potatoes, the vegetables being planted at the ends of the field rows so that both crops can be cultivated at once.

The soil. — If we are starting the garden on new ground, we must first put the land in good condition by plowing under a liberal quantity of stable manure, or by planting a cover-crop to be plowed under the season before the garden is to be made. A dressing of five to ten loads per acre of fine, rich stable manure should be worked into the soil with a disk or spring-tooth harrow. If stable manure cannot be had, a good commercial fertilizer may be used. Vegetables must grow rapidly, and so the soil must be rich. A small, rich garden is likely to be much more satisfactory and less expensive than a large, poor one.

If the location of the garden can be secured in the fall, much of the preliminary work, as leveling, the removal of rough material, and the plowing or spading, may be done before freezing weather. Fall plowing is to be recommended, as winter freezing has a beneficial effect on the soil, causing it to crumble and separate into fine particles. It is possible also to work fall-plowed land earlier in the spring than unplowed land. If spring plowing must be done, it is best to begin as early as the ground will permit. It is well to plow to a depth of four to six inches and to make the soil fine with a spring-tooth harrow, after which the small stones and rubbish may be raked off with a hand rake and the ground leveled for sowing seeds.

Heavy clay is not the best soil for gardens. If such a soil must be used, it should be drained, and muck, grass, sand, or coal ashes added to lighten it. Clay should never be plowed when it is wet. Gravelly, sandy, and clay loams are easy to work and are good garden soils.

Sowing the seeds. — The entire garden need not be planted at one time. If radishes, lettuce, and peas are planted early, they

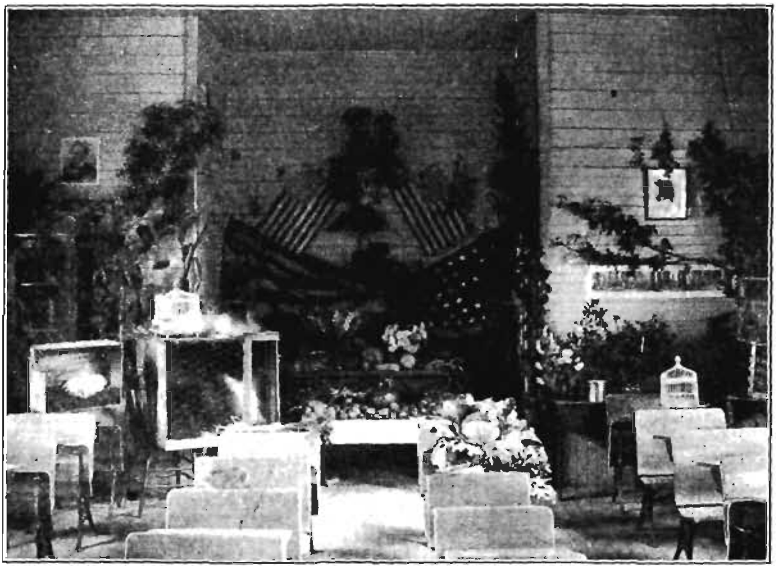


Fig. 95. — Exhibition of products grown in the garden by boys and girls. Has your school had an exhibit?

may be harvested in time to plant sweet corn, cucumbers, squash, late beets, cabbage, and other crops in their places. After early beans, sweet corn, and potatoes, we may plant celery, turnips, spinach, and the like. Usually it is desirable to have a succession of sweet corn and peas. To do so, early, medium, and late varieties are planted at one time, and some good variety is planted every week or ten days for a few weeks thereafter.

In planting the seed, it is much better to sow in rows than broadcast. The seedlings may then be more easily distinguished from one another, thinning and weeding may be quickly done, and the soil between the rows may be hoed without injury to the seedling plants.

It is best, if possible, to have the rows extend north and south; this will give each row its share of sunlight. If the rows run east and west, and one or more rows contain tall plants, there is danger of shading the rows in the rear.

Starting the plants. — The seeds of all but the coarser growing plants may be started in the house in March or April, by using shallow boxes or trays filled with light soil. Care should be taken not to sow the seeds too early, for if the plants grow spindling they will be difficult to transplant. Six weeks before the time to plant out of doors is early enough to sow the seeds in boxes, and even then it may be necessary to transplant to other boxes before the ground is fit to receive the seedlings.

Planting out-doors. — With a fine, mellow seed-bed, the seeds should be covered according to their size and the weather conditions. Small seeds should be covered three or four times their thickness in dry weather, and less deeply in wet weather. The soil should be pressed firmly about the seed with the hands, foot, or hoe.

Watering the garden. — If it is necessary to water the growing plants, it should be done late in the afternoon, if possible, or else by daylight in the morning when the soil is cool. If watered in the morning, the sun causes very rapid evaporation, leaving the soil dry and causing heavy soils to bake.

As we have learned, thorough cultivation of the soil will hold the moisture and lessen the need of watering. Much of the watering in gardens may be done with the cultivator or the rake. With either tool we can prepare a fine, loose, dry mulch which will keep the water from escaping by evaporation. A mulch may be made, also, by spreading on the ground grass, hay, straw, coarse manure, leaves, or boards.

Care of the garden. — The garden demands careful attention throughout the summer. Weeds must be kept out, the surface soil must be loose, and the plants must be protected from destructive insects and diseases. Many enemies will come upon the garden to destroy it. For insects that bite or chew the leaves, hellebore, Paris green, arsenate of lead, and other poisons may be used. For insects that puncture the leaves and suck its juices, whale-oil soap, kerosene emulsion, and lime-and-sulphur wash, are valuable. For blights, rusts, and rots, Bordeaux mixture is a good protection.

Harvesting. — Early vegetables should be harvested as soon as they are large enough for table use. Radishes, beets, turnips, and kohlrabi become woody if left in the ground too long. Lettuce, spinach, cabbage, and cauliflower will run to seed if left after they are fully mature.

Fig. 96. — Pigweed, or lamb's quarter. A common weed in gardens.

Winter vegetables should be fresh and tender when gathered, and should be stored in a cool, moist place at a temperature of about 32 or 33 degrees. Beets, parsnips, and similar crops may be packed in cool, slightly moist leaves. Such leaves may be gathered in the morning after a frost or when there is a light snow on them.

Small fruits. — The garden will not be complete without its strawberries, blackberries, raspberries, currants, and gooseberries. These, also, should be planted in long rows, wide apart, so that they may have horse-cultivation and not be crowded in their growth. It is just as important to cultivate the berry-bushes as any other of the farm crops.

Strawberries will yield as large a crop to the acre as apples. They do well on new land that has grown a crop of potatoes or some other cultivated or hoed crop. The soil must be carefully prepared and all weeds kept out. Usually only one or two crops are gathered from the strawberry bed, and then a new one is made. In the North the plants must be protected from freezing during the winter. A light covering of straw, old hay, strawy manure, pine needles, or other light material will serve for this purpose.

Raspberries, blackberries, currants, and gooseberries do best on loose, deep, rich loam soil, but may be grown on others that contain plenty of vegetable matter. New plantations may be made every six to ten years. The best time to plant is in the fall. Raspberries and blackberries are pruned each year by removing the canes that have borne fruit as soon as the fruit is gathered. In pruning currants and gooseberries, wood more than three or four years old is removed, so as to encourage the growth of new canes.

Problem 167. How many farmers in your neighborhood have gardens? What are the six crops mostly grown in them?

Problem 168. Is the same land on your farm used year after year for the garden? If so, how is it fertilized — with barnyard manure, commercial fertilizers, or green manures?

Problem 169. Is commercial fertilizer applied to some crops and not to others? What kind of fertilizer is used for each of the particular crops? Why is it used?

Problem 170. What kinds of root crops are grown in your farm garden? What kinds of vine crops? What kinds of crops are grown for their leaves? Which crops are planted earliest? Which latest? Do you grow any crops that bear their fruit on the surface of the ground? If so, what are they?

Problem 171. Describe the different ways in which a garden may be watered, or the water made available to the plants.

Problem 172. In the spring, lay out a garden on the school grounds, at one side where it will not interfere with the playground. It may need a good dressing of barnyard manure. Let each member of the class have a share in it for which he is especially responsible. Plant such crops as lettuce, radishes, peas, strawberries, sweet peas, and China asters. Take special care and pride in each step in the work — preparation of the soil, straight, even planting, grouping each crop by itself, a fine, clean mulch, freedom from weeds. Compare the school garden with the home garden. See how many ideas you can carry from the school garden to the home garden.

Problem 173. For your home garden keep a complete record of everything — how much you paid for each kind of seed, the date when each was planted, how many bunches, heads, quarts, or pecks of each crop were harvested, what they sold for, and other important items. Try to make your home garden the best in the neighborhood. Save a few of the best products of each kind for a fair at the school in the early fall. Beside your exhibit on a card write the leading facts about your garden as shown by your records. Perhaps ribbons or other prizes can be given for the best exhibits. A permanent record should be kept at the school, showing who received prizes for the best exhibits each year. The prize list may be neatly framed and hung on the wall.

CHAPTER XXVI

THE WOOD CROP

Trees grown in the farm woodlot are as truly a farm crop as corn or cotton. They are planted, harvested, and used to supply human needs. If the woodlot is mismanaged, it will return a poor crop, just as will the wheat-field. Most farm woodlots are poorly managed, and farmers are thereby wasting or neglecting an important source of income.

Importance to the farmer. — It is estimated that the farmers' woodlots of the country alone are capable of growing more timber than our present total consumption.

The farmer himself uses considerable wood. It is his usual fuel, and supplies material for fences, buildings, and for many other purposes. If the farmer cannot get what wood he needs from his own farm, he must either go without or be put to much expense. It is important, therefore, that in the East the farmer know how to grow the largest and best wood crop, and in the West, where timber frequently is scarce, how to choose and plant trees that will supply his needs.

In some places, woodlots are useful to protect buildings and livestock from driving winds. On the treeless plains and prairies, trees are sometimes planted for this purpose alone.

The loose, deep vegetable mulch in a well cared for woodlot or forest will hold a large part of the water of rains and snow. As this water drains away slowly, floods are prevented and a continuous supply of water is made available in streams.

The farmer should look upon his wood supply as one of his regular farm crops. He should give it a share of his attention. As he does not harvest the entire crop at one time, he must know when and where to cut so as to leave the remainder in the best condition to encourage the growth of young trees. He must know what kinds of trees will grow best in his locality, what each is useful for, how it behaves toward other trees in the forest, how long it requires for growth, and other similar facts.

Place on the farm. — Trees will grow on land that is useless for general farm purposes. On most farms there are some soils that are fit only for timber crops. By leaving this land in timber, or planting it in trees, the farmer has made his best investment in that land. Farms are sometimes deserted or abandoned because they will not produce good farm crops. Very often such farms are naturally well adapted for the growing of trees.

Lumbering is generally done in winter. The farmer who has a large, well-kept woodlot will be able to use his help in the woods in winter when general farm work is light. The care of the woodlot fits in well with other work, as it can be done at odd times. A few months' difference in time in cutting the wood crop will not result in injury to it.

History. — The farm woodlot is almost everywhere the remnant of a large forest that once covered the region. When the early settlers from the Old World landed on the Atlantic coast of North America, they found a country almost covered with dense forests. There was little open land for the growing of crops. While the forest gave the settler fuel and shelter, and provided him with game, yet it was too often filled with hostile Indians, who, from its cover, dealt death to the settler and his family, and destruction to his home. Instead of being an aid and protection to him, it became an object of fear. How to make a clearing most rapidly was the important question.

When the settlers in the northeastern states hewed their farms out of the forest, turning into pasture and field a large part of their holdings, they left parts uncut for their own wood supply. This was to furnish fence-posts and rails, repair wood for buildings and implements, and, above all, firewood. In 1681, an ordinance of William Penn, intended to protect the forests, required that one acre of land be left in trees for every five acres cleared. This was not faithfully obeyed.

The better land was usually cleared first, and the woodlot left on the poorer lands and hillsides. The fact that the land was unsuited for farming or inconveniently located was doubtless important in determining what land should be left in trees.

From the first, land-owners mismanaged their woodlots, or did not manage them at all. Instead of taking out the dead and dying, the crooked and inferior trees and limbs for firewood, they thought the best trees none too good for the fireplace. The best trees of the best kinds were cut for posts, fence-rails, fuel, and other less important purposes. Consequently, the woodlots were left with the undesirable and useless trees. There was no thought as to the new crop to take the place of the old one. Cattle roamed in the woodlots, trampling the soil and destroying the young seedlings. In this unfortunate condition we find a large part of the woodlots on American farms to-day. The time has now come when the wood crop must receive attention and be made productive.

Distinction between field crops and wood crops. — While the products of both field and woodlot are farm crops, they have not much in common. Wood crops require years to develop. They do not have a definite age at which they should be harvested. The wood crop is not necessarily reproduced by cutting and re-planting, as is usual with farm crops, although this may be done. The wood crop is not fertilized and cultivated as are field crops.

Field crops are dependent on the weather, while wood crops are not so much affected by the weather and are seldom a total failure. The work on the wood crop may be done at almost any time of year, whereas general field crops demand attention at particular times.

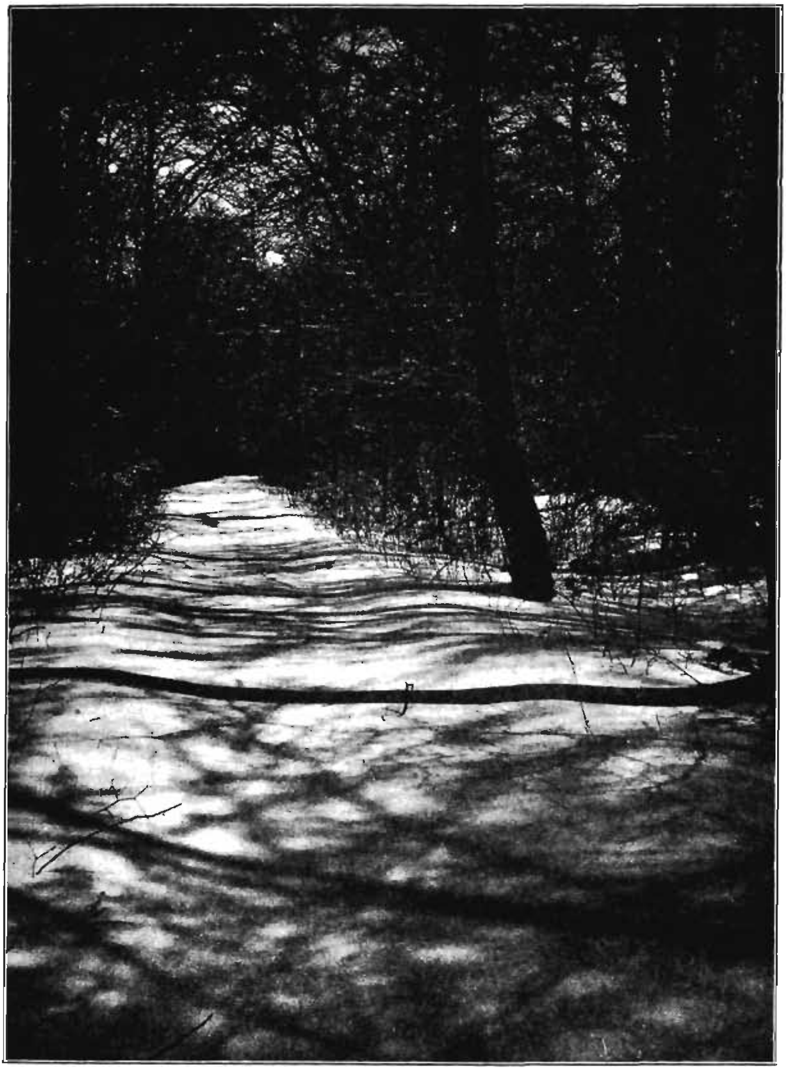


FIG. 97. — The forest has overgrowth and undergrowth. Animals find protection here.

The nature of the wood crop. — There is *great variety* in wood crops, as in field crops. There are many kinds of wood and many forms of growth. Conifers, most of which are evergreens,

FIG. 98. — Sometimes trees are planted merely to break the force of the wind. This windbreak protects the orchard.

as pines, spruce, hemlock, fir, cedar, and the like, furnish building materials. They grow from seed only and require a long time to reach suitable size. Broad-leaved trees, as maple, oak, hickory, catalpa, and chestnut, used for a variety of purposes, may be ready much sooner than conifers if grown from sprouts. They will reproduce by sprouting from the stump as well as from seed.

The battle of the trees. — The forest is a society of trees. If we go into a good woodlot in winter, and look up, we shall see that the crowns of the trees fill all the space overhead. The large trees have struggled to get ahead of each other and to spread their tops in the light. The lower branches have been shaded off, and the long, clean trunk, or upward-stretching branches, with narrow crown lifted high in the air, has been developed.

In an opening in the woods, where large trees have been taken out, we may find a heavy growth of bushes, seedlings, and saplings, struggling to get ahead of one another and to occupy the best places. Those that have broken through the tangle below are racing with each other to fill the open space above with branches. When their branches meet and the crown is again formed, the shade deepens, and the weaker of the seedlings and saplings below will give up the battle and die. Some of the bush-like plants, however, continue to grow in dense shade; but they are not the kinds that become large trees.

The trees that forge ahead are said by the forester to be *dominant;* that is, they dominate or overshadow others. Those struggling just below are said to be *intermediate*. Still others, hopelessly beaten and overtopped, are said to be *suppressed.*

Some kinds of trees are *tolerant* or shade-enduring. They are able to withstand the dense shade. They hold their places and wait patiently for the time when their immediate superiors shall be removed. Still other kinds never enter the severe struggle for the highest places. They will always be found among the lower-growing trees and bushes in the woods. A few kinds, as locust and catalpa, require a great deal of light and will die if they are over-topped. A forest, therefore, may have several stories of bushes and trees.

The care of the woodlot. — If the farmer cuts the most valuable trees year after year, his woodlot will constantly become poorer. The trees that he does not want will tend to take the places of those he cuts.

In order to keep the woodlot at its best, the dead, or dying, and undesirable trees should be removed for firewood, posts, poles, and similar uses, and only the mature trees cut for building pur-

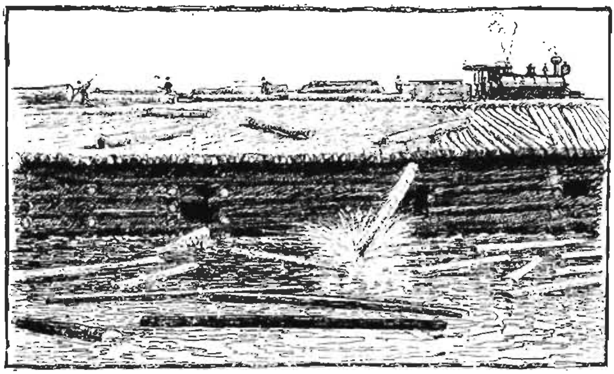


FIG. 99. — The transportation of logs by both steam cars and water.

poses. The spaces thus left open should be filled by natural growth or by planted seedlings. The felled trees must be carefully removed so as not to destroy seedlings.

If the young growth is too dense, it may be necessary to remove some of the young trees. Sometimes it is desirable, also, to remove limbs or parts of trees that interfere with the best growth of the tree itself or of others near it. When a person thins his woodlot, he must have in mind the best development of the trees that are to be left.

The woodlot should be protected from fire and from grazing and browsing animals. As fires are difficult to control after they have started, precautions must be taken to prevent them. If the woodlot borders the railroad, a cleared strip along the roadside is a safeguard. Such strips, or "fire lines," should be kept clean.

Persons should be warned against starting camp fires in the woods. In removing trees in winter, the brush should be piled and burned; it should never be allowed to remain through the summer.

Cattle, sheep, and goats should not be allowed to run in the woodlot where a new growth is desired. By eating the leaves and tramping the ground they destroy the young trees. Frequently woodlots are ruined by allowing stock to run in them.

Forestry. — The raising of timber-crops, and the management of forests, is known as "forestry." It is a great branch of agriculture, or the producing of things from the land. It is recognized as such by the government in making the subject a part of the United States Department of Agriculture. In the heavily wooded regions, as in the East, forestry is of importance in properly managing the forests; in the treeless regions, as in parts of the West, it is important in the planting of forests. The farmer who has a woodlot should practice forestry.

Problem 174. If there are woodlots on the farms in your locality, tell whether they are on land that would be useful for farming purposes if the trees were removed. Why have they been left, or planted, on the land they occupy?

Problem 175. Ask the teacher to take the class on an excursion into the woods. Plan to visit two woodlots, if possible, one that has a heavy young growth and many large trees, and one in which cattle have browsed. Note the differences in the large and the small trees, and in the soil cover. In which is the soil cool and moist?

Problem 176. Name all of the ways in which wood from the woodlots is used on the farms in your locality. Does it pay the farmer to keep his woodlot in good condition?

Problem 177. Write a list of as many trees in the woodlot as you can name, and tell for what the wood of each is used.

Problem 178. During a heavy rain, when the bare hillsides wash, what becomes of the water that falls in the woodlot? How long after the last snowfall have you found small patches of snow in the woods? Is the fact that forests hold the snow and allow it to melt gradually of any importance to the farmer?

Problem 179. Of what timber is the school-house made? Where did it come from? Of what is your residence made? Your barn? The fences?

Problem 180. What is the best timber for fence-posts? Why? Where do the fence-posts in your neighborhood come from?

Problem 181. Ask the teacher to take the class to a place where a large tree has just been cut down, to notice the *rings on the stump* — one ring after another from the center to the bark. Each ring represents one year in the life of the tree and shows how much the tree grew that year. Some rings may be wider than others, showing that those years were favorable for the growth of the tree — the wider the ring the greater the growth. Count the rings and find out how old the tree is, and whether it had any years of specially rapid growth.

CHAPTER XXVII

FARM WEEDS

WEEDS are plants that are not wanted. They are out of place. They may be either plants for which no use has ever been found, or plants that are regularly cultivated on the farm. If they are a nuisance and are occupying space where they are not wanted, or that is needed by crops, they are weeds.

The farmer has never found any use for thistles or ragweed. They creep into his fields and interfere with his growing crops. He thinks of them always as weeds. Daisies and buttercups have attractive flowers, but when they establish themselves in the farmer's hayfield among the timothy, they are undesirable weeds. When timothy, in return, appears in the flower-garden, it is just as truly a weed; it is not wanted there and is out of place. Potatoes may be weeds in a cornfield, or corn may be a weed in a potato field. In fact, when corn or potatoes are planted too thick, some of them are weeds to the others.

Why weeds grow. — If we go out on the farm to a plowed field that has lain idle for a year, we shall find that it is more or less covered with weeds. When the farmer ceased to give the field attention, Nature clothed it with herbage. Nature will not long allow the land to remain bare, if it is possible to cover it. She is always ready with a seed to grow at the first opportunity. It is one of her practices to keep the earth covered, during the growing season, with some kind of plant. The plants that she establishes in our fields, however, we are likely to call weeds, because they usually come where we do not want them; and they are not the kinds that we can use.

FIG. 100. — A pigweed growing alone, showing spreading habit. The pigweed is a very common nuisance.

Why weeds are objectionable. — As we learned in Chapter XVI, more seeds are produced by plants than can find room to grow on the surface of the earth. There is a struggle among them for room and for place.

Weeds enter into this struggle. Always having had to look out for themselves, without the aid of man, many of them have become vigorous and persistent, and will struggle hard to keep their places. Because they are useless to the farmer and tend to crowd out plants that he desires to grow, they are objectionable to him.

Again, weeds require the same kinds of food for growth that other plants need. When they grow in a field of corn, for example, they take from the soil both moisture and plant-food that the corn plants should have. They may take so much mois-

FIG. 101.—Pigweeds growing in a colony, showing narrow, erect growth from crowding.

ture that in a dry season the crop of corn will be able to make only a short, stunted growth. The greatest objection to weeds is that they take moisture and plant-food that the farmer's crops should have. They compete with the crops.

How weeds increase. — Weeds appear in all localities and in great numbers. There is never a time when a farmer does not have them to contend with. He may spend much time in destroying them, but they soon appear again.

Fig. 102. — Wild carrot establishes itself in pastures and neglected fields.

All of our common weeds produce seeds, some of them in very great numbers. Others are too impatient to wait for the seeds, and during the growing season send out runners, as does the strawberry, to start new plants. Orange hawkweed, sometimes called paint-brush, is a weed of this kind. Its runners are sent out on the surface of the soil, and they send up new plants every two or three inches.

Certain other weeds will grow from parts or pieces of root, so that if any of the root is left in the ground a new plant will spring up. Horse radish, for example, which may sometimes be a weed, will produce new plants from the very smallest pieces of root.

When we add to the fact that weeds will grow from many parts of the plant, the additional facts (given in Chapter XVII) that they employ almost every conceivable means of spreading their seeds, it is little wonder that they are so plentiful.

The control of weeds. — War can be waged against weeds most successfully when we know something of their habits, especially how long they live and how they spread.

Annual weeds, that is, those that live but one year, come up in the spring or summer, produce seed, and die in the autumn. They reproduce themselves only by seed. The seed lives in the ground over winter and grows in the spring. If annual plants are not allowed to produce seeds they will be utterly destroyed. Such weeds are destroyed by cutting them before the seed has formed.

Biennial weeds, or those that live for two years, produce roots, stems, and leaves the first year. The second year they produce blossoms and seeds. If they are mown before they have formed seed, they also will be destroyed. Cultivation in the fall will kill them.

FIG. 103. — Canada thistle is one of the worst weeds on the farm.

Perennial weeds, or those that live for more than two years, are not so easily controlled. If they are prevented from forming seeds, they still will grow from the roots. Each fall they die down to the ground, but in the spring send up new plants from the roots. The only way to get rid of them is to dig them up or to crowd them out by keeping the land tilled or occupied by other plants.

Ridding the farm of weeds. — The best method of getting rid of weeds on the farm is by good farming. The man who has a well-planned crop rotation system, tills his crops at the right times, cuts the weeds in the fence-rows and other waste places, and keeps his land so much occupied with growing crops that there is neither time nor room for weeds to grow, will have little trouble.

Weeds are most easily destroyed when they are young. If they are not disturbed until after they have become well rooted, they cannot be removed by cultivation. They must then either be dug out with a hoe or pulled out by hand. The farmer who runs a weeder or harrow lightly over his corn or potato field, just before or soon after the plants are up, will kill most of the weeds.

To keep the land free from weeds the farmer must not sow them himself. Unfortunately, much of the seed of farm crops, especially of grasses, which is sold on the market is not clean and pure that is, it contains large numbers of weed seeds. Frequently there are thousands of weed seeds of many kinds mixed with every quart of timothy or clover seed that is sold. The use of such unclean seed is one of the most common means of establishing weeds on the farm. If the farmer does not know that his seed is free from weeds, he should either examine it himself or send it to the agricultural experiment station in the state. Prevention is better than cure.

Lists of weeds. — It is impossible here to name all the kinds of weeds; but a small list, classified by length of life, may serve as a framework to which the pupil may add others that he knows

Annual weeds

Purslane, or "pussly"
Pigweeds, of several kinds
Smartweeds
Mustard
Ragweed
Cocklebur, or Clotbur
Jimson weed
False flax
Buffalo bur
Foxtail
Kinghead
Russian thistle
Pepper-grass
Barnyard-grass
Crab-grass
Squirrel-tail grass
Chess
Chickweed
Dodder
Cockle
Mayweed
Prickly lettuce (sometimes biennial)
Shepherd's purse
Tarweed
Tumbleweed

Biennial weeds

Wild carrot
Mullein
Burdock
Bull or pasture thistle
Wild parsnip
Sweet clover
Brown-eyed Susan
Evening primrose

Perennial weeds

Quack-grass	Golden rod
Johnson-grass	Sorrel
Hawkweed	Buttercup
Dandelion	Yarrow
Poison ivy	Bindweed
Sow-thistle	Live-forever
Docks	Man-root, or Man-vine
Canada thistle	Coco-grass, or Nut-grass
White daisy	May-pop
Plantains	Sneezeweed

Problem 182. Count the number of seeds on a ripe dandelion head. Also count the number of seed stalks which one plant will produce. If the plant produces five seed heads, or balls, in one year, and each head contains two hundred seeds, how many plants could be produced in five years from one plant? How many do you suppose could be produced in one year from all the dandelions in your neighborhood if they could find a place to grow?

Problem 183. Name as many as you can of the common weeds in your locality, and tell where they grow and how they spread. Can you name one annual, one biennial, and one perennial weed that is common in your locality?

Problem 184. How may weeds be kept out of the meadow?

Problem 185. What weeds are most common in the cornfield? In the wheat-field? The meadow? The pasture?

Problem 186. Do the best farmers in your neighborhood have many or few weeds in their fields? Do those that have few weeds practice crop rotation? To what extent can we judge of a farmer's success by the number of weeds on his farm?

Problem 187. It will be of interest to have in your school museum small bottles filled with weed seeds of various kinds. The labels on the bottles should give the name of the weed, place where found, whether annual, biennial, or perennial, and means of dissemination. (See page 127.)

CHAPTER XXVIII

INSECT ENEMIES OF PLANTS

PLANTS are not free to live their lives undisturbed. Not only must they struggle for room, light, moisture, and food, but they are constantly besieged by an innumerable array of enemies. Weeds try to crowd out and take away their food-supply. Insects come upon them to eat them or sap their life blood. Diseases come to weaken and destroy whatever they lay hold on.

Of these enemies, none brings greater devastation to the farmer's plants than insects. In a single year, they may destroy $700,000,000 worth of crops in the United States alone. This is more than all the money spent by our national government. It is an enormous sum to pay for the support of this destructive army. How to protect his crops and reduce this expense, is one of the greatest problems the farmer has to face.

There are many kinds of insects. — Nearly every kind of farm plant has at least one insect enemy. There are enemies of vegetable crops, others of grain crops, fruit crops, forest or wood crops, and so on through all the list of farm plants.

Some crops have very many insect enemies, each of which causes injuries in its own way. The apple is one of these. The small brown bud-moth caterpillar devours the tender leaves and flowers of the opening buds in early spring. It is assisted by the case-bearers and the tent-caterpillars. The leaves may be attacked by canker-worms and leaf blister-mites. The fruit may be visited by the codling-moth, which bores its tunnels through it and makes the apples "wormy." The San José scale, oyster-shell scale, and scurfy scale, live on the trunk and branches, sapping out the juices. The San José scale also fastens itself on the fruit, causing bright red spots. Into the trunk the borer eats his way and adds to the destruction.

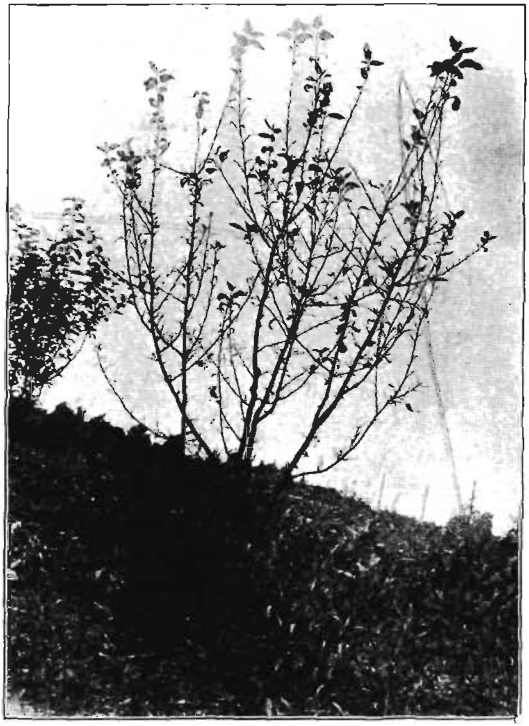


FIG. 104. — *A tree almost stripped of its leaves by caterpillars. Caterpillars are biting insects.*

Fortunately for the apple-grower, not all of these enemies are likely to fall upon his trees in the same year, at least not in dangerous numbers. But some of them will always be present to weaken his trees and reduce his crop unless he is able to prevent them.

The fruit-grower is troubled most by the insects just named for the apple, also with the aphis, curculio, leaf-hopper, flea-beetle, and pear psylla.

The more common insect enemies which the grain-farmer has to fight are the cutworm, wire-worm, chinch-bug, grasshopper, hessian fly, and army-worm.

The vegetable-grower has to contend with the potato beetle, cabbage-worm, cabbage aphis, striped cucumber beetle, plant-louse, flea-beetle, cutworm, and white grub.

Nature helps the farmer. — The farmer is not alone in his fight against insect pests. Nature lends him aid that accomplishes more than anything he can do. Strong winds, sudden changes of temperature in winter, rains, and forest and prairie fires destroy vast numbers of insects. Many birds feed largely on insects, and numbers too great to be counted are destroyed by them every year. Birds are really among the farmer's best friends.

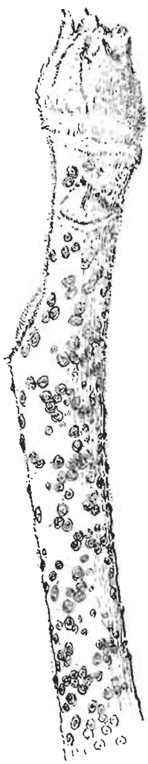


FIG. 105. — Example of a sucking insect. San José scales (enlarged) attached to a twig and drawing the juices from it.

But, strangely enough, the insect enemies of the farmer find their greatest foes among their own kind. Some insects prey upon others. A little lady-bird beetle saved the citrous orchards in California by destroying a scale insect that was ruining them. It would not be possible to grow wheat in many parts of the United States if it were not for little insect friends of the farmer that prey upon the hessian fly.

The farmer's methods. — Man cannot depend on Nature to defend his crops, but must enter the conflict himself. For centuries he has been fighting insects. The ancient Greeks mixed hellebore with milk to kill flies. The Romans required the inhabitants in regions that were overrun with grasshoppers to kill certain quantities of them. In the Middle Ages, priests marched around fields that were infested, praying and pronouncing curses on the pests; or the insects were summoned to appear in court and told to leave the country.

The farmer of to-day is beset by so many pests that he has to use more active means than these. His present methods of defense are of three general kinds: (1) hand, or mechanical methods; (2) farm practices; (3) spraying with poisons.

(1) *Hand, or mechanical, methods.* — Insects are gathered and destroyed by very many different kinds of hand methods. Sometimes they are merely picked by hand, as potato beetles in the garden patch. Sticky pans may be drawn across fields to collect

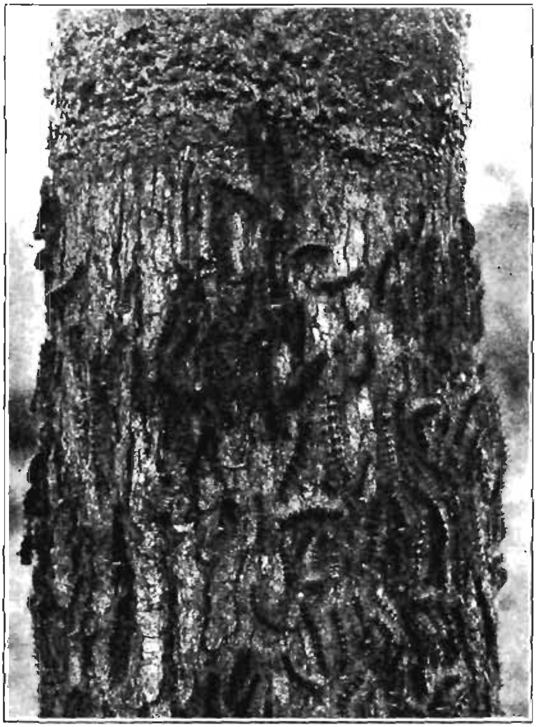


FIG. 106. — Caterpillars checked in their journey up a tree by a sticky band.

grasshoppers. Sticky bands placed about trees prevent the ascent of the wingless canker-worm moths. Sheets may be placed under small plum trees and the trees jarred so that the *curculio* insects will fall into them. Strips of tar poured along small ridges plowed up all about a field will prevent chinch-bugs fron passing.

Many other hand, or mechanical, methods are employed. The: are most useful in small areas or gardens.

(2) *Farm practices.* — We have learned that crop rotation help to destroy weeds. It also helps to destroy insects that attacl such crops as corn, clover, wheat, and potatoes. When th insects find their favorite crop gone and replaced by one they d not like, they are without food and starve to death.

Good tillage destroys many insects and grubs that live in th soil, such as wire-worms and white grubs. Canker-worms, whicl attack fruit trees, live in the soil a part of the time during thei development, and are easily killed by tillage.

Sometimes crops can be planted early enough so that they wil be able to resist the attacks of insects when they come. Or strip of the crop may be sown around or near the field to attract th attention of the on-coming pests. Such strips are called " tra] crops " because they are planted to entrap, or catch, the insects While the insects are working on the strips, the farmer destroy them.

One of the best methods of protecting crops from their enemie is to keep the farm clean; that is, to burn up all weeds, rubbish old vines, tree prunings, and the like, so that the insects will hav fewer places in which to live over winter.

(3) *Spraying with poisons.* — Farmers have found that one o the best methods of protecting their crops is to spray them wit poisons that will kill the pests. In order to spray successfully they must know something about the insect they desire to kill.

Insects secure their food in one of two ways. Some of them as caterpillars and potato beetles, are provided with strong jaw which enable them to bite off and swallow solid pieces or par ticles of their food-plant. They are called *biting* insects. Others as plant-lice, scale insects, and mosquitoes, do not have jaws fo biting and chewing, but are provided instead with long, tube-lik mouth parts. These they force into the tissues of their food-plants, and suck their food. They are called *sucking insects.*

Biting insects can be killed by covering the leaves of the plants they attack with poison. When they chew the leaves, they get the poison and die. Sucking insects, which secure all their food from inside the plant tissues, are not disturbed by any poison that is on the surface. To destroy them, it is necessary to spray at such a time that the poison will be placed directly on the bodies of the insects themselves. When they are "hit" by the poison spray, they are killed.

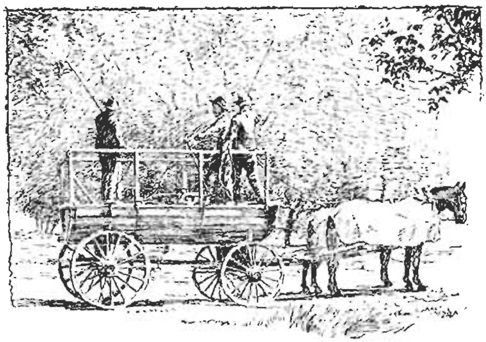


FIG. 107. — A large spraying outfit operated by hand power. For use in orchards.

The kinds of poisons to use. — Most of the biting insects are killed by poisons that contain arsenic. Such poisons are sold under the names arsenate of lead and Paris green. Some other kinds that do not contain arsenic, as pyrethrum and hellebore, will also destroy some of the biting insects.

Sucking insects are killed by poisonous powders, oils, soaps, and other special mixtures. The best known powder is the ordinary insect powder. Substances known as whale-oil soap, fish-oil soap, kerosene emulsion, and lime-sulphur wash are commonly used against the sucking insects.

Spraying. — Poisons used for spraying, except some that are powders, are applied in a liquid form. Usually the poison is dissolved in water. The spray mixture, as it is then called, is placed in a tank, from which it is forced by a pump through a hose having a nozzle at the far end. This nozzle breaks the mixture into a fine spray or mist. By having the spray fine, the foliage of the plant or tree is covered more thoroughly and with less quantity of the mixture. In large farm and fruit operations, power pumps are now extensively used, run mostly by gasolene engines.

The farmer needs to know when to spray his crops and which kind of spray to use in order to protect his plants from particular insects.

Problem 188. Name three insects that the farmer must fight against, and tell what each attacks. Describe the different methods of destroying insects that are used by the farmers in your locality.

Problem 189. Can you tell what insects breed in low, wet places?

Problem 190. If any of the farmers in your locality spray, for what insects do they spray? What poisons do they use? What crops do they spray?

Problem 191. Have any crops on your father's farm or on a neighbor's farm ever been entirely ruined by insects? When? By what insects? How much did the loss of the crop cost the farmer?

Problem 192. If Paris green is worth a dollar a pound and it requires two pounds to spray an acre of potatoes, and one day's time at $1.50, what will be the expense for spraying six acres, making two applications? If potatoes sell for $.40 a bushel, and the farmer who sprays averages 160 bushels per acre on six acres and the one who does not spray averages 120 bushels per acre, which one will gain most by his method, and how much?

Problem 193. Name and describe one insect that attacks apples, one that attacks potatoes, one that attacks some other garden crop.

Problem 194. Watch the birds as you go to and from school, and discover how and where they get most of their food. After you have studied them for a few days, write a short essay about their habits.

Problem 195. What is the most common insect on the farm — the one that swarms in the house, and especially in the kitchen? What kinds of diseases does it carry? How may it be kept out of the house, and how may it be destroyed? (See page 26.)

CHAPTER XXIX

DISEASES OF PLANTS

PLANTS, like animals, have diseases that disable or kill them. Almost every plant that is cultivated, be it vegetable, grass, grain, fruit or forest tree, has one or more diseases to which it is subject. There are diseases of the roots, others of the stem, others of the leaves and the fruits. Sometimes the entire plant is weakened or destroyed, and at other times only the part that is diseased.

FIG. 108. — Corn attacked by the smut disease.

The nature of plant diseases. — Most of the diseases of plants are caused by fungi (singular, fungus) and bacteria. Fungi are plants of a low order. Many of them live either wholly within other plants or on their surfaces. In the latter case, they send their thread-like roots in search of food into the tissues of the plant. Because they live wholly at the expense of others, they are called *parasites*. The plants on which they live are spoken of as their *hosts*.

The fungi are very different from other plants. They bear no flowers, and consequently never produce seeds like those of flowering plants. They produce little bodies called spores, which answer the same purpose as seeds. The cloud of dust or smoky powder that rises from the puffball that we kick as we walk through the cow pasture is composed of spores. The puffball is a fungus, and its smoke consists of millions of spores from which other puffballs may grow.

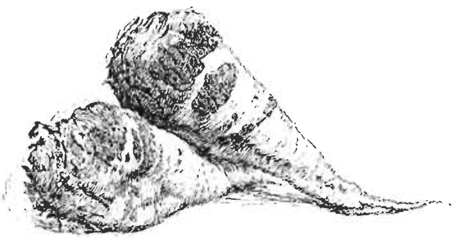


Fig. 109. — Sugar-beets attacked by the potato scab disease. The fungus of this disease lives in the ground from year to year and may injure other vegetables besides potatoes.

The fungi that cause disease in plants are parasites. They live on or within the tissues of other plants, and in exchange for their food-supply, or rather in securing it, produce disease in their hosts.

We have all seen rotten apples or peaches or oranges. These fruits are diseased. Fruit rot is a disease. So also are scab on potatoes, smut in wheat, oats, or corn, blight of pears and apples, clubroot of cabbage, curl of peach leaves, and wilt of cotton.

How plant diseases spread. — The light spores of fungi are carried by wind, water, and insects from one place to another. They alight on the surfaces of plants, or in wounds, cracks, and crevices. If they find suitable conditions of food and moisture, they will begin to grow, working their way into the plant tissues from the outside.

Some diseases live in the soil and attack the roots. Plants that are grown on such soils become diseased if they are subject to the kind of parasite that is present. When taken to other places such plants carry the parasite with them, and the soil in the new field becomes infected. Tools that are used in these soils carry the fungus.

The fruit-grower may spread some disease germs by means of his tools also. When he cuts away a diseased branch with a knife or saw, the spores may be left on the blade. Then, when he cuts away a healthy branch, the disease may be deposited on the fresh surface left by the saw.

Plant diseases are frequently spread by spores on the seeds of crops. We have seen the black or smutty heads of oats as they stand in the field. These black heads are diseased, and are filled with spores. When the grain is threshed, the cloud of black dust that rises as it passes through the thresher contains many of these spores. The dust settles on the grain as it comes from the machine. When any of this grain is planted, the disease is present to develop in the growing plant.

Photo by Morton

FIG. 110. — Fungi frequently establish themselves on old tree-trunks.

The fact that many plant diseases are contagious is well shown in the apple and potato bins. One rotten apple or potato may in time spread decay to all the others in the bin.

Diseases must be prevented. — Since the fungi that cause plant diseases draw their food from within the tissues of their hosts, they are not greatly disturbed by any poison placed on the surface of the plant after they have become established. They must be prevented, for they can seldom be cured. Several means of prevention are in use, about some of which we shall now learn.

Rubbish should be burned. — Every diseased leaf, branch, fruit, or vine bears millions of spores, a single one of which can carry the disease to a new plant. These parts should be gathered and burned. The diseased limbs that are cut from fruit trees should not be allowed to lie in the orchard, but should be burned at once.

FIG. 111. — Potatoes that were not sprayed and have been destroyed by the potato blight disease.

The stumps of cabbages that have been attacked by clubroot should be raked together and destroyed by burning. Keeping the farm clean of all such rubbish is the farmer's first step in protecting his crops.

Clean, vigorous seed should be used. — The second step is to plant seed that is both clean and vigorous. Strong plants that are grown from vigorous seeds are as likely to resist disease as are strong boys and girls.

Seed that has already been infected with spores may sometimes be made clean by certain kinds of treatment or disinfection. Before it is planted, it may be dipped into a chemical solution that

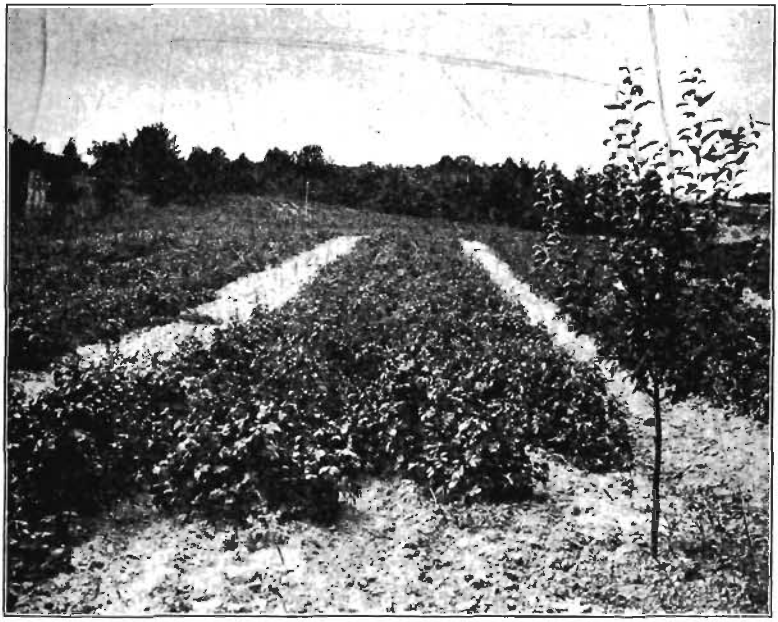


FIG. 112.—Potatoes sprayed as a protection against blight. Does it pay to spray?

will kill the spores. The solution most commonly used is known as formalin, or formaldehyde. Some diseases will be destroyed by suspending the seed, inclosed in a sack, for a few minutes in a tub of hot water.

This method of prevention is used for crops that are grown from seeds, and that are difficult to spray in the field. The seeds of grains, millet, flax, onions, and potatoes are often so treated.

Spraying is the most common method. — If all of the surfaces of a plant are covered with a thin film of poison before the spores arrive, they will offer a very unsafe home for the spores. Destruction will be in store for them wherever they alight. The poison may be in the form of powder and be dusted on. More commonly, however, it is a liquid, and is sprayed on in much the same way as is done for insects. Spores germinate only in moisture, therefore we should spray before rains and not after.

A long list would be necessary if we were to name all the diseases for which spraying or dusting is the common remedy. We may name a few of them: apple scab, leaf-spot, asparagus rust, onion mildew, celery blight, black rot of grapes, lemon scab, orange scab, peach scab, peach leaf-curl, pear scab, potato blight, and potato rot.

A spray mixture that is used to destroy the spores of plant diseases is called a *fungicide*. The word means a substance that will kill fungi. The fungicides used more than all others are Bordeaux mixture and lime-sulphur. Bordeaux mixture consists of lime and another chemical called copper sulphate, or blue vitriol, dissolved in water. Lime-sulphur is a combination of lime and sulphur mixed in certain proportions and boiled in water.

Other methods of prevention. — Fruit trees are attacked by many kinds of diseases. When large limbs have been pruned off, spores may settle on the fresh wounds and cause decay to appear. If the cut surface is coated with paint, tar, wax, or some other substance, the spores may be prevented from entering. Farmers that do not take this precaution often lose valuable trees.

Rotation of crops will lessen injury from those diseases that live in the soil. Usually such diseases will affect the roots of only one or two kinds of plants. If these plants are not grown on the land for a few years, the spores in the ground will die.

A farmer will sometimes find that one variety of wheat or potatoes or cotton will not be greatly injured by disease, while another variety on his farm, or on a neighbor's, will suffer very much. He discovers that some varieties of plants are able to resist disease much more successfully than others. By planting each year the seed from the variety that is injured the least he may greatly reduce his losses. Some persons are now spending much time trying to develop varieties of crops that can wholly resist the attacks of disease.

Problem 196. Collect and bring to school as many different diseased plants or parts as you can find — potatoes, grains, fruits, parts of trees, etc. Note what part of the plant is attacked in each case. Find the spores. Do you know what the disease is in each case, and how it may be prevented?

Problem 197. Dip a match in the mold on a rotting apple, or other fruit, and draw it across a slice of moistened bread. Set the bread in a damp place for a few days and watch it. How did the mold which appears come to be there? Did you plant the spores? Where does the mold get its nourishment?

Problem 198. Name the diseases which injure crops in your locality. If you do not know, ask your father.

Problem 199. Find out, and explain to the class, what methods are used in your locality to prevent diseases from spreading.

Problem 200. Give as many reasons as you can why a farmer should not allow weeds, limbs, roots, and other kinds of rubbish to lie scattered over his farm.

Problem 201. If potatoes are attacked by bugs and by blight, with what should they be sprayed? If you don't know, ask a farmer who sprays his potatoes. Ask how much it costs him to spray his potatoes, and what his yield is. Find out what the yield is on some other farm where they are not sprayed; then, after finding out the selling price, compute the gain or loss to the farmer who sprayed as compared with the one who did not spray.

CHAPTER XXX

THE IMPROVEMENT OF PLANTS

MAN is able to modify or to change plants. The ancestors of all our cultivated plants lived originally in a wild state, but in many cases were quite unlike our present forms. The changes made by man have been in the nature of improvements, so that the cultivated plants might better serve his needs. The large, juicy garden strawberry is greatly improved over its wild ancestor. So also is the large garden blackberry over its small wild form found in neglected fields.

How the improvement has come about. — In wild conditions, all plants struggle for a place to live, and for food and moisture. Frequently they appear in places where they cannot do their best and must adapt themselves to the unfavorable conditions about them.

Cultivated plants are spared much of this struggle. Instead of being planted in a tangle, each crop is by itself and each plant among its own kind; and the individual plants are placed where they can grow best and with least interference from others. Competing plants (weeds) are kept away. The soil is specially prepared for them, and if it is lacking in fertility, plant-food is added. Moisture may be added directly, or saved for the plants by a surface mulch. The farmer reduces the struggle for existence among his crops as far as possible, and tries to make the conditions for growth perfect. All of these advantages, which constantly stimulate plants to do their best, have gradually produced cultivated forms that in some instances differ widely from their ancestors. In some cases the changes have been great, in others small.

There is another reason why plants have improved by cultivation.

No two plants, or parts of plants, are exactly alike. If we compare any two plants of the same kind ever so closely, we shall find that they differ from each other. The difference may be in size, form, color, mode of branching, number of leaves, number of flowers or fruits, vigor, season of ripening, or in other factors.

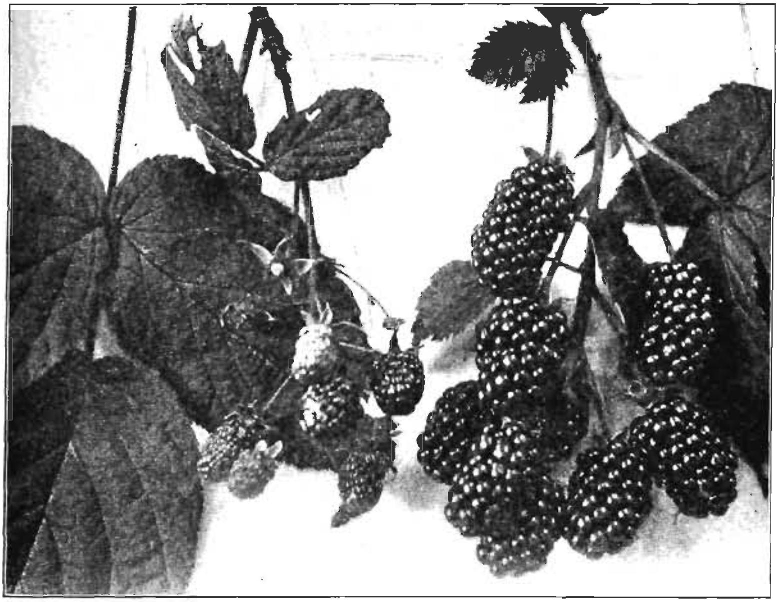


FIG. 113. — The improvement brought about by domestication. Wild blackberries on the left, garden blackberries on the right.

From the beginning man has taken advantage of these differences. The plants which showed some quality or characteristic which made them more useful to him were chosen for the new crop. This long-continued choice of the best has been the means of much improvement in plants.

The differences have great value. — The differences among plants of the same kind are spoken of as "variations"; that is, the plants vary, or differ from one another. The fact that plants vary is of great importance in all efforts to improve them. If they

Fig. 114. — No two plants are alike. These corn plants are all of the same variety, but show great differences in the position of the ears. There is opportunity for improvement.

did not vary, but held steadfastly to a particular *form* or type, they could not *be changed or improved.* It is because plants do *vary* that the farmer is able to select some from the others, and so improve his crops.

Means of improvement. — Two methods of improving plants are in use. One is gradually to modify the forms that now exist, so as to make them more useful and establish, or "fix," them. The other is to create new kinds that will be better than the types now raised.

Improving present types. — Let us suppose that the farmer wishes to improve his corn crop. He must first have in mind what he wants to accomplish — to develop longer ears or heavier ears, more ears to the plant, earlier maturity, or some other quality. With his ideal in mind, he will go over his cornfield while the corn is growing and select the plants that most nearly resemble the

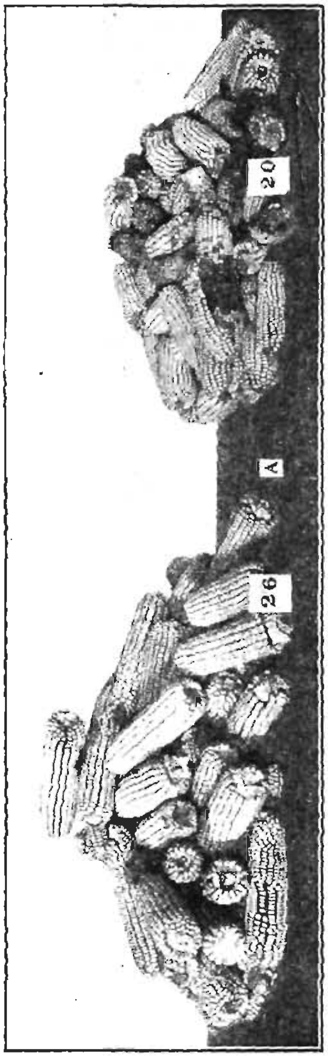


FIG. 115. — One step in plant improvement. The two piles of corn were grown from the seed from two ears of the same variety of corn. The rows from which the ears here shown were taken were of equal length. Does it pay to select the ears for planting? From which pile should next year's crop be grown? The best ear and the poorest ear in the pile at the left may give crops next year that are as different as these two piles; but both piles should be larger.

ideal. He will mark them so that he may harvest them separately and save the seed.

The next year, the seed of his chosen plants will be sown by itself, away from any other cornfield so that the new crop may not be mixed with any other variety. This field will be gone over before harvest, as in the first year, in order to select the plants in it that are nearest the ideal. Some of them will be nearer than in the first year.

From the second year's crop, grown from the seed selected during the first year, only that seed will be saved which comes from the

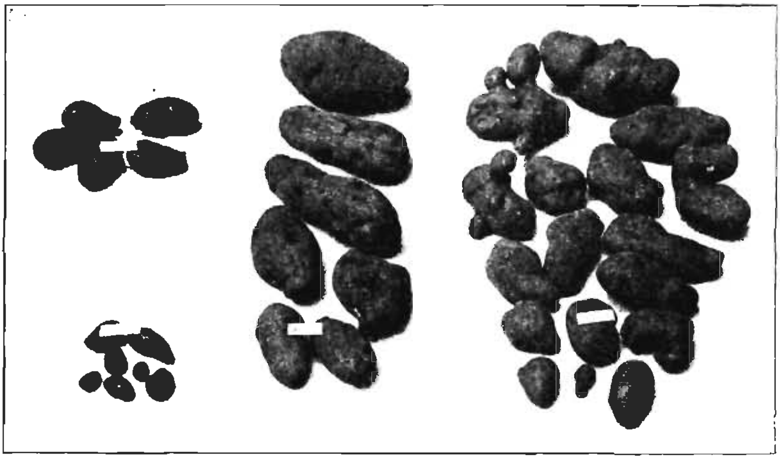


FIG. 116. – Potatoes. Each of these piles represents the yield from four hills planted from the same tuber. Does it pay to select the seed carefully?

best plants, those that are nearest to the type that is wanted. Year after year this selection and planting of the best will go on until the farmer has developed or isolated the type that he desired; that is, until he has produced his crop up to his ideal.

This method of improving crops is called "selection." It should be used by every farmer. The one who always chooses his best for his next year's seeding should grow better crops each year.

Creating new types. — Let us suppose that in our locality two varieties of corn are grown. One produces larger ears than the other, but the second one matures earlier than the first. The farmer may wish to have a variety that will have large ears and will also mature early. He desires to combine in one plant the best qualities of the two. How shall he do it?

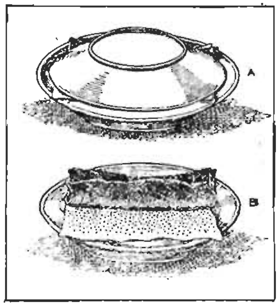


Fig. 117.—A simple home-made seed-tester. Two plates and two pieces of canton flannel. Blotting paper will serve as well as flannel.

We know that if the kernels of corn are to be developed, pollen from the tassels must fall on the silks, which are part of the pistils of the corn plant (page 139). When the pollen from one plant falls on the pistils of the same plant, the same sort or variety of corn will be produced. If the pollen from a different plant falls on the silks, the kernels of corn will probably produce the qualities of both plants, or parents, in some measure, and the offspring will show some of these qualities in combination.

If the farmer places the pollen from the variety of corn that matures early on the silks of the variety that has large ears, the characters of both plants will probably be represented in the seed that is formed. When this seed is planted the next year, it may show some of the qualities of both parents. Most likely it will resemble one parent much more closely than the other.

This seed is planted for the second year's crop. When the time comes for the silks to receive pollen, the tassels will be cut off or covered, so that none of the pollen of the same plant can fall on the silks. Pollen from the other parent, the one that appears least in the new plant, must be placed on the silks. The plants from the seed that results from this second crossing should approach the ideal type somewhat more closely than that from the first year. This operation will be continued year after year, until the desired type is secured.

When two varieties are mixed in this way, they are said to be "crossed." Crossing is the most important means of plant improvement.

Plant-breeding. — The changing of plants by man for the purpose of producing certain desired results is "plant-breeding." Every farmer should be a plant-breeder to the extent of improving his varieties by means of selection; but it is from professional plant-breeders that we are to expect most of the new varieties and new types.

Problem 202. If there are wild strawberries, raspberries, blackberries, or apples in your locality, compare them with the kinds that are cultivated. Explain what the differences are.

Problem 203. Compare two plants of any kind of crop grown on your farm. Tell in what respects they differ from each other. Can you find any two that are exactly alike?

Problem 204. Find out whether any farmers in your locality are trying to improve their crops either by selection or by crossing. Ask them to explain just what they are doing.

Problem 205. Ask your father for a small piece of land, on which to begin an experiment to improve the crop that is raised most largely on your farm. If yours is a fruit farm, plant potatoes or corn or small grain. Each year select your best seed for the next year's crop, and ask your father to plant all of the other seed from your plot by itself in his field crop. Notice from year to year whether better crops are secured from your seed than from your father's.

Problem 206. Seed testing. One of the means of improving plants is to plant only seed that is strong and vigorous and that will make a healthy growth. Much of the seed on the market is poor, and some of it either will not grow when planted or will make only a weak growth. In order to know whether your seed is strong and healthy, it should be tested.

For this purpose, the seed should be germinated or sprouted. The simplest device in which to germinate the seed consists of a pie pan covered with a square pane of glass or by another pan. This device is suitable only for small seeds, as the clovers, grasses, and flower seeds. One hundred seeds are placed on a piece of clean blotting paper which has been moistened with water. Another moist blotter is placed over this. The cover should fit tightly over the pan in order that none of the water may escape. If the blotters should become dry in a few days, a very small amount of water should be applied. When the sprouts on most of the seeds are one-fourth to one inch long, the ones which have germinated should be counted. This will give the percentage of germination. If the test shows a low percentage of live seeds, the seeds should be discarded or a larger amount sown on a given area. From 90 per cent to 95 per cent germination is considered good for most seeds.

For testing corn, beans, melons, and other seeds of equal size, take a box of any convenient size, about four inches deep. Fill it one half full of sawdust which has been moistened thoroughly. Over this tack a piece of cheesecloth marked off in squares. For testing ears of corn, these squares should be numbered. The numbers should correspond with numbers attached to the ears of corn. The numbered ears of corn should be arranged in order of their numbers, and placed where they will not be disturbed until the test is finished. Take up ear No. 1. Remove two kernels of corn from near the tip; turn the ear one-third around and remove two more kernels from the center. Now turn it around another third of the distance and remove two kernels from near the butt. Place these kernels on the square numbered 1 on the cloth. Continue this operation until all the ears are represented in the germinator, one in each square. Place another piece of thin muslin over the grains of corn, allowing it to extend up the sides of the box for some distance. Fill a sack, made to fit snugly in the box, with damp sawdust. Press this down tightly over the corn and set the box where there will be no danger of freezing or disturbance. In mild weather the corn will germinate within a week. Some will probably germinate 100 per cent, while others will be less than this. The sprouts on some will be weak, while those on others will be strong. It is safe to take these typical kernels as an index of what the whole ear would do if planted. Therefore, if the test is unsatisfactory in respect to any ear, this ear should be discarded at planting time.

If shelled corn or other loose seeds are tested in this germinator, one hundred seeds should be used, as in the case of the pie tin. At least 85 per cent should germinate strongly or the seed should not be used.

Problem 207. Plant in one box or pot 6 kernels of corn that are large and heavy and plump. In another pot plant six that are light in weight. Set them where they can germinate, and then watch the growth for a few days. From which seeds do the largest and strongest plants come? What does this show as to the selection of seed for planting?

Problem 208. If by selecting his best seed for planting each year a farmer can increase his yield of corn three bushels to the acre, what will be his gain in one year on a forty-acre field? How much will he have gained at the end of six years? At the price for corn in your locality, how much will he have been paid at the end of six years for the time he spent in selecting his seed?

PART IV

FARM ANIMALS

CHAPTER XXXI

THE NEEDS OF FARM ANIMALS

Animals are kept on the farm for what they can add to the farmer's comfort, pleasure, and income. We may call them productive agents because they must return certain products to their owner. The products which they return will vary with different classes of animals. Horses return labor; cattle return milk, meat, hides, and sometimes labor; sheep yield wool and meat; swine return pork and lard; poultry return eggs, meat, and feathers.

In order that animals may be productive, they must receive such care and attention as will keep them in the best condition for work. If this care is not given, they still may live, but they are not likely to return a profit to their owner. Attention must be given to their food, air, shelter, rest, and exercise, which are their more important requirements for existence and service.

Food requirements. — We may liken an animal to a machine, which, in the performance of its work, receives wear and tear in its various parts. As coal is shoveled in at the furnace door to make the energy to turn the great wheels of the machine, so must food be taken into the body to supply energy and replace waste that results from using the body. The food requirements of farm stock demand more attention from the owner than any of the other needs.

We readily understand that a horse at hard work must have an abundance of the right kind of food to keep his body in good condition. Perhaps we have not realized that in a similar way it is a tax on a cow to give a large flow of milk. It is likewise a tax on sheep to produce wool, and on hens to lay eggs. To produce

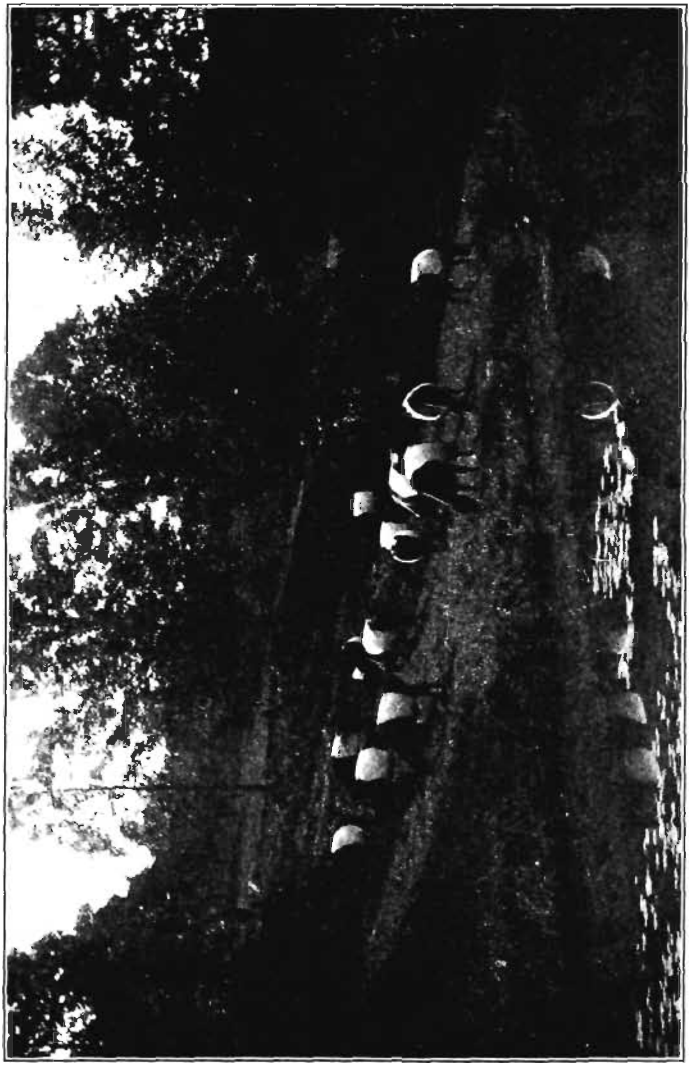


Fig. 118. — Cattle need good pasture and fresh drinking water. Dutch Belted cattle.

wool and eggs is a form of effort or work, and it uses up energy. Abundant food is as necessary in one case as in another.

Foods are given for two purposes: to support the animal, that is, to keep its body in good condition, and to lay up a reserve supply for the work the animal has to do. If only enough food is given to maintain the animal's body, keep it alive, the animal either cannot work, or, if it does work, the body suffers from lack of sufficient nourishment and becomes weakened. To realize a profit on animals, there must be food for growth as well as for service, in addition to mere sustenance. The profit comes from the reserve supply, that which the animal may use wholly for work without robbing the body of what it needs for its development. When beef cattle, swine, and some kinds of poultry are reared for meat, the reserve supply enables them to fatten rapidly so as to be ready for market in the shortest possible time. In the draft animal, the reserve supply keeps the muscles in repair and provides the energy for work. In the cow, the reserve supply is used in the production of milk; in the sheep, it goes to produce both wool and mutton.

To satisfy the animal's needs, the maintenance ration[1] must provide the materials out of which the body is created and by which it may be sustained. If we study the composition of the animal body, we shall find that these materials are water, mineral matter, nitrogenous matter (containing nitrogen), and fat.

Water. — There is much water in all parts of the body. Often one half of the body is water. It becomes part of all bone and flesh. It is used to carry, or transport, the building material, just as it is in plants. The blood is largely water. Water also helps to remove the waste or worn-out parts from the body. Animals

[1] The quantity, or portion, of food that is given to an animal in 24 hours is spoken of as a *ration*. A ration includes all of the food, of every kind, that is given in one day. When we speak of the *maintenance ration*, we mean that part of the ration that is necessary to maintain, or keep up, the animal's body. It includes all of the ration except the part that is used for work or production.

require at all times an abundant supply of good drinking water.

The mineral matter in the body is found in the bones, in the blood, and in the protoplasm, which exists in the cells in all parts of the body. From 2 to 5 per cent of the body is mineral matter. This mineral is supplied to animals in their food. It comes

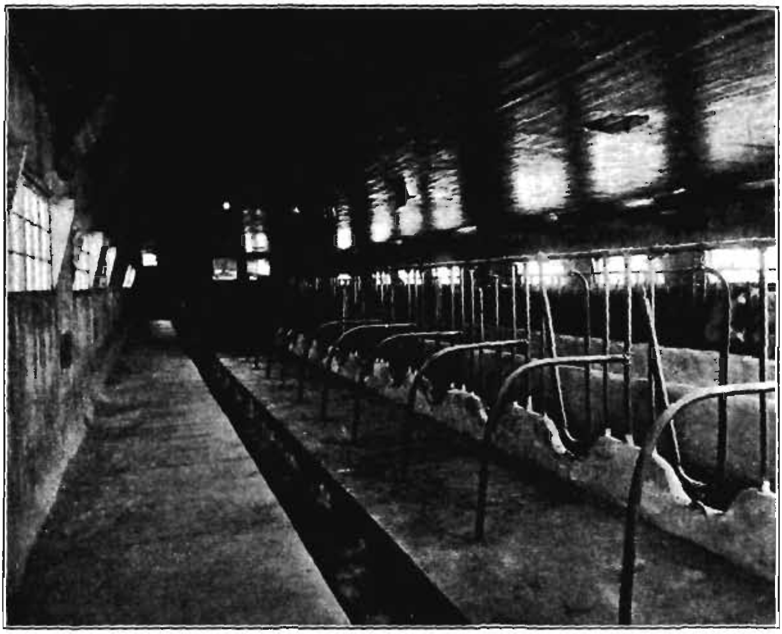


Fig. 119.—A stable that provides room, sunlight, and ventilation.

from the mineral parts of plants, and is taken by plants from the soil.

Nitrogenous matter is the name given to substances containing nitrogen. It is usually spoken of either as *protein* or as nitrogenous matter. Flesh, skin, muscle, hair, wool, horn, hoof, feathers, blood, lean meat, white of egg, and curd of milk are rich in protein.

We know that all green plants require nitrogen in their growth. Some of this nitrogen is found in every part of the plant, in the roots, leaves, stalks, and fruits or grains. When the plants or grains are fed to stock they provide the required nitrogenous matter.

Fat is reserve food, or that laid by for special or later use. The amount of it in the body will vary with the age of the animal, the work it does, and the kinds and amounts of food given. The

FIG. 120. — Animals need exercise.

lean animal seldom contains less than 5 per cent, and the fattest seldom exceeds 30 per cent of fat.

Fat-producing materials are usually given to animals in the form in which they are found in plants; that is, in the form of starches and sugars. The chemist calls these materials carbohydrates, because they are made from carbon and water. Carbohydrates make up the larger part of dried plants, including all kinds of hay and fodder, and are abundant in roots and grains. Within the animal body, some of the carbohydrates are changed into fat.

Uses of nitrogenous matter and fat. — The nitrogenous parts of plants build up the working parts of the body. They may be called muscle-makers, although they have other uses as well. They enter into many of the products of animals. When cows are kept for milk, sheep for wool, horses for work, and geese for

FIG. 121. — Clean milk cannot be produced here.

feathers, they should be given foods, or rations, containing considerable nitrogen, as it is required for the production of all of these products. It can perform the same use as fat, however, when necessary.

Fat keeps the body warm, and, in part, supplies the energy which enables the muscles to do work. All the higher farm animals are warm-blooded. They receive their body heat from their food. That is why most animals consume more food in cold weather than in hot weather. Eskimos and other people who live in very cold climates subsist almost wholly on fatty meats and oils. They need heat-giving foods to keep them warm.

The nitrogenous matter, the carbohydrates, and the fats are

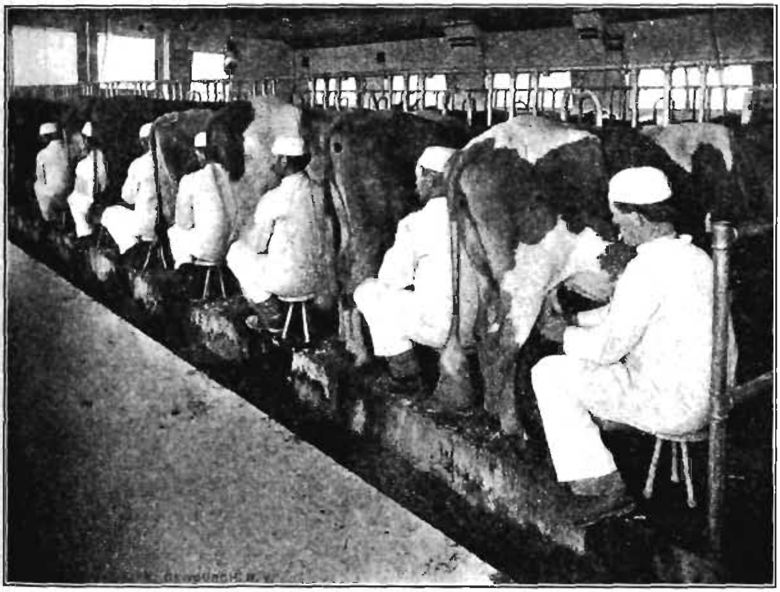


FIG. 122. — Clean milk is likely to be produced here.

the food elements that the farmer must provide for his stock. He seldom needs to supply mineral matter, as only a small quantity of it is needed and all plants contain it.

Air. — Air is as necessary to the animal as to the plant. All of the activities in the body would cease, and the animal would die, if air were not provided. Energy is supplied by a burning of the tissues in the animal body, just as it is created in the steam engine by the burning of fuel. Neither the fire in the engine nor the burning in the animal body can take place without air. Stables are not built to allow space large enough to contain all the air needed by each animal in twenty-four hours, so that fresh air must be provided continually by ventilation.

Shelter. — Animals, like people, are most useful when they are happy and comfortable. They can then do their best. Good quarters must be provided for all farm stock. The buildings must afford shelter from storm, protection from excessive heat and cold, proper ventilation, and must admit sufficient sunshine so that they will be bright and fresh and dry. Too often the ventilation and the sunshine are not provided for. Under such conditions the animals cannot remain vigorous and healthy, as they should be in order to return the largest profit to their owners.

Rest. — Animals need rest periods, and comfortable quarters for resting should be furnished. Rest is as necessary for them as for vigorous boys and girls. There must be time to relax the muscles, to allow all of the vital activities in the body to subside from the increased demands of work, and to repair the broken down tissues.

It has been found that a steer produces 30 to 50 per cent more heat when standing than when lying down. As this heat must come from the burning up of food, there is so much less energy for useful work or fattening. This shows that it pays to provide comfortable quarters and good beds for the farm stock.

Exercise. — Exercise is essential to the healthy development and maintenance of all creatures. It stimulates and strengthens the organs, and this tends to keep the animals vigorous and to prevent disease. Stables should have yards adjoining, which are protected from the cold winds of winter and the hot sun of summer, where the live-stock can be exercised. Ordinarily the larger the field in which stock may take exercise the better.

Animals that are being fattened for market should have only sufficient exercise to keep the body in good condition. Exercise requires energy, and in fattening animals all the energy possible must be saved for storing as reserve fat.

Cleanliness. — Animals require clean food, clean water, and clean quarters, and must themselves be kept clean. Filthy con-

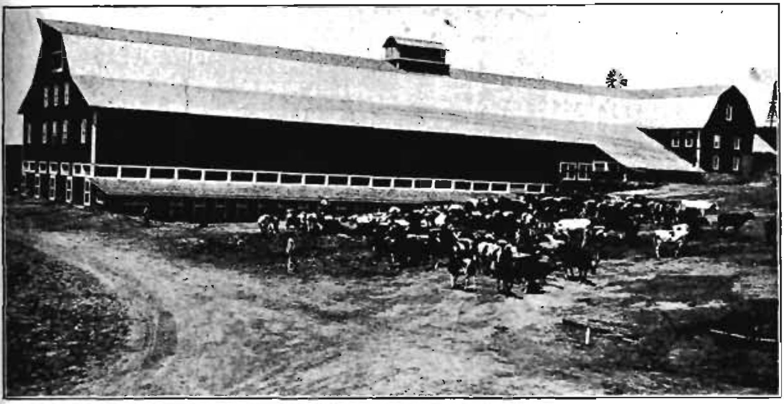


FIG. 123. — A yard adjoining the barn, where the cattle may exercise. A Nebraska stock farm.

ditions breed disease, and diseased animals are a loss to the farmer. We commonly think of pigs as very uncleanly animals; but if they have an opportunity to choose their own beds, they will keep cleaner than we usually find them in their pens. Pigs thrive in spite of the filthy surroundings, not because of such surroundings. Nearly all animals are naturally cleanly.

Problem 209. When a horse works hard on a warm day, and "steams" and sweats, what is he wasting from the body? How can this waste be replaced?

Problem 210. When the cow stable is closed in winter, it becomes warm and damp. Why?

Problem 211. Can you make a fire burn in an air-tight can? Why not?

Problem 212. Why does a stout person feel the heat more than a slender person?

Problem 213. If there are animals on your father's farm that are being fattened for market, do they receive different food and care from the others? In what respects?

Problem 214. Name all the different kinds of farm animals in your neighborhood. Tell the purpose for which each is kept.

Problem 215. What care should a working horse receive?

Problem 216. Should animals be given ice-cold water? Why?

Problem 217. Write a list of the things used in the house, either for food or for clothing, that are animal products.

Problem 218. Is it well to give cows exercise by making them run in from pasture? Why not?

CHAPTER XXXII

THE FEEDING OF FARM ANIMALS

In the preceding chapter we learned that animals require food both to keep their bodies in good condition and to repair the tissues that are broken down by work. There must also be food for growth and for the production of young. These needs of animals are satisfied through the process of *nutrition*.

We have learned, also, that the food requirements are met by giving animals water and foods containing mineral matter (sometimes called *ash*), nitrogenous matter (or protein), fats, and carbohydrates. But this is not all. If an animal is to be properly nourished, the foods must be given in certain definite quantities or proportions. This is where skill in feeding and knowledge of the value of various foods is required.

In former days the farmer planned to produce all the feed for his few animals. Now he expects greater return for each animal, and he buys much expensive feed. Therefore the old haphazard or traditional method of feeding is no longer profitable.

Foods are not all alike. — Foods of many different kinds are given to farm animals. Hays, grains, fodders, and roots are very unlike one another. The farmer who desires to feed his live-stock intelligently must know what these differences are and what effect they have on the animal.

The chemist who has carefully studied the various foods in his laboratory, and has analyzed them (has taken them apart), tells us that all the ordinary foods contain water, protein, carbohydrates, fats, and mineral matter, but that most of them contain more of one of these groups than of the others. This is what we should expect, since we know that plants require all of these substances for their growth. But we do not find the protein and the carbohydrates in separate packages, so to speak, ready to be mixed

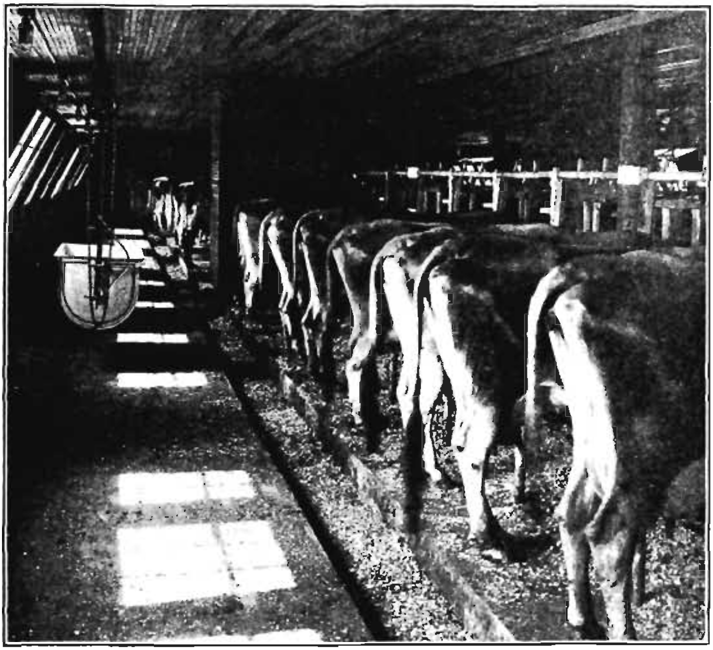


Fig. 124.—The labor of feeding may be lessened by the use of a car, or conveyer, for the feed. Note the cement floor.

as needed. They are combined in all feeding-stuffs and in very different proportions. The chemist discovers what these proportions are. Without knowing the proportions, we should not be able to prepare satisfactory combinations of food for animals, although by repeated trials we might be able to make fairly good rations. With this knowledge, we can readily learn how to put together the various foods so as to give the amount of each food-element that is desired.

Nearly all foods contain some material that is of no direct use to the animal and that will not be digested. Each food then has a digestible part and a waste or indigestible part. It is the composition of the digestible part that is of value in the ration.

Choice of foods. — The choice of foods will vary for different classes of animals and with the work they have to do. A horse at

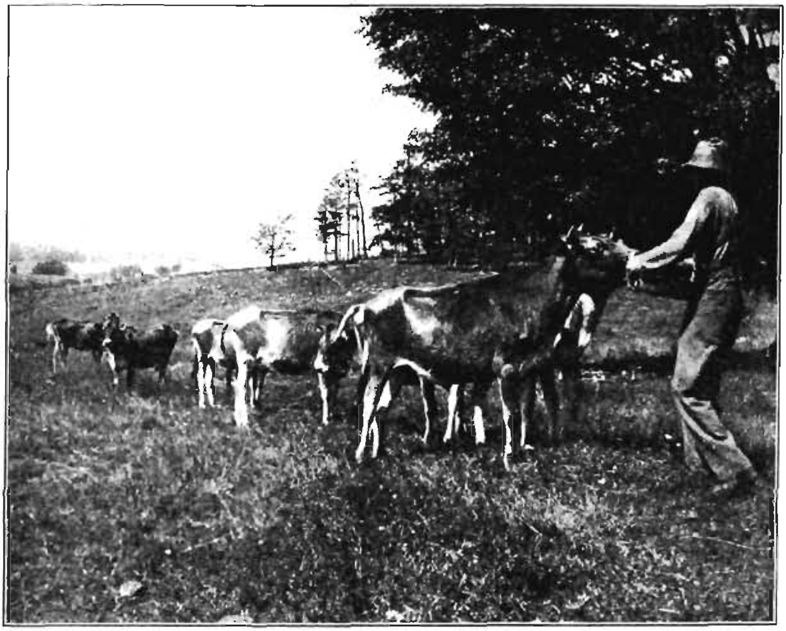


Fig. 125. — Salting the young stock.

work requires different kinds and quantities of food from one at pasture. A cow does not require the same kind of food to produce milk that a hog does to produce pork. Neither does a cow giving milk require the same combination of food as a steer that is being fattened for market.

Balanced rations. — Most school pupils have now heard of "balanced rations" for live-stock. This is an expression that every farm boy and girl should understand. We shall learn what a balanced ration is.

When an animal is working hard, there is a heavy tax on the muscles and tendons of the body. When it is at rest in the stall,

Fig. 126. — Salting the sheep.

there is no severe strain on the muscles. If the heavy ration that is given to the working animal is given to the idle animal, the latter will not be able to digest and utilize it, and will become sick. The idle animal should be fed a lighter ration. Both rations should contain protein and carbohydrates, but in different proportions.

When the protein and the carbohydrates are combined in such proportions as experience has shown will produce the best results, we have what we call a balanced ration; that is, the food elements are proportioned, sometimes with a larger ratio of one, sometimes of the other, to satisfy the needs of a particular animal. There is a proper balance for the ration for each animal, which is determined largely by what the animal does. A ration that is balanced for a horse may not be balanced for a sheep. A ration that is balanced for a cow giving milk would not be suitable if she were being fattened for market.

Experts who have studied the matter carefully have determined approximately how rations should be balanced for all ordinary farm purposes; and they have prepared tables showing what these proportions are for various purposes so that the farmer has something to guide him in making up his rations.

Nutritive ratio. — The competent stock-feeder speaks of the "nutritive ratio" of the feed he is giving his stock. We should learn the meaning of this expression, for it has to do with the most important factor in the feeding of animals. We do not know that we are feeding a balanced ration unless we know its nutritive ratio.

Let us recall again that the substances in stock-foods that especially concern the farmer are the protein, the carbohydrates, and the fat; and that the protein and the carbohydrates are used for quite different purposes in the animal body. As they exist in all feeding-stuffs in greater or less proportions, the first step in preparing a ration for stock is to determine the proper balance between them for the desired purpose.

These food-elements are "nutrients"; that is, they contain nutriment, or nourishment. The nutritive ratio, then, is simply the ratio in which these nutrients (protein, carbohydrates, and fat) are combined in the food. For example, if corn-meal is 8 per cent protein and 76 per cent carbohydrates and fats, these two groups of elements are combined in the ratio of 8 to 76, or, when reduced to its lowest terms, 1 to 9.5. The nutritive ratio, or ratio of the nutrients, of cornmeal is then 1 to 9.5 ; that is, cornmeal contains 1 part of protein to every 9.5 parts of carbohydrates and fats.

Each food has a nutritive ratio of its own, because it contains all of the food-elements. When two or more foods are combined in a ration, which is usually the case, the complete ration will have a nutritive ratio of its own. This ratio will be different from that of any one of its ingredients. In order to obtain the exact ratio, the composition of all the foods concerned must be considered.

The kinds or classes of foods. — Every boy who has helped his father feed the stock knows that there are many different kinds

FIG. 127. — Duroc-Jersey hogs at pasture.

of foods. Some of them closely resemble others in certain characteristics, so that it is possible to consider them together in groups or classes. Practically all feeding-stuffs may be placed in one of three general classes. These are (1) coarse fodders, or roughage, (2) root crops, (3) grains and meals. Those of the last group are commonly called "concentrated foods" because they contain a large amount of nutriment in a small weight and bulk. A ration for horses ordinarily will contain a rough fodder, as timothy hay, and some grain. A ration for dairy cattle ordinarily will contain a rough fodder, a root crop or corn silage, and some grain or meal.

Coarse fodders. — The coarse fodders are bulky, and are generally fed to stock in larger quantities than other kinds of feed because they carry considerable material that is of little or no value to the animal. The common coarse fodders are timothy, clover, alfalfa, cowpea hay, and all other kinds of hay, straw, and corn-stalks.

Corn silage is a much used coarse feed. The corn is cut and stored in the silo while it is still green, so that it is juicy and appetizing when fed to the cattle.

Roots and tubers. — Roots and tubers contain a very large percentage of water, sometimes as much as 80 to 95 per cent. Because of this watery or juicy condition, they are said to be succulent; they are frequently called *succulent foods.*

The more common root crops given to stock are beets, mangels, and carrots. Cabbages, kale, and pumpkins serve much the same purposes as root crops when fed to stock, as they also are watery. Silage and root crops serve similar purposes in the ration.

Concentrated foods. — Concentrated foods contain very little water or useless material. They are of two general kinds:

(1) The grains, as corn, oats, rye, barley, wheat, peas, and beans. These contain some protein and a rather large percentage of carbohydrates. Corn contains a very high percentage of carbohydrates; that is why it is such a good food in cold weather, and for fattening animals.

(2) The by-product feeding-stuffs, or those that are left in

the manufacture of starch, breakfast foods, flour, sugar, alcoholic liquors, and oils. The common names of some of these by-products are bran, middlings, shorts, rice bran, hominy, gluten, cottonseed meal, oil meal, brewer's or distiller's grains, malt sprouts, and beet pulp. For the most part they are very nutritious and easily digested foods.

Problem 219. Name the foods that are commonly fed to horses in your locality; to cattle; to sheep; to hogs; to poultry. Tell which are coarse fodders, which are roots or succulent foods, and which are concentrated foods.

Problem 220. How many of these different foods are raised on the farms in your locality? How many are shipped in from distant places? Find out how much the different foods cost in your neighborhood.

Problem 221. How are these different foods stored?

Problem 222. If a balanced ration is fed to any of the animals on your father's farm, tell what foods it includes and why it is balanced. Ask your father which of the foods he uses are most fattening.

Problem 223. Why should not the same ration be given to a horse at rest in the stall, as to one that works hard every day?

Problem 224. Find out what hay is worth by the ton and oats by the bushel in your locality. If a horse eats 2 tons of hay, $8 worth of pasture, and 43 bushels of oats a year, how much will it cost to raise him till he is 6 years old? Will it cost much more for food to raise a good horse that will sell for $250 than to raise one from common stock that is worth not more than $100 when six years old?

Problem 225. If one sheep consumes 700 pounds of hay, $1 worth of pasture, and 4 bushels of oats in a year, what will be the cost of raising a flock of 150 for 1 year? If a farmer clips 7 pounds of wool from each one, worth $.22 a pound, and each one raises a lamb worth $3.50, how much will the farmer gain or lose in raising the flock?

CHAPTER XXXIII

HORSES

OUR ancestors made little progress in the tillage of the soil until beasts of burden were domesticated to do the heavy work. The use of the slow-moving ox was a great advance over hand work. But when the horse, which long had enjoyed special distinction as the animal of emperors and persons of noble birth, and of war, was pressed into the common work of the world, rapid progress became possible. The horse had power, speed, and endurance. He worked faster and to better advantage than the ox. The latter gradually had to give place to him for work.

History. — The history of the horse, extending over thousands of years, is one of absorbing interest. Although the modern form of the horse did not exist on the American continent in prehistoric times, yet fossil remains of his very ancient ancestors have been discovered in those parts of the continent which are now included in the states of New Jersey, Nebraska, South Dakota, and Wyoming.

It was many thousands of years ago that Eohippus, the name by which the earliest prehistoric horse was known, lived in the Rocky Mountain range and southward into Mexico. He inhabited also parts of Europe and Great Britain, and could pass between the continents on dry land. This early horse was no larger than a small dog. He possessed four toes on each front foot, with the splint of a fifth, and three on each hind foot, with the splint of a fourth. In his day, the earth was warm and damp, and the toes added greatly to his ability to move about in the mud.

In time, Eohippus was succeeded by a higher form called Orohippus. This was also a small animal, about fourteen inches high. The splints of the extra toes had disappeared from the feet. This form in turn gave place later to Mesohippus, which somewhat resembled the modern horse. He was about eighteen inches high. In this type the toes had been reduced to three on each foot. The center toe was more prominent than the others and bore most of the weight.

Down through the ages the horse continued, gradually becoming larger and losing the use of his toes as he needed them less. The last stage is the modern horse, with its graceful limbs that terminate in a dense hoof covering the single middle toe. The remaining toes have disappeared, but traces of the two toes are to be found in the splints on both fore and hind legs. The present horse is much larger than any of his prehistoric ancestors.

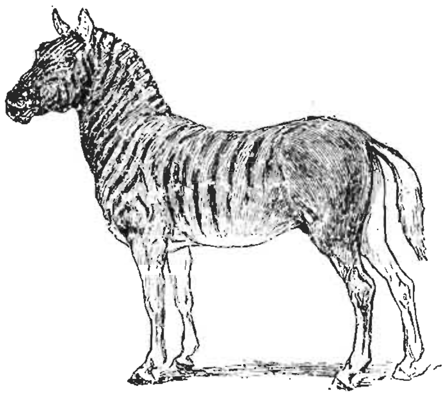


FIG. 128. — The quagga.

The gradual development of the giant draft horse of to-day from the small dog-like animal no larger than the fox terrier is a most interesting demonstration of the changes wrought by nature to adapt animals to the conditions under which they live.

There are three types of horse-like animals in the present day, which mark stages in the development: first, the horse proper, as we know him on the farm; second, the wild ass; third, the zebra and the quagga, which somewhat resemble the ass, but are beautifully striped. There are still wild horses in herds on the plains of Tartary, and occasional herds of untamed mustangs on the great plains of our own country. The present wild horses of this country, however, are descendants of horses introduced here by Europeans.

Types of domestic horses. — After man had domesticated the horse, he proceeded to develop from him a great number of races, or breeds, that would be useful to him under particular conditions. By comparing the horses we see on the road, we shall observe that they are of different forms or types. Some possess a form that enables them to draw very heavy loads, but at a slow pace. Some are so formed as to draw light loads and at a very rapid pace. Between these two extremes we may observe a form that is suited to draw a moderate load, but with high action and much style. These are three distinct types, and they are called draft horses, driving horses, and coach horses.

The draft horse is the largest and heaviest representative of the horse tribe. He is massive, powerful, low-down, blocky, and compact. He has been developed for weight so as to be able to move great loads. In average condition he may weigh from 1500 to 2000 pounds.

There are several breeds[1] of draft horses, a few of which are popular in America. The *Percheron* breed came from France. It is either gray, chestnut, or black in color. The *Belgian*, usually of

[1] The word *breed* is a term applied to a group of animals that rather closely resemble one another, and which often take their name from the region in which they originated. Among the larger animals, as horses and cattle, a breed may be subdivided into *families* and *tribes*. Among fowls, a breed is subdivided into *varieties*, which are smaller groups within the breed, and which include the animals that still more closely resemble one another. The word *type* is a larger or more general term than breed, and is applied to larger groups composed of breeds and races that have a number of general characteristics in common. Thus, we have the draft type of horses, which includes such breeds as the Percheron, Clydesdale, Belgian, etc. We have the meat type of chickens, including the Plymouth Rock, Wyandotte, and other breeds. There are single-comb and rose-comb varieties in the Wyandotte breed, and Barred and White varieties in the Plymouth Rock breed. If we were to represent the divisions by a tree, we should have, first, the trunk, or type, which breaks into smaller branches or breeds; the branches divide into smaller branches and twigs, which may represent the families, tribes, or varieties.

a bay color, came from Belgium. The English *Shire*, which may vary through bay, brown, and chestnut in color, was imported from England, as its name indicates. The *Clydesdale*, from Scot-

FIG. 129. — The Percheron. Draft horse.

land, resembles the Shire, but may be smaller and more active. The *Suffolk Punch*, from Suffolk County in the eastern part of England, is uniformly of a chestnut color.

The coach horse is the next largest type. He was originally developed for pulling heavy coaches at a good speed. He is mod-

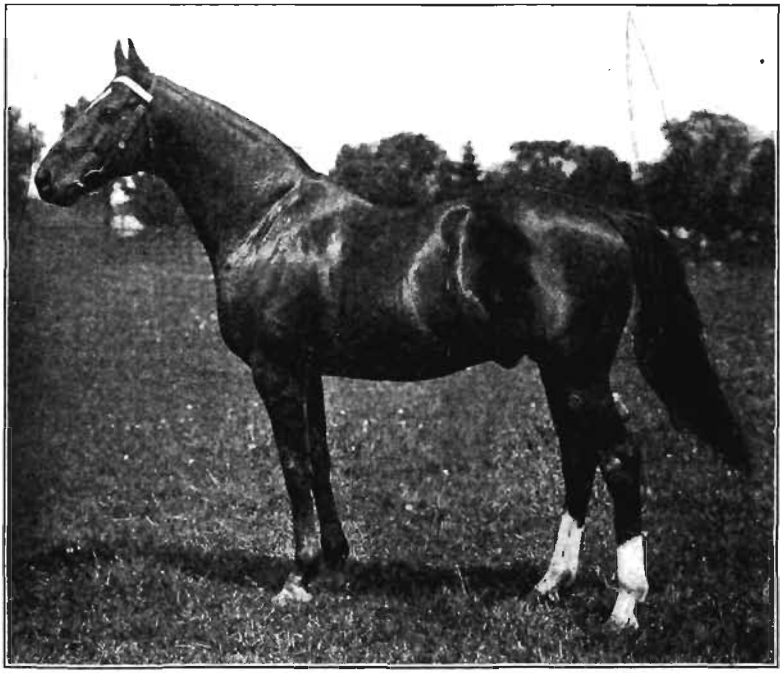


FIG. 130. — The roadster.

erately heavy, smooth and symmetrical in form, and of graceful carriage. The Hackney, French coach, and German coach are the principal breeds.

The *Hackney* came from England, where for centuries he has been a favorite saddler and roadster. He is usually of a chestnut color. The *French coach,* as its name implies, was developed in France and imported to America. Bay and brown are the most common colors in this breed. The *German coach,* bred for

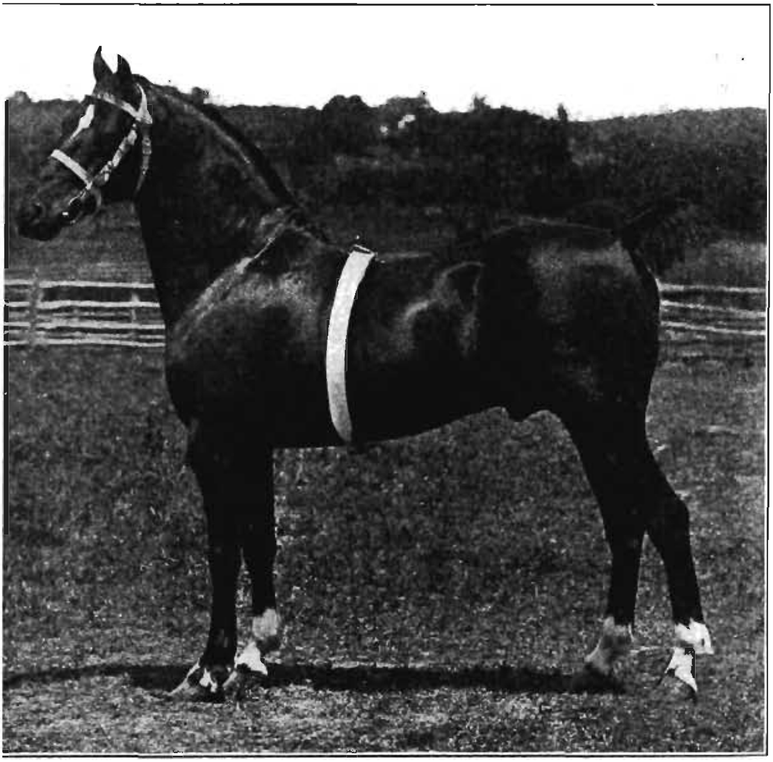


FIG. 131. — The Hackney.

many hundreds of years in Germany, is usually bay, black, or brown in color.

The American trotter, pacer, or roadster, a distinctly American breed, is the common type of driving horse. It has a rather long, graceful neck, long body, narrow chest, and long legs. The conformation, or general shape, is angular, muscles prominent,

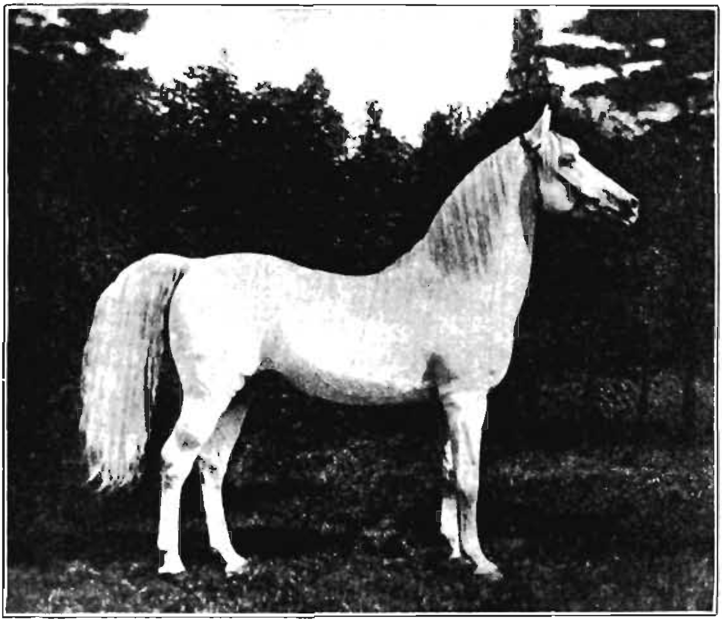


FIG. 132.—Arabian horse, Shahwan. Bred in Egypt, and owned in England and then in America. Saddle and driving horse.

and ribs more or less noticeable. Speed and endurance are important qualities. The colors vary greatly, bay, black, brown, and roan being common.

The American saddle horse, also called the Kentucky saddle horse, is the most beautiful modern breed. He has been developed in America, as his name suggests. He has graceful form, erect carriage, smooth action, and is possessed of much courage and spirit. He may be trained to go several gaits, as the rack, or single-foot, running walk, straight walk, trot, and canter.

The Thoroughbred, or English running horse, is a small, nervous, muscular animal. He is possessed of much endurance at the running gait. He has been bred for sport and racing. His color may be bay, brown, or chestnut.

Horse training. — The pleasure and profit to be derived from the use of a horse will depend on how well he is trained to obey the wishes and orders of his master. The horse has a rather remarkable memory. If he succeeds in breaking his halter once, he will try to do it many times thereafter. If the first time he is tied he tries to break his halter and fails, he is not likely to try again.

The trainer should be firm and quiet in his handling of a horse, and should always accomplish what he undertakes. The horse must learn from the first that the master's will is to be obeyed.

FIG. 133. — A bucking bronco, an unbroken horse of the west.

At the outset the horse should be trained to stand still while being harnessed and hitched. The harness should be put on from the left side and gently but firmly placed in position.

In driving, only a few signals should be used. These should mean exactly the same thing at all times. Signals or commands should always be obeyed. *Whoa* should mean to stop, and nothing else. It should not mean to go slowly or steadily, or even to get ready to stop. *Steady* should be used when it is desired to have the horse go slowly or steadily. *Back* should mean to move backwards, and it should not mean to stop. *Get up* should mean to move forward after the animal has been hitched. These commands

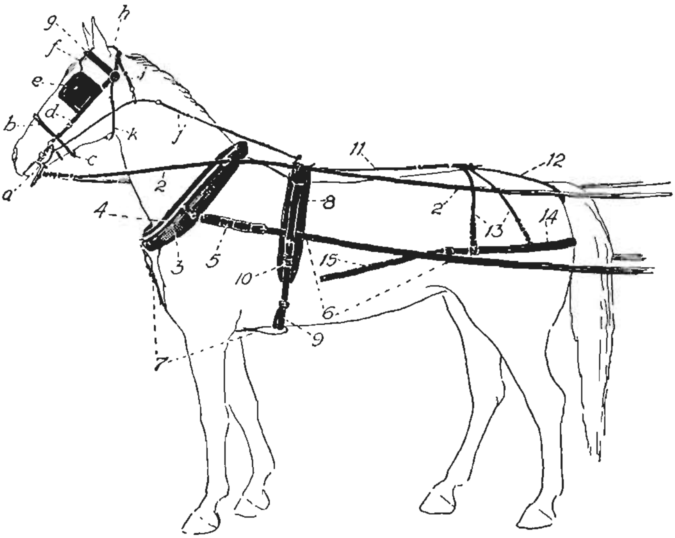


FIG. 134. — Parts of a harness: 1, bridle, having the following pieces: *a*, bit; *b*, nose band; *c*, chin band; *d*, face band; *e*, blinds; *f*, winker braces; *g*, brow band; *h*, crown band; *i*, gag swivel; *j*, side check; *k*, throat latch; 2, lines; 3, collar; 4, hames; 5, hame tugs; 6, traces; 7, martingale; 8, saddle; 9, girth; 10, shaft tug; 11, back strap; 12, crupper; 13, hip strap; 14, breeching; 15, holdback strap.

should always be spoken clearly so as to be understood by the horse.

Harness. — The work of the horse is accomplished by means of harness. Properly fitted harness adds to the usefulness of the horse as well as to his comfort. A well-kept harness adds to the appearance when the horse is hitched.

Harness is used to enable the driver to control the horse, and to enable the horse to control the load — to move it forward and backward. To control the horse, the driver must gain command of the head. This is accomplished through the bridle, and by placing in the mouth a bit to which the lines, or reins, are attached.

The horse can best control the load from his shoulders. For this purpose the harness is provided with collar, hames, and traces. The breeching and hold-back enable him to back the load.

There are four places in which the harness rubs the body constantly. Unless it is carefully adjusted, these places may become sore. A poorly fitting bridle or a severe bit may cause sore mouth; a poorly fitting collar may cause sore shoulders; a poorly fitting saddle or back-pad may result in a sore back; a poorly fitting crupper may develop a sore tail. Sores give horses much pain. A sore mouth may provoke a horse to run away. Sore shoulders and sore back may provoke balking. Sore tail frequently provokes kicking.

Feeding. — Horses relish good timothy hay, or hay mixed with clover. Corn and oats are the best liked concentrated foods. Oats are better for driving horses, and corn should be included in the ration for work horses. As we learned in the preceding chapter, the kinds of rations must be adapted to the work the animal has to do; one kind for a draft horse, another for a coach horse, others for driving and race horses.

The food should be provided regularly. Water should be given before feeding, but not while the animal is overheated. In winter it should have the chill taken off.

Grooming. — Nothing adds more to the appearance of a horse than careful grooming. Since the coat shows so readily the effects of grooming, the body generally receives more attention than the legs. Usually the legs are most in need of grooming. Time spent in cleaning and rubbing the horse in the evening, after the day's work is done, is worth much more than the same length of time spent in the morning, because the horse will rest so much better.

Animals properly groomed, fed, and blanketed in the evening come from the stable in the morning with spirit and vigor. They also are much less likely to develop any of the diseases and difficulties to which the feet and legs of horses are subject.

Problem 226. Make a list of all the different kinds of labor performed on your father's farm by the horse.

Problem 227. Could many of these tasks have been done without the aid of horses? Would it have been more expensive to perform them by other means?

Problem 228. A horse well directed can do as much work as ten men. Does he earn good board, kind treatment, a comfortable place in which to rest, and careful grooming?

Problem 229. Can you name the parts of a harness and tell what each does?

Problem 230. How many breeds of horses are represented in your locality? How do you tell them apart? Are most of the horses common, mixed stock?

Problem 231. Name the parts of a horse. (Perhaps your father will drive a horse to the school-house and explain the parts to all the pupils.)

Problem 232. How would you care for a harness?

Problem 233. Why are horses shod?

Problem 234. What is the best way to hold the lines in driving? Which hand should do most of the guiding? When two vehicles meet, to which side should they turn in passing? When one vehicle desires to pass another from behind, to which side of the vehicle ahead should it drive?

CHAPTER XXXIV

CATTLE

CATTLE are the most important domestic animals of the English-speaking peoples. They are much more necessary than horses. They may be used as beasts of labor, and they supply meat, hides, and milk. From the milk are made butter and cheese and other products of less importance.

History. — Our domestic cattle probably have descended from at least three prehistoric races. These races were entirely distinct from one another. One, called the Urus, was domesticated by the Swiss lake-dwellers. It existed in large numbers in the forests of Europe, down to the time when history began to be recorded. It is described as being a little smaller than an elephant, but resembling a bull in form.

A second prehistoric ancestor was an ox that once ran wild in Sweden. It also was bred by the ancient lake-dwellers. It was smaller than our present-day cattle.

The third of the original ancestors was an animal larger than the ox just mentioned, which lived with the ox in the forests of Scandinavia. The mountain cattle that are now found in Norway are supposed to have descended from it.

Two races to-day. — Cattle, as they exist among civilized peoples to-day, are of two races. One is the common beef and dairy cattle, which nearly every farm boy and girl in America knows. The other, called zebus, is a race of peculiar looking cattle that are common in India. They have an immense hump of fat over the shoulders, large, drooping ears, and a heavy, loose dewlap hanging from the underside of the neck and extending from the lower lip back to the chest.

The humped zebus were domesticated in Egypt 2000 years before the Christian era. In India they are now used as beasts of burden and also as saddle animals. They have an easy trot, or gallop, and great endurance, being able to cover sixty or seventy miles in a day. Occasionally a pure white animal is found. It then becomes the sacred bull of India and plays an important part in religious festivals. Zebus are sometimes called sacred cattle. They enjoy a hot, dry climate. A few have been introduced into the southwestern part of the United States.

Beef and dairy cattle. — Cattle are reared in America chiefly for two purposes: for the production of milk, and for the production of beef. A few are still kept as draft animals. As the production of milk and beef make different demands on the energies of the animal, they cannot both be developed to their highest condition in one animal. For this reason, there have gradually grown up two distinct types of animals, one which excels in milk production, and another which excels in meat production. We call the one dairy animals and the other beef animals.

But these two types are not wholly distinct or separate from each other. The cows of the beef type give some milk, and the animals of the dairy type will furnish beef of fairly good quality when fattened. There are a great many animals of intermediate form that produce beef of fair quality and at the same time are used for milk production. They are spoken of as dual-purpose (two-purpose) or general-purpose animals.

Beef type. — Animals of the beef type are reared for meat. The more meat they can furnish from a given quantity of food, the more profitable they will. be. They have been developed with broad, deep, compact, rectangular bodies which are covered thickly and smoothly with flesh (muscle), so that the angles of the bones are nowhere prominent. The neck is short and heavy, and blends smoothly into the shoulders. The legs are short and set wide apart so as to support a large, heavy body.

Not all beef animals are alike, however. They have been developed from different ancestors and under different geographical

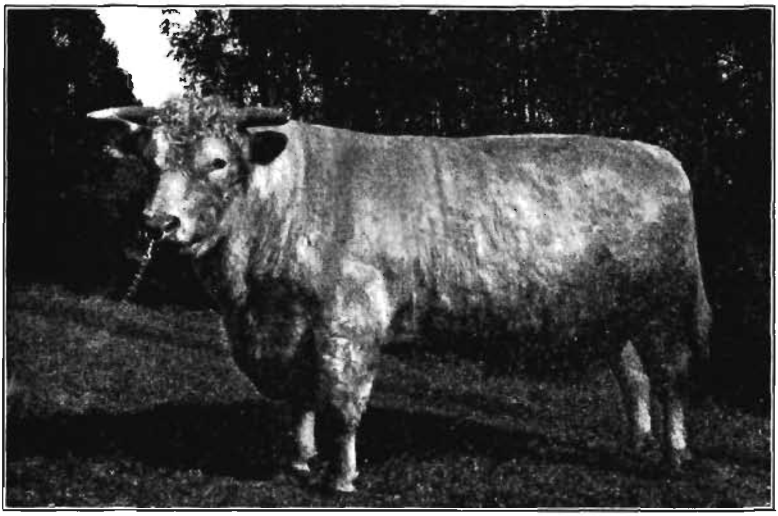


FIG. 135. — The Shorthorn. The leading beef breed in America.

conditions. There are now several types, called breeds, among beef animals. The most common breeds in America are Shorthorn, Aberdeen-Angus, Hereford, and Galloway. All of these breeds originated in Great Britain and have been imported into America.

The Shorthorn is perhaps the most popular beef breed. It originated in the valley of the Tees River, in the northeastern part of England. It has short, heavy horns, that curve gracefully forward. In color it varies more than any other breed. It may be white or red, a mixture of red and white, or roan. The

Shorthorn was first imported into the United States in 1783, and into Canada in 1833. It is now the most widely distributed beef breed in America.

The Hereford originated in the southwestern part of England, in the county of Hereford. The breed is distinguished by its color markings. The head, including jaws and throat, is white, with

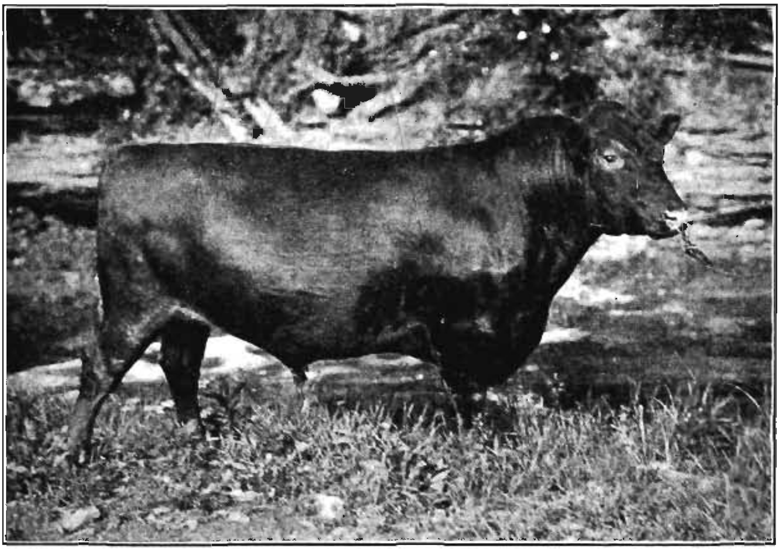


FIG. 136. — Polled Durham bull. Beef type.

white under the neck, down the breast, under the body, and more or less on the legs. The bush of the tail also is white. There is a white strip on the top of the neck from about the middle to the top of the shoulders. The remainder of the body is red. The coat of hair is long, soft, and curly.

The Hereford first reached America in 1817. It is now one of the leading beef breeds in Canada, the United States, and Mexico.

The Aberdeen-Angus had its origin in the northeastern part of

Scotland. Its color is black, and it has no horns. It was brought to America in 1872. It is now reared in large numbers both in the United States and in Canada.

The Galloway is a very ancient breed, which originated from the wild cattle that the Romans found in the forests of Britain when they first visited that country. It takes its name from the province of Galloway in the southeastern part of Scotland. It has a long, soft, shaggy coat of black hair, and is hornless. The shaggy coat easily distinguishes it from the Aberdeen-Angus. The breed first reached Ontario, Canada, in 1853, and later came to the United States.

Fig. 137. — Young Galloway cow. Beef type.

Dairy type. — Animals of the dairy type are reared for milk. The less flesh they carry the better, as it is desired that all the surplus food-energy shall go for the production of milk and not for the production of meat. The body of a good dairy animal is narrower before than behind; that is, it appears wedge-shaped as we view the animal from the side, with the smaller end of the wedge toward the front. This is caused by a large development of the rear quarters, and by rather low, thin shoulders. The animal has a spare, angular appearance because of the lack of muscular development. The angles and joints of the bones are prominent. This does not mean that the animal is poor, for there may still be abundant fat stored in the body.

There are several distinct breeds of dairy cattle for the same reason that there are separate beef breeds. The more common breeds in America are Jersey, Guernsey, Holstein-Friesian, and Ayrshire. Dutch Belted and French Canadian cattle are found in smaller numbers.

Jersey cattle originated on the island of Jersey in the English Channel. They are rather small, quiet animals, but not lacking in spirit. The horns are small and in-curving. The body is well-rounded, large, and deep. The color is soft gray brown, or fawn. The breed was first imported into America in 1850. It has increased so rapidly in this country that there are now more in America than on the island of Jersey.

Guernsey cattle originated on the island of Guernsey, near the island of Jersey, in the English Channel. They are slightly larger than Jerseys. Their color is a shade of fawn with white markings. It is supposed that they were first brought to America in 1818. They are most numerous in this country in the northern part of the United States and in Canada.

Holstein-Friesian cattle had their origin among the ancient Friesland people, a tribe which, at the time of our earliest historical knowledge of it, occupied the shores of the North Sea. The Friesians were the oldest inhabitants of Holland. Holstein-Friesian cattle are the largest of the dairy breeds, and are black and white in color. It is probable that a few animals were brought to America by the early Dutch settlers. There were few of them in this country earlier than fifty years ago. The breed is now scattered throughout the United States and Canada.

Ayrshire cattle were developed in the county of Ayr, in Scotland. They are of medium size, and somewhat less angular than Jersey or Holstein cattle. The common color in America is red with white patches, and rather more white than red. They first reached America between 1820 and 1830. Ayrshires have been popular especially in Canada.

Feeding and care of cattle. — We have learned that it is a severe tax on a dairy cow to produce milk. The more milk she yields to the pound of food the more valuable she is to her owner, and the heavier the tax on her system. She is expected to be

Fig. 138. — Holstein-Friesian cow. Dairy type.

ready twice a day with a good flow of milk. In order to do this, she must have kind treatment, regular milking, watering, and feeding, and plenty of nourishing food.

In the summer, when dairy cattle are at pasture, they need little else except when the pasture becomes short and dry. Then corn, alfalfa, peas, oats, rye, rape, and a few other crops may be cut while green and fed to them. In the winter, they relish well-made clover, alfalfa, or other kinds of hay, corn fodder, silage, root crops, and concentrated or grain feeds. If possible the ration should contain some hay or other dry forage, a succulent food, as silage or roots, and some grain. The careful farmer will feed a properly balanced ration.

Beef cattle are given such foods as will make them fat most quickly and at least expense. Sometimes they are fed fattening foods as soon after birth as they are able to digest them, and are kept on fattening foods until they are ready for market. They may then be made ready for market when ten to sixteen months old. Other cattle are allowed the freedom of the range or pasture

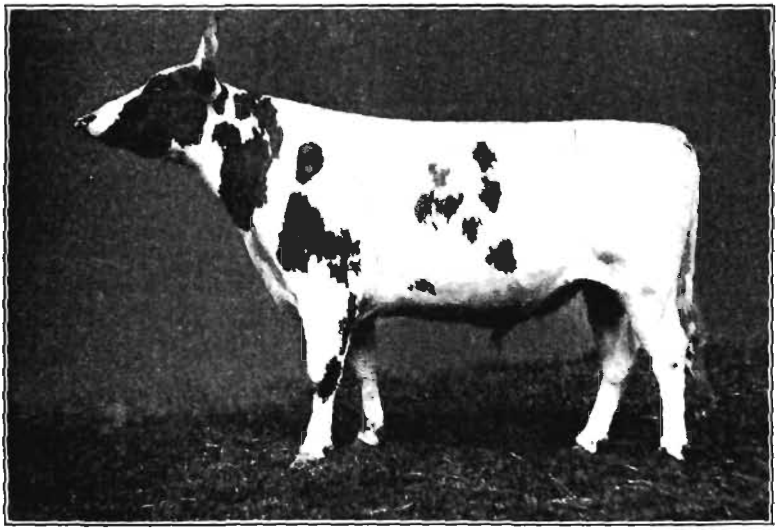


FIG. 139.—Young Ayrshire bull. Dairy type.

for a few months or a year or two, and are given fattening foods for a period just before they are to be marketed. Corn is the chief fattening food, with the addition sometimes of oats, oil meal, gluten meal, or other concentrated foods. Corn fodder, silage, clover, alfalfa, cowpeas, and other kinds of forage are also fed.

In the central and middle western states, the feeding of cattle for market has been developed on a very extensive scale. Formerly they were allowed to feed in great droves over the broad unfenced country, being attended by cowboys; but now that the Great

West is becoming settled and fenced, the cattle are more confined to regular farms, and the days of "ranging" are passing away.

Problem 235. Do the farmers in your locality raise dairy or beef cattle? If most of them raise dairy cattle, are there any small herds of beef or dual-purpose cattle?

Problem 236. What kinds of products are received from the cattle raised in your locality? Are the products used in the locality or shipped away? If shipped, how are they prepared for shipping?

Problem 237. If there is a creamery, find out how much milk and butter is handled each day, and what becomes of the butter. Find out how the farmers are paid — on what basis. If there is a skimming station, secure similar information from it.

Problem 238. Of what value are cattle to the farmer and to his farm, aside from the dairy or beef products he gets from them?

Problem 239. Ask the teacher to take the class to the best stock-farm in the neighborhood, and have the owner show the class the points of a good cow. Ask the owner about the ration he feeds.

Problem 240. Name the different breeds of cattle represented on the farms in the locality. Describe how one breed differs from another.

Problem 241. Make an estimate of the number of cattle in your school district; and estimate how many are giving milk, how many are fattening for beef, and how many are young stock.

Problem 242. For your school museum, bring samples of the different kinds of grain foods given to the cattle on the farms in the locality. They may be put up in glass bottles. The names of the foods should be written on the label. Examine all of the different foods until you can quickly recognize them without looking at the names.

CHAPTER XXXV

SHEEP

Our earliest records tell of shepherds keeping watch over their flocks of sheep. The first animals mentioned in the Bible are sheep. Abraham's wealth was measured by his "sheep and oxen and camels." This useful little animal has known a long period of domestication. It has furnished food and clothing for many races of men. Special distinction has attached to it, because of its ancient use for sacrificial purposes in religious worship.

Fig. 140. — The musmon, one of the wild ancestors of our domestic sheep.

History. — On the elevated plains of Asia, from the Caucasus northward and eastward to Kamchatka and the ocean, roam many small flocks of wild sheep, or *argali* as they are known. They are larger than our common sheep, with enormous horns sometimes a foot in circumference at the base and three to four feet long. The wool is brown, with a buff-colored streak along the back and a large spot of buff color on the haunch. These animals are agile and strong, but wary and suspicious. They are hunted for their flesh and their skins, which are made into clothing.

In the mountains of Greece, and on the islands of Crete, Cyprus, Corsica, and Sardinia, are found other large herds of animals much smaller than the argali, and also less powerful and less active. They also are wild sheep, and are called by the name *musmon* or *mouflon*.

It is thought that domestic sheep are descended from these two wild forms. Like the argali and the musmon, domestic sheep are mountain and highland animals, or they do best in cool climates. They are able to thrive on steep rocky hillsides, mountain-sides, and other rough lands inaccessible to the plow.

The wild sheep of America have not had part in the formation of our domestic breeds.

There are many types of sheep. — As is to be expected of an animal that has been long under domestication in many countries, the sheep presents many types or forms. Some have two horns, others three, others four or more, and still others have none. Some have short tails, others have long tails, and one breed in Asia has a very thick, fat tail. There are large races and dwarf races. Some kinds have a heavy double coat, and in tropical regions there are woolless sheep. The great variety in domestic sheep illustrates how animals in nature adapt themselves to the conditions in which they live. The adaptability of the sheep has found for it a place in nearly every part of the world.

Sheep may be classified according to use. — Sheep are raised for wool and for meat. Some types that yielded finer fleece than others have been developed for their wool, so that we now have special wool breeds. Others, which furnished a fine quality of mutton, were bred principally for this purpose, and so we have also mutton breeds.

Practically all of our domestic sheep belong in one or the other of these two groups. But these two classes are not wholly distinct. Wool is sheared from the mutton breeds, and mutton is the final disposition of most of the wool breeds.

Since all domestic sheep in America yield some wool, it is more common to classify them according to length or quality of fleece. Three classes are given: fine wool, medium wool, and long wool. The fine-wool sheep are the best wool breeds, and the other two classes are the mutton breeds.

The breeds of sheep. — In America we have the following breeds of sheep:

Fig. 141. —American Merino.

(1) Fine-wool breeds: American Merino, Delaine Merino, and Rambouillet, or French Merino.

(2) Medium-wool breeds: Dorset Horn, Hampshire Down, Oxford Down, Shropshire Down, Southdown, Suffolk Down, and Tunis.

(3) Long-wool breeds: Cheviot, Cotswold, Leicester, and Lincoln.

Wool production. — Next to cotton, wool is the product most extensively used in the manufacture of cloth, felt, and other fabrics. It is estimated that in 1900 the world's wool clip was 2,685,000,000

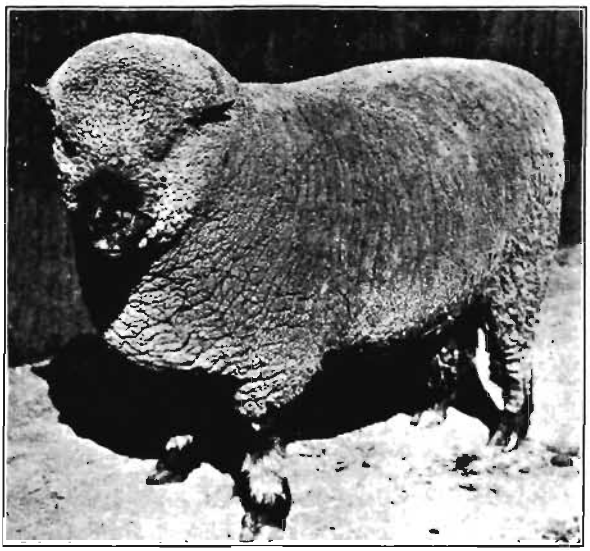


Fig. 142. — Shropshire ram.

pounds. Argentina, Australia, America, Russia, Great Britain, and British India are the leading wool-producing countries.

For many years sheep-breeders in America paid much attention to the production of fine wool. In 1893, the price of wool became very low, and many breeders, especially in the middle and eastern states, abandoned wool production and undertook to produce mutton. On the ranches of the west and the southwest, wool-growing is now receiving much attention again. The wild pastures that are too scant for cattle are yet valuable for sheep-raising. The ranchman can place wool on the market at much less expense than mutton. Many breeders ship lambs east to be fattened for market.

Mutton production. — The rearing and feeding of sheep for the production of mutton is to-day an important industry in America. In 1907, there were 3,069,391 sheep slaughtered at the Union Stock

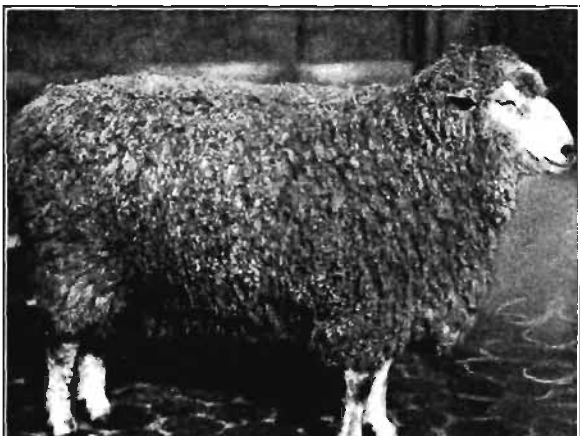


Fig. 143. — Lincoln ram.

Yards in Chicago. Large numbers were slaughtered at many other points.

Sometimes lambs are "forced," or fattened from their birth until they are six to ten weeks old. They are commonly called "hot-house" lambs. They furnish the finest quality of mutton

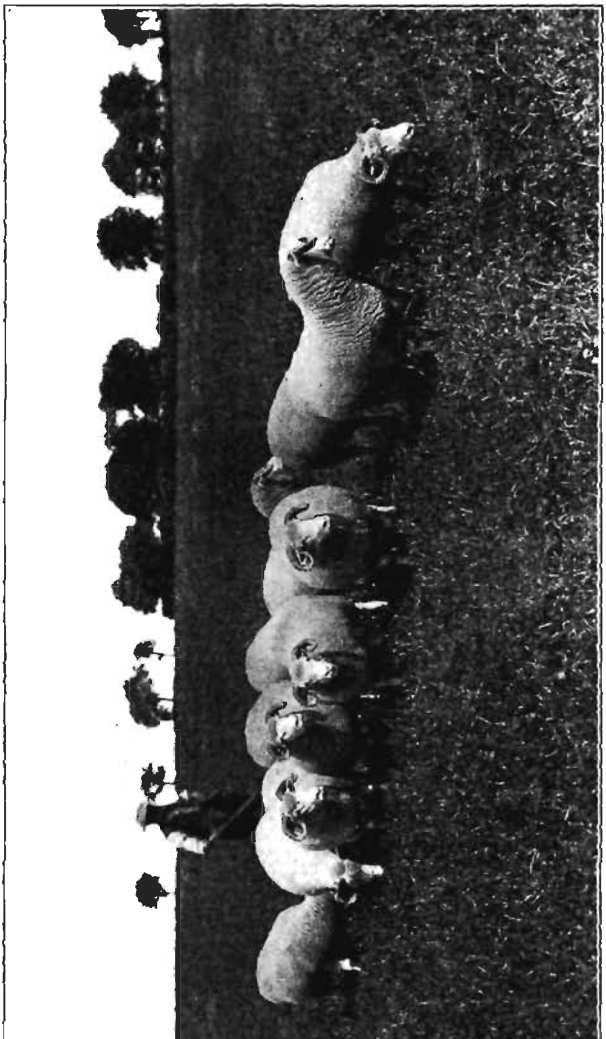


FIG. 144. — At pasture.

and bring high prices. They require special buildings and much care in their rearing.

Usually sheep are allowed to run on pasture during the summer, and are given a small amount of grain. The lambs are slaughtered in the fall before it is time to house them for the winter.

A method of producing mutton that is becoming important is to allow the lambs to run on the free range until they are either eight or twenty months old, depending on the age when it is desired to market them. They are then shipped to eastern farms to be fattened for market. Here they are fed corn, clover, or mixed hay; sometimes oats, peas, and barley are given. The

FIG. 145. — Shropshire lamb ewes.

western man makes his money on the raising of the sheep and on the use of his pasture; the eastern man makes his profit on the feed that he raises or buys.

Sheep-farming in America. — In the East sheep are kept in small flocks within fenced fields, and in winter are housed in regular barns. In the West great sheep ranches have been developed. Sheep-farming as an industry is now largely a business of the West. Formerly sheep were pastured on the open unfenced range (or public domain); but now they are mostly confined to large privately-owned ranches, at least during some part of the year.

In the mountain states of the West the sheep are pastured on the highlands in summer, often above the timber-land and near the snow-line, and on the plains or in the valleys in winter. Immense flocks or "bands" are kept, which are moved from place to place to secure pasturage. Men with camp equipments and sheep dogs move with the flocks. The sheep are sheared just before they go to the summer range.

Problem 243. If any sheep are raised in your locality, write or explain how they are handled: on what lands they are pastured, when they are housed, what they are fed, what becomes of the wool and the mutton.

Problem 244. Name and describe any breeds of sheep with which you are familiar.

Problem 245. Do sheep require much attention? In what ways are they useful on the farm?

Problem 246. If sheep have been shipped into your locality for fattening, find where they came from, how they had lived before, what they are now being fed, where and when they will be marketed.

Problem 247. If the mother dies, or will not own the lamb, how would you save the lamb?

Problem 248. What sort of foot has a sheep?

Problem 249. How much may a full-grown sheep weigh?

Problem 250. Do sheep flock together in bands, or do they separate and scatter? Do they follow a leader? Describe the movements of a flock of sheep.

CHAPTER XXXVI

SWINE

Swine, or hogs as they are more often called in America, have long endured an unenviable reputation. In ancient time, Moses was instructed to have his people abstain from eating pork because it was unclean. Wherever hogs are kept in small numbers they are likely to be given poor houses and small yards; and the fact that they are able to make such good use of waste material from the kitchen and the farm has added further to their lowly reputation. But, as we shall see, hogs are naturally clean in their habits, and will keep their houses clean and in order when it is made possible for them to do so.

History. — The exact origin of swine is not certainly known. They belong to a family of animals that inhabit tropical countries mostly. It is thought that the farm hog has descended from the wild boar of Europe, Northern Africa, and Asia. Perhaps, also, a native race in India has had part in its development.

It is probable that hogs were first domesticated in Asia. They are now very widely scattered. They have a tendency to return to a wild state when kept in mild climates. This is well shown by the wild razorback hogs found in a few places in the southern part of the United States. These hogs doubtless have developed from hogs brought to America by early settlers and which escaped from domestication or were allowed to roam freely in the woods.

The wild boar is still found in central and southern Europe and Asia. From the earliest times it has been a much sought game animal, the boar hunt being one of the leading pastimes of royal and noble families. The boar is a swift and fierce animal, larger than our common hog. Its great tusks are dangerous weapons. When pursued it becomes ferocious and will attack both men and dogs.

Under domestication the hog has been much changed. It is now quiet and docile, although old boars will still become vicious when aroused. The wild hog was not a fleshy animal, but the domestic hog has developed remarkable ability to fatten. Frequently it will fatten so much that its legs can scarcely support it and it is able to move about only with difficulty.

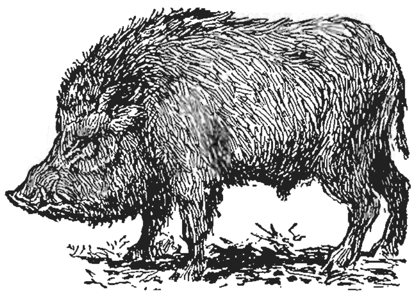


FIG. 146. — The wild boar from which our present-day swine have descended.

The male of swine is known as a boar; the female as a sow. A young pig, particularly after weaning, is called a shoat, or shote.

The nature of hogs. — Unlike other domestic animals, the hog has almost no covering for his body. The few bristles and hairs do not protect him from the attacks of flies and other insects. Furthermore, the hog does not perspire as a horse does. Thus it is that he has learned to wallow in water and mud to rid his body of pests and to keep it cool. Hogs that are kept in woods or groves have less need for the wallow.

When hogs are given large yards or free range, and have a clean place in their houses for sleeping, they will keep their bedrooms neat and clean. It is only when the small pen is made to serve as dining-room, bedroom, and wallow, all in one, that the hog is filthy. That is not his fault. It is the way in which he is kept.

Hogs have always had to dig for much of their food. As some of this food was the roots of plants, the name "rooting" has been applied to the method by which they secured this part of

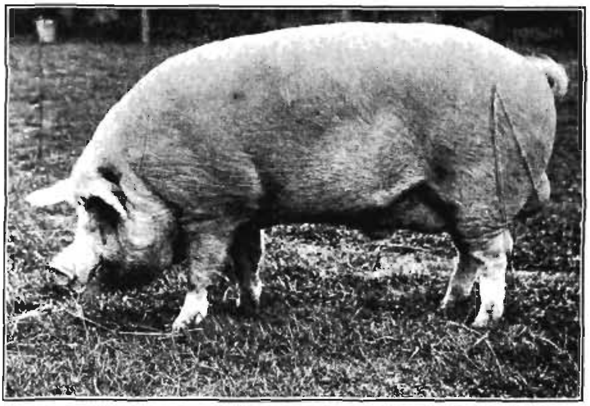


FIG. 147. — Chester White.

their food. The strong, fleshy disk on the nose has been developed for this purpose. Not only is it able to stand the wear of rooting, but it is very sensitive to smell and can readily detect what the animal is looking for. A pig will follow a track or trail almost as well as will a dog.

Classification of hogs. — Hogs are raised for lard and for bacon, and it is usual to divide them into two classes: lard or fat hogs, and bacon hogs. These two classes overlap, as some hogs are useful for both purposes.

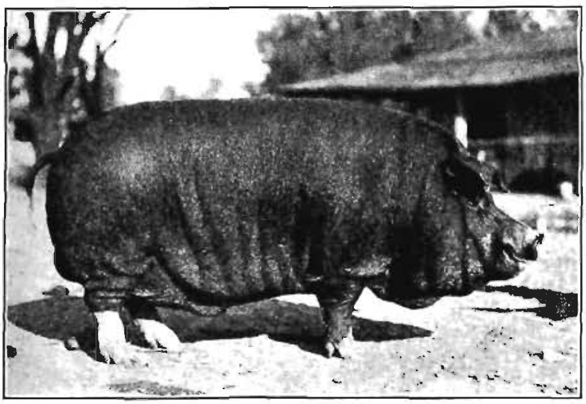


FIG. 148. — Poland China.

Sometimes swine are classified according to size into large breeds, medium breeds, and small breeds. Sometimes they are classified as white, black, and red hogs.

Breeds of hogs. — The more common breeds in America, grouped as lard and bacon breeds, are as follows:

(1) Lard hogs: *Berkshire*, a black animal with white markings and ears extending erect; *Chester White*, a white hog with drooping ears; *Cheshire*, white with erect ears; *Duroc-Jersey*, red or chestnut with drooping ears; *Essex*, black with small, fine, erect ears; *Poland China*, black and white with drooping ears; *Victoria*, white, with occasional dark spots on the skin, and erect ears. The Cheshire, Chester White, Duroc-Jersey, Poland China, and Victoria breeds were originated in America.

Fig. 149. — Cheshire.

(2) Bacon hogs: *Hampshire*, usually black with a white belt, four to twelve inches wide, encircling the body and including the fore legs; ears inclined forward; *Large Yorkshire*, white with erect ears; *Tamworth*, red or chestnut with large, pointed, erect ears.

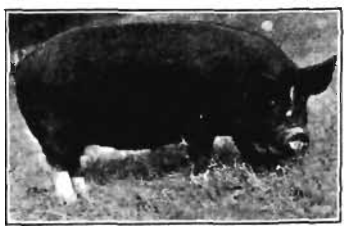


Fig. 150. — Berkshire.

If we classify, or group, the breeds of hogs according to size, they will be arranged as follows:

(1) Large breeds: Chester White, Large Yorkshire, and Tamworth.

(2) Medium breeds: Berkshire, Cheshire, Duroc-Jersey, Hampshire, Poland China, and Victoria.

(3) Small breed: Essex.

The rearing of hogs. — When hogs are allowed to roam in the woods, they will live on roots and nuts, especially acorns and beechnuts. The beechnut bacon of the semi-wild hogs of the southern states is of very high quality. Hogs will eat almost anything that comes in their way, be it animal or vegetable. On the frontier they once did good service as destroyers of rattlesnakes.

There are two rather distinct or unlike methods of raising hogs in America. One is to keep a few animals in small pens and yards to use the wastes from kitchen and farm. This is the common practice in the East. Such hogs are raised largely for home use.

The other method is the raising of hogs in large numbers to supply the market demands. It is practiced in the central west,

FIG. 151.—Hampshire.

where there are extensive hog farms. Usually, but not always, hogs are raised on farms on which beef cattle are being fattened for market. The hogs, as well as the cattle, are fattened on corn. For this reason the extensive hog farms are nearly all found in that part of the country where corn is the leading crop, that is, in the corn-belt. The hogs run with the cattle and are able to use the corn which the cattle waste and which otherwise would be lost.

It is now coming to be the practice to provide "colony houses" for hogs. These are small houses or pens scattered about the fields, each accommodating three to six animals. The small, separate houses are for the purpose of guarding against the dreaded hog-cholera disease. When the animals live all together, the disease is likely to spread rapidly. If it invades one of the separate houses, the house can be burned and the disease prevented from spreading.

Hogs enjoy free range, and when given good clover or alfalfa or rape pasture, will make rapid growth. Wherever they are raised in large numbers pasture must be provided.

Problem 251. Name and describe the breeds of hogs that are kept in your locality.

Problem 252. What is done with the products from the hogs on farms in your locality? If used at home, how are they prepared and stored? If shipped away, how are they prepared for market?

Problem 253. Tell how the hogs are cared for in your neighborhood — how they are housed, what pasture they have, what they are fed, how expensive it is to raise them.

Problem 254. Watch the hogs for a few days and then tell what you have observed as to their habits, especially with reference to the care of the body. See whether you can find any indications that hogs like to have clean living-quarters, especially for sleeping.

Problem 255. What kind of fence is needed to confine hogs?

Problem 256. What is meant by "pork on the hoof"? How much is it worth in your neighborhood now?

Problem 257. What is a pig's foot like?

Problem 258. Can you tell the difference between a pig's track and a sheep's track? How?

Problem 259. How heavy (what weight) was the largest hog you ever saw?

CHAPTER XXXVII

POULTRY

Not many years ago poultry was a part of the farm stock of which no separate account was taken. The fowls lived on refuse and such food as they could find on free range. Whatever they produced in the way of meat, eggs, and feathers was looked upon

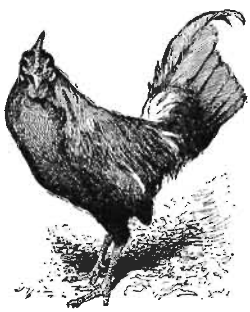


Fig. 152. — The red jungle fowl, one of the ancestors of domestic fowls.

Fig. 153. — The Aseel fowl, another of the original ancestors of domestic fowls.

as clear gain. Because they thrived everywhere, cost very little to keep, multiplied rapidly, and returned a marketable product, they found a place on nearly every farm. Fowls are kept to-day on more farms or homesteads than any other domestic animals *except cats; and they are receiving as careful and studious* attention as other animals.

Farm poultry is of several kinds. Domestic fowls, or chickens, are the most common. Turkeys, ducks, geese, and guinea-fowls are reared in small flocks on many farms, and ducks and geese in large numbers on special farms.

Fig. 154. — White Leghorn hen.

The origin of the domestic fowls. — The domestic, or barnyard fowl, as it has been called, belongs to a race of scratching birds that includes also the turkey, guinea-fowl, pheasant, partridge, and grouse. Its origin seems to trace largely to a wild bird called the jungle fowl, still common in the jungles of India, southern China, and the East Indies. This wild bird has a slender body and a single comb, and is able to fly considerable distances.

Another wild form also seems to have contributed to the early development of domestic fowls. It was the very ancient ancestor of the Aseel, or Malay fowl, which has been bred in India for more than 3000 years. It has a larger body than the jungle fowl, a triple or pea comb, and yellow-skinned legs. It does not fly great distances.

Fig. 155. — White Leghorn rooster.

The history of the domesticated fowl reaches far back into the sheep, and swine. But this is because it did not reach Syria until 300 or 400 years before the beginning of the present era.

About 330 B.C., domestic fowls were taken to Europe from Persia. There they spread rapidly. From Europe they were brought to America in the early days of the colonization. Game fowls, Leghorns, Dorkings, and Scotch Grays were brought over

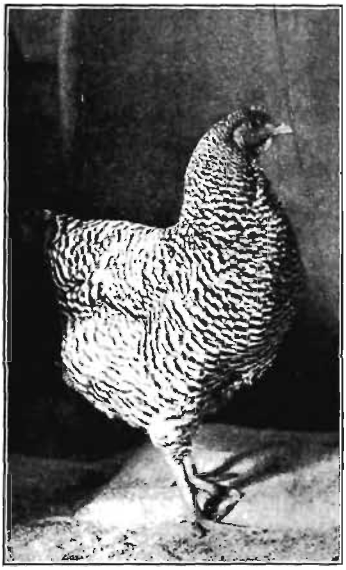


FIG. 156. — Barred Plymouth Rock hen.

FIG. 157. — Barred Plymouth Rock rooster.

by the colonists. From the Scotch Gray the Barred Plymouth Rock was developed. Later, Brahmas were imported from the Brahmapootra River, and Cochins from Shanghai.

much of the day in scratching for food, especially for insects, grubs, and earthworms.

Chickens are not provided with teeth and must swallow their food whole. It passes into the crop, where it is softened by juices. Then it passes into the gizzard — a veritable mill filled with gravel which the fowl has swallowed and which grinds the food into fine particles in preparation for digestion.

A chicken has no muscles in its throat to enable it to swallow

FIG. 158. — Hen and ducklings.

the skin. It is nature that has taught hogs to wallow and fowls to use the dust bath for health and protection.

Breeds of poultry. — As there are beef and dairy types of cattle, and wool and mutton types of sheep, so there are meat and egg types of chickens; that is, some types have been developed to fatten for meat purposes, and others to lay many eggs. All fowls

The majority, but not all, of the breeds that are raised in America belong to one of two families, the American and the Mediterranean families.

The American family includes the Plymouth Rock, Wyandotte, and Rhode Island Red, and the Dominique and Java of less importance. These fowls are large, and fatten readily for market. They are rather good layers, and are dual-purpose breeds.

The Mediterranean family includes the Leghorn and the Minorca, and the less important White-faced Black Spanish, Blue Andalusian, and Ancona. These are neat, active fowls that lay large numbers of eggs. They are the *true* egg breeds. Their bodies are small even after they are fattened.

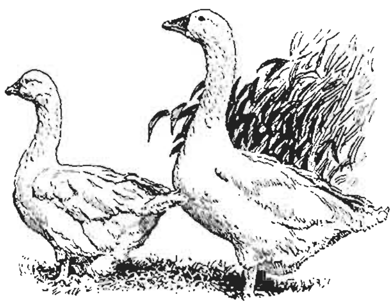


FIG. 160. — Embden geese.

The Brahma and Cochin, which are true meat breeds, belong to the Asiatic family. The Orpington, which is now raised in considerable numbers in America, belongs to the English family. It is a dual-purpose breed.

Color of eggs. — Most of the eggs from farm poultry are either brown or white. Brown eggs are laid by Plymouth Rock, Rhode Island Red, Brahma, and Cochin fowls. White eggs are laid by Leghorn and Minorca fowls. Medium colored or tinted eggs are laid by Dorking, Wyandotte, and Orpington fowls.

The color of eggs is sometimes an important factor in their sale. Some markets will buy only white-shelled eggs, others only those having brown shells. There is considerable difference in color and shape of eggs, even in the same breed.

The care of poultry. — By nature fowls are able to care for themselves. But by nature they lay few eggs, and are not likely to be fat enough for market when needed except in the fall.

Fowls that are kept for profit must be fed proper foods, at regular intervals, must have clean, well-ventilated houses, and plenty of room for outdoor exercise. There must be opportunity for scratching and for the dust bath. The natural desire of the hen is to hide her nest, and she should be provided with a secluded place in which to lay her eggs.

All classes of poultry, including domestic fowls, turkeys, ducks, geese, and guineas, eat freely of grain and meat foods and green forage. Domestic fowls eat most freely of grains; turkeys and guineas are insect-hunters; ducks and geese are grazers and fishers.

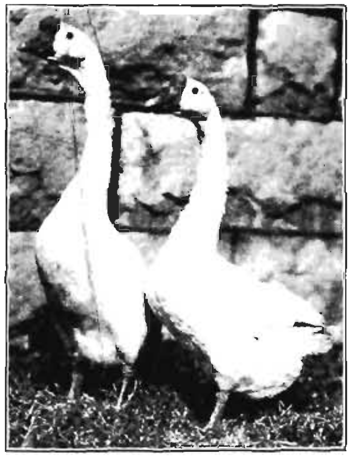


FIG. 161. — White Chinese geese.

Every ration for domestic fowls should contain whole grain, as wheat, corn, oats, or peas; ground feed, as wheat bran, wheat middlings, corn meal, or ground oats; meat in some form, as beef scraps, green cut bone, or skimmed milk; green food, as clover pasture, mangel beets, or cabbage; and grit and cracked oyster shells. Fresh, clean drinking water should always be available.

Poultry should be fed properly balanced rations for particular purposes: for eggs, or for meat, or to encourage the production of both. They like variety, and do better when several kinds of food are given. They should have food that they like.

Hatching. — When a small number of chickens are to be raised each year, broody hens may well be used for the hatching. Fowls in the American and Asiatic families are good sitters. Those in the Mediterranean family are usually very poor sitters.

Chickens may be hatched in an incubator. This is a machine in which eggs can be kept at the same temperature as when covered by a hen. Chickens hatched in an incubator are frequently reared in another machine, called a brooder, until they are able to care for themselves. A brooder takes the place of the mother by supplying, for the chicks, protection and the right degree of heat. Incubators and brooders are used mostly when chickens are reared in large numbers.

About twenty-one days are required for hatching the eggs of domestic fowls.

Problem 260. How does the covering, or coat, of fowls differ from the covering of other domestic animals? What advantage over other animals does this give to fowls?

Problem 261. On how many farms in your locality are chickens kept? Are they in large flocks or small flocks? How are they cared for?

Problem 262. If there are any farms in your neighborhood on which poultry are raised in large numbers, find out how they are taken care of. Explain the differences between handling very large flocks and small flocks.

Problem 263. Name and describe all the types and breeds of poultry reared in your locality so far as you are able. Tell which are meat breeds, which egg breeds, which dual-purpose breeds.

Problem 264. If eggs are shipped from your neighborhood, find whether the market to which they go has any preference as to color.

Problem 265. What price do eggs bring by the dozen in your locality? How many dozen would have to be sold on your farm to pay for the food given to the fowls in a month? Do your chickens pay for themselves?

CHAPTER XXXVIII

BEES

THE raising of honey bees has always been one of the occupations of man. Until the seventeenth century honey was the only means people had for sweetening their food, as manufactured sugar was unknown.

The development of bee-keeping. — Ancient Egypt, Babylon, Assyria, Palestine, Greece, Rome, and Carthage, all had their bee-keepers. The keeping of bees in Egypt to-day is probably not very different from what it was four thousand years ago. At that time floating apiaries were common in Egypt, and they are still found on the Nile.

The raising of bees has received a great deal of attention down through the centuries, and more books have been written about bees than about any other domestic animal. It was not until 1852, however, that the production of honey as a great commercial industry began. In that year Mr. Langstroth, of Philadelphia, invented a new kind of hive that greatly changed the methods of keeping bees, and made it possible for one person to manage a large number of hives. It is said that the Langstroth hive has meant as much to bee-keeping as the invention of the locomotive has to transportation. Most of the hives in use to-day are fashioned after the one made by Mr. Langstroth.

The keeping of bees for honey is now a large industry in America. In almost every community there is at least one apiary, or place where bees are kept. The honey and wax produced each year in the United States is valued at about $25,000,000. In one year, California exported five hundred carloads of honey. Single bee-keepers have produced as much as eighty tons in a year.

There are different races of bees. — Bees, like other insects and animals that have existed for many centuries and in various parts of the world, have developed many varieties or races. They are of different sizes, shapes, colors, and habits. Some are wild forms

Fig. 162. — The keeping of bees is one of the farm industries.

that have never been domesticated by man. Most of them have stings, but there are races of stingless bees in South America, some of which have been imported to this country.

The most popular honey bees in America are the Italians, whose original home was in Italy. They were brought to this country in 1860. A race known as Carniolan has found favor in cool, elevated places in the northern part of America. Several other races are kept in a small way.

The bee colony. — Bees live together in very great numbers, in well-ordered households, or colonies. If the affairs of their colonies were not well ordered, they could not live together. Their government is peculiar, however, in that in each colony there are many kings and only one queen. The kings do little or no work, while the queen works as hard and longer than any of her subjects. The common citizens are all females, and they are busy all the day long.

The number of bees in a colony will vary. There should be at least 40,000 in a colony that is in good condition. Most of them are workers, a few hundred are drones or kings, and there is only the one queen.

The queen. — The mistress of the hive is a very graceful insect, with a long pointed body that extends far beyond the tips of her closed wings. She is the largest member of the household. She starts her life in the same sort of egg as do the worker bees. This egg is selected by the workers for special attention throughout its development. After the queen is three days old from the egg, she is fed on a special food called "royal jelly." After feasting on this for five days, her cell is closed and she undergoes further development. When she finally emerges, she is full-grown.

The first task of the new queen is to hunt for other queen cells, and, if any are found, to sting the occupants to death. If she finds another fully developed queen in the hive, war is waged between them until one is killed. If the workers interfere in the fight, she takes her followers from the hive to a new home.

The queen is responsible for maintaining the colony. She will lay as many as 3000, and occasionally 5000, eggs in a day. During her lifetime she may deposit 1,500,000 to 2,500,000 eggs.

The workers. — The workers are the citizens of the colony, and are the smallest members of the household. All are females, but unlike the queen, which received special attention, they are not perfectly developed and cannot lay eggs. Only the queen has this power. The workers are provided with long tongues, by means of which they can reach deep into flowers to gather the nectar. This they deposit in pollen or nectar baskets on their hind legs for transportation to the hive for storing.

The drone. — The drone is the king, whose only responsibility is to mate with the queen. Even though he is an idler, he is a very necessary part of the household. He is perfectly developed for his purpose, is larger than the worker, and broader and more blunt in form than either the queen or the worker. He has no pollen baskets and no sting. His tongue is not long enough to gather honey from flowers. He has no responsibility for the food-supply of the colony.

How bees live and work. — Wild bees live in hollow logs and in caves. Those that have been domesticated are provided with houses, called hives. A hive usually is a box, on top of which one or two stories, called "supers," are placed. In the lower story, or box part of the hive, are placed frames which the bees fill with comb, in which the queen may deposit eggs for the new brood. On these frames a considerable supply of honey is stored also. The supers are filled with box-like frames, called sections, each of which will hold a pound of honey. By nature, bees place their brood in the lower part of their nests and most of their reserve honey above. Bee-keepers take advantage of this fact, and remove the sections from the supers as soon as they are filled and replace them with empty ones. It is not safe to take all the honey from the brood chamber below, as twenty-five or thirty pounds will be needed by the colony for winter use.

Honey is made from the nectar of flowers, gathered by bees. The nectar is carried in small receptacles with which bees are provided. Here it is mixed with a secretion made by the bee that produces changes in the nectar which result in the formation of honey. After the honey has been deposited in the comb, it is exposed to the air for a while before it is capped. This ripens it.

Comb foundation. — The honey comb, in which the honey is stored, is made up of long, tube-like cells that are six-sided. When the sections are removed from the supers and replaced by new ones, or when new brood frames are placed in the lower part of the hive, to accommodate the young, the bee-keeper furnishes the sections and frames with what is called comb foundation, or foundation for the building of new comb. This is a thin sheet of beeswax which has been pressed by a machine that has covered its entire surface with a net-work of impressions of the six-sided cells. From these impressions the new cells are built.

The skilful bee-keeper usually fills the brood frames completely with the comb foundation. In the pound sections, ordinarily only a small piece, called a "starter," is used. Bees naturally dislike small frames such as those in the pound sections, but when they find foundation in them, they proceed to fill them out.

Swarming. — Bees will swarm when there are two queens, and one is unable to destroy the other. In such an event, part of the colony will leave the hive with one of them and go in search of a new home.

But this is not the only cause of swarming. Bees will swarm when they have become over-prosperous. When there is an abundance of food on hand and numerous young bees in process of growth, the queen, accompanied by the larger part of her colony, will rush from the hive to give vent to pent-up energy. They go forth with their sacs filled with honey. They maneuver in the air for a while, then settle on a branch or bush near by, at the same time sending out scouts to find a suitable home in a hollow tree or elsewhere. Then it is that the bee-keeper gives them a hive merely by shaking them into it or down in front of an enlarged entrance. They are glad to find a home so soon, particularly if it is clean, and usually will take possession at once.

By removing part of the accumulated honey, so that the bees are kept at work, they may sometimes be prevented from swarming.

Protecting the colony. — Bees must be protected from the cold in winter, or they may perish. The best method is to use the "box" hive in which the inner part, or real hive, is surrounded by an outer case that is large enough to leave a space between the two to be filled with chaff or other good packing material. A small opening is left so that the bees can go out in good weather.

FIG. 163.—Swarm of bees on limb of a cherry-tree ready for housing.

The packing is left in the case during the summer as well as the winter, as it helps to protect the hives from the hot sun. The hives should be placed during the summer where they will be shaded part of the day. The grass should be cut around them so that the honey-laden bees will not become entangled when they return to the hive.

Problem 266. If you have ever found a wild bees' nest, tell where you found it and how it was protected; what the comb looked like; whether the honey tasted the same as that from domesticated bees.

Problem 267. If bees are kept by any one in the neighborhood, ask him to show you a hive where the bees are at work. Look for the cells in which young bees are developing. Find out what a brood frame is, a section, a super, and comb foundation.

Problem 268. Does all honey that is offered for sale look and taste alike? Is some lighter colored than other? What is the cause of the difference?

Problem 269. Name five plants from which honey bees secure nectar.

Problem 270. What is beeswax? For what is it used?

Problem 271. Are bees an aid to the fruit-grower in any way? How?

CHAPTER XXXIX

BIRDS

BIRDS are necessary helpers on the farm, and the farmer should recognize them and encourage their presence. Nature maintains a proper balance between all her animals and plants. The birds are set over against the insects; when the one decreases the other increases. If the farmer wants more insects, the first thing for him to do is to destroy the birds.

It is not enough that the farmer merely allow the birds to come. If he is a thorough farmer he will first protect them, and then he will attract them by the planting of bushes and trees, by feeding them in hard times, by supplying water in dry times, by building bird-houses.

The song and form and plumage of birds give much satisfaction to every sensitive mind. Let any country girl or boy try to picture a perfectly birdless world: would it be the same kind of world as that in which we live?

Why birds are useful to the farmer. — We think of cities as having policemen to guard and protect the people; but the open country also has its policemen, a great army of them, in the birds that guard its crops against thieving and destroying insects. These thieves come unexpectedly in great bands, and if there were not vigilant scouts on every part of the farm to help the farmer protect his crops against them, his plight would be a hopeless one. Let us see what these enemies are and what they do, and how the bird allies help the farmer against them.

In Chapter XXVIII we learned that in a single year insects may destroy as much as $700,000,000 worth of crops in the United States alone. An expert in the United States government recently made the following estimates of the losses to certain crops from insect pests: to the corn crop, $80,000,000 a year; to wheat, $100,000,000; to hay, $535,000; to fruits from the codlin-moth alone, $20,000,000; and these are only a few out of a long list of losses. A few years ago a list of the insects that injure apple trees in the United States was published, containing the names of one hundred and seventy-six different kinds; and the codlin-moth alone destroyed $20,000,000 worth of fruit!

Photo by Allen

FIG. 164. — Red-wing blackbird that delights to dwell in the marsh.

What the birds do. — Birds have to hunt for their living, and much of their food is composed of insects and weed seeds. They patrol the air and the earth and capture vast numbers of insects. The robins search the fields for grasshoppers, earthworms, and cutworms. The bluebirds supplement the robins, and in addition search the fruit and shade trees for insects. Chipping sparrows are on the watch for grasshoppers and caterpillars. Out in the fields and the pastures the blackbirds, bobolinks, sparrows, and meadow-larks exercise control. On the edge of the woods, the brown thrashers and chewinks search the ground for insect life.

Up in the trees, the vireos, kinglets, warblers, and chickadees hunt for leaf-destroying insects, while the nuthatches, creepers, and woodpeckers search for the insects that live on or beneath the bark. There is no safe place, on ground or tree, for the insect to alight without fear of annihilation.

But the insects that take refuge in flight are no better off, for the birds patrol the air as well as the trees and the ground. The swallows, chimney-swifts, fly-catchers, pewees, kingbirds, warblers, vireos, bluebirds, and redstarts capture from the air, by day, all of the insects that come within their range. When they cease their labors to rest for the night, the whippoorwills and nighthawks go on duty and capture insects of many sizes and kinds. The hawks and the owls also sweep down on the moles, meadow-mice, rats, and mice that lurk about the farm and do damage to the farmer's crops and products.

Nor is this all. Another of the farmer's foes is weeds, most of which produce seeds in great numbers. Such seeds are good food for birds, and they are eaten in great quantities. One authority has estimated that in Iowa the tree sparrows alone eat eight hundred and seventy-five tons of weed seed in one season. The weeds that birds prefer seem to be ragweed, pigweed, smartweed, pigeon-grass, bind-weed, crab-grass, and lamb's quarters; but birds eat the seeds of a large number of other weeds also.

How much the birds help. — Birds are such active, energetic creatures that they require an amount of food out of all proportion to their size. The adult birds of many kinds will eat a quantity of food each day greater than their own weight; and their little ones in the nest eat relatively more than their parents. Indeed, birds eat all the time when not occupied by sleeping, nest-making, or feeding their young. A yellow-billed cuckoo had in its stomach at one time 217 fall webworms; a flicker had eaten 5000 ants; a night-hawk consumed 60 grasshoppers; a mourning dove had eaten 7500 seeds of the yellow woodsorrel at one meal; a bob-white consumed 1700 seeds of weeds on one occasion.

The help that birds give the farmer in controlling insect enemies and weeds is much greater than we usually give them credit for. They are on guard day and night, winter and summer, an army that can fly with great speed to the place where the insects are thickest and the conflict heaviest. Their scouts are always on the lookout, and they can assemble in a very short time a flying army to attack swarming hosts of destructive insects.

How to attract the birds. — Wherever the farmer or his neighbors has attempted to kill the birds, he has suffered by an increase in his insect and weed enemies. Of course birds destroy some fruits and take some grain and garden crops; but these are only small pay in exchange for their great services. The farmer can well afford to pay something to keep a flock of bird allies on his farm. Not all birds are useful, and when the farmer knows the ones that do more harm than good he does well to lessen them; but he should be careful to protect the helpful ones.

Food will always attract birds, especially if given at those times of year when food is hard to find. Such fruits as the berries of barberry, juniper, and sumac, which remain on the plant over winter, are greatly relished by birds. If thickets of such plants are occasionally left on the farm they will encourage the birds. Chaff and hayseed from the barn floor cast on the snow or frozen ground will be appreciated. Bits of suet, and bones with shreds of meat attached, fastened to trees will be found by the birds.

Nesting places. — Houses may be built for some of the birds that like to build their nests in houses — as the bluebirds, wrens, tree swallows, martins, doves, pigeons, and sometimes the chickadees. The houses may have several rooms, as some birds, such as the martins, pigeons, and tree swallows, like to live in families or colonies. The floor space of each room should be from 5″ × 6″ to 8″ × 8″. The size of the doorway should be just sufficient to admit the bird. A larger opening not only looks unattractive, but it exposes the inhabitants to danger from cats and other enemies. Only one opening should be provided for each house or compartment. A perch or doorstep should be provided just below each door.

The houses should be placed on poles or on buildings in somewhat secluded places. Martins and tree swallows like to build their nests twenty-five feet or more above the ground, but the other birds usually prefer an elevation less than twelve feet. Newly made houses do not often attract the birds, so we must not be disappointed at first.

Fig. 165. — Meadow-lark's nest.

If food and attractive nesting places are provided during the severe months of late fall and winter, the birds will remain and become true neighbors, and will spend their time searching for weed seeds that still cling to the plants, and insects that linger in the trees.

Protection of birds. — If in addition to providing for their wants, shooting of useful birds is not allowed, and cats, bird-hawks, snakes, crows, and jays, English sparrows and squirrels that destroy birds' nests are dealt with severely, the farmer will, gain a great host of bird friends that will repay him well for his care of their needs; and while he will still suffer great losses from the ravages of insects, he will suffer much less than if he were thoughtless of the birds.

It is especially important that we control the cats. One has no more right to allow his cats to wander at will than he has to allow his pigs or chickens or dogs to trespass and destroy. Even at home the cats should be watched closely and prevented from killing birds. A bell on the cat will prevent it from catching old birds, but it will not keep it away from the nests and the fledgelings. All bird-catching cats should either be killed or kept within regular inclosures.

Problem 272. Write a list of all the birds that visit your locality, so far as you know them. Tell when they come, where they build their nests, and when they go; also describe those that you know best.

Problem 273. What birds remain in your neighborhood over winter? Do they stay near the houses and barns in the hope of receiving food? What do they eat?

Problem 274. Watch the birds that hop about on the ground and find out what they are eating. Find out also what the birds that hop about in the trees and fly about in the air are eating.

Problem 275. Have you ever fed the birds in fall and winter? If so, what ones came to receive your food? Did they seem to appreciate it? Where did they go after feeding?

Problem 276. Build two or three bird houses, and place them where they will be secluded somewhat. Make the opening into one a one-inch auger hole. Make the door into another one and a half inches in diameter. Discover what birds nest in each; how they build their nests; whether they stand on the perch or doorstep and chatter merrily together.

Problem 277. Do we find the same birds about the buildings as out in the orchard, the meadow, the woodlot, the marsh; or are there some birds that spend most of their time in some of these places and less in others?

Problem 278. What birds build their nests on the ground? What ones in barns? What ones under the eaves of buildings?

Problem 279. What means are taken in your community to attract the birds? What is done to protect them from harm? What more can you do on your farm to attract these creatures that will make you good friends and companions as well as guards over your crops?

Problem 280. How many bird songs or notes can you recognize? Can you tell six wild birds by their songs or notes?

CHAPTER XL

MILK AND ITS PRODUCTS

EVERY household uses milk. Nearly every farm produces milk. Dairying is one of the most extensive industries in America.

What milk is. — We all know that milk is nature's food for the newly born of most of the larger animals. Frequently the young are fed little except milk for many months, and during these months make rapid growth.

The value of any product for food depends on the kinds and amount of nutriment, or nourishing food substances, it contains, and the form in which the nutriment exists — that is, whether it is easily digested and made use of in the body. Milk contains all of the food materials that are needed for the development of the body, and they are in a very easily digested form. There is water, which is necessary for all growth; ash or mineral matter, for the making of bones and for other uses; protein, for the production of flesh and muscle; fat and sugar, to supply heat and energy.

When we speak of the *composition* of milk, we mean the proportions, or relative amounts, of these several materials that are present. The composition is usually stated in percentages, as that is the best method of comparing proportions. The percentages are not exactly the same for the different breeds of cows or for individual cows in the same breed. That is one reason why some are better milk-producers than others. But if we average the composition for all of them, we shall find that milk contains, in round numbers, the following proportions of materials: —

4	per cent fat
2.6	per cent casein
.7	per cent albumen
5	per cent sugar
.7	per cent ash
87	per cent water
100	

The names of some of these substances may be new to us, but we shall learn what they are.

Fat. — If we were to examine milk under a very strong microscope, we should find that there are floating in it, that is, in the

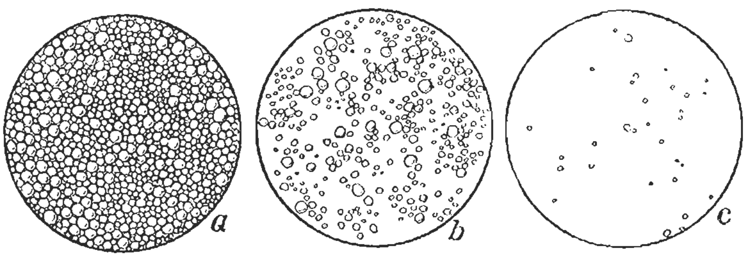


Fig. 166. — An enlarged view of cream, whole milk, and skimmed milk under the microscope, showing the relative number of particles of fat in each. *a*, represents cream; *b*, whole milk; *c*, skimmed milk.

fluid, or watery part of it, many small round bodies of different sizes. These floating bodies are minute particles, called globules, of fat. They are so small that there may be as many as 100,000,000 of them in a single drop of milk.

Although fat usually makes up only about 4 per cent of average milk, it is still the most valuable part. It is the substance from which butter is made. It is part of cheese also, and the value of cheese may depend on the amount of fat that it contains. Great quantities of milk are bought and sold for prices that are determined by the amount of fat present. In most states there are laws which specify that milk offered for sale must contain at least a certain amount of fat. Usually, 3 or 3.25 per cent is the lowest amount that is allowed. Milk from some cows may contain as much as 6 per cent, or even more.

Cream is largely composed of fat. When we skim or separate milk, we remove the fat in the cream. The cream contains also small amounts of all the other substances in milk, which are removed with fat. "Thin" cream contains a relatively large percentage of these other substances. "Heavy" or "thick" cream is rich in fat and contains much less of the other materials.

Casein. — This is the part which curdles when milk sours. It is suspended in the fluid part in very fine particles. It helps to make milk "heavier" than water. After fat has been taken from milk, the most valuable part remaining is casein. It is this substance which makes skimmed milk and buttermilk valuable for human or animal food. It contains nitrogen, and is therefore a protein food.

Albumen. — This part of milk is much the same material as the white of egg. Like the casein, it also contains nitrogen, and is therefore a valuable food-element. It is easily digested.

Sugar. — Milk contains more sugar than fat. This is not just like granulated sugar, but has many of the same characteristics.

The sugar can be separated from milk. It is used by druggists for covering "sugar-coated" pills. Because it is so easily digested, it is used also in the manufacture of infants' foods.

Ash. — Ash is the mineral part of milk, and is especially useful in the formation of bones. It is grayish white in color.

Skimmed milk is milk from which part or nearly all the fat has been removed, or skimmed. It is seldom possible to remove every bit of the fat. Skimmed milk therefore contains the same substances as whole milk, except that there is less fat. For this reason it still has much food value.

Buttermilk is the liquid part that remains after the churning of cream into butter. Its composition is nearly the same as that of skimmed milk except that it contains more fat. It is unlike skimmed milk, however, because cream is usually sour before it is churned. Souring changes the form of some of the casein and the sugar.

The weight of milk.—Milk is slightly heavier than water because of the substances it contains. Since it is largely water, the in-

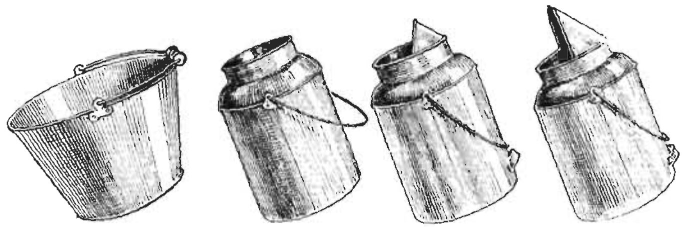


FIG. 167.—Different kinds of milking pails. The one at the left allows the most dirt and dust to enter while milking, and the one at the right, the least. A small topped covered pail is the best to use.

crease in weight is not very great. If we take enough milk so that the weight of the water in it alone is one pound, the weight of the whole milk will be about 1.032 pounds. That is, milk is about 1.032 times as heavy as water.

The care of milk. — There is no other food product that is so easily made unfit for use as milk. Farmers may lose much of the profit they should receive from their cows, because the milk is not produced under the best conditions and handled in the best way.

Milk is most likely to be spoiled by bacteria. We have learned that countless millions of very minute plants, called bacteria, inhabit the soil. Other kinds of bacteria live in milk. Some of those in milk are useful, some harmless, and others harmful.

When milk is kept in a warm place, and sours, it is not heat that has soured it, but bacteria, which produce acid and which are most active where it is warm. Cold milk does not sour quickly because the bacteria cannot work rapidly where it is cold.

Every bit of dust and dirt that falls into the milk is loaded with

Fig. 168.—Cooling the milk and exposing it to the air. When this is done in a clean place immediately after milking, the milk will keep sweet longer.

bacteria. Hairs and dirt may be brushed into the pail by the milker, either from his clothes or from the animal's body. Dust, chaff, and many other particles that float in the air in stables may fall into the pails while they are exposed. If the milk pails and cans and strainer cloths are not perfectly clean, they may carry bacteria to the milk. A few bacteria enter milk while it is still in the udder and before it has been drawn.

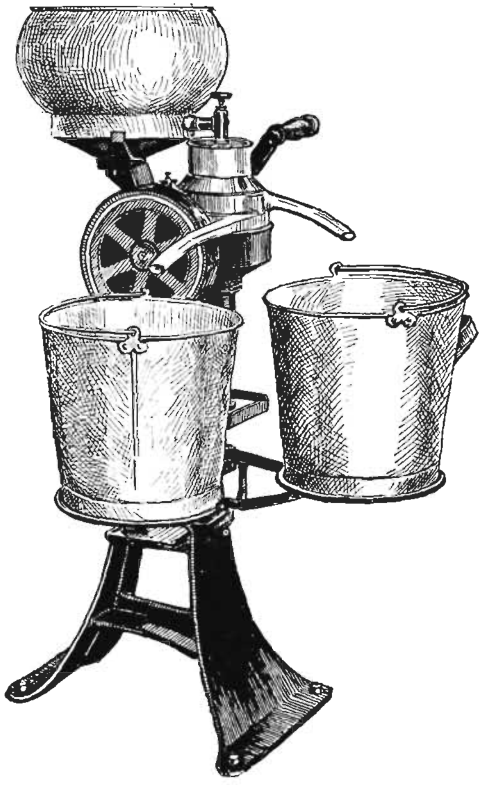


FIG. 169. — A hand separator for use on the farm to remove the cream from the milk.

In order to produce clean milk, in which there will be few bacteria, the cows must be cleaned before milking, the suits and hands of the milkers must be clean, and all pails and other utensils which the milk will touch must be perfectly clean. Bacteria may remain in cracks and seams and rusty places in cans, and cannot be killed by washing unless scalding water is used. It is better if the utensils can be exposed to steam after they have been washed. Handling hay or bedding or anything else that will stir up dust in the stable should not be allowed during or just before milking time.

As soon as possible after milk is drawn it should be taken from the stable. It should be strained at once so as to remove the dirt. It should then be cooled, by placing the can in a tank of cold water, or by other means. No matter how careful the milker has been, some bacteria will have found their way into the milk. By cooling the milk as soon as drawn to a temperature of 50° F. or lower, the bacteria will be prevented from multiplying rapidly. They cannot grow rapidly when the milk is cold. If the milk is allowed to remain warm, they will develop quickly and soon sour it or cause it to spoil otherwise.

Healthy cows, kept in clean, sunny, well-ventilated stables, will do their part in producing clean milk. Most bacteria and

FIG. 170. — Milk in bottles. This is the cleanest way to market milk and cream.

dirt fall into the milk while it is being handled, and the farmer himself is responsible for this.

The Babcock test. — Since the market value of milk depends very largely on the percentage of fat it contains, it is a great aid to farmers who produce milk to know how much fat there is in the milk from each of their cows. The milk from some cows contains much fat. That from others contains so little that their milk will not sell for as much as it costs the farmer to keep them. He loses money on every such cow in his herd.

Fortunately, there has been discovered a simple method of finding the percentage of fat in milk. It is called the Babcock test. We shall learn how it is made in Problem 285. It is now used by a great many farmers, and has been the means of saving them many millions of dollars. Dairy farmers who test their milk usually dispose of the cows that do not "pay for their board," and keep only the profitable ones.

Butter and cheese. — The two most important products made

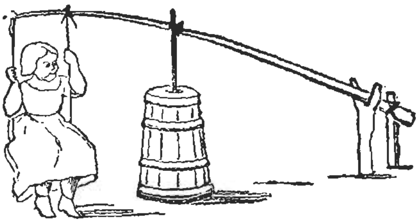


FIG. 171. — An ancient device, said to have been used for churning.

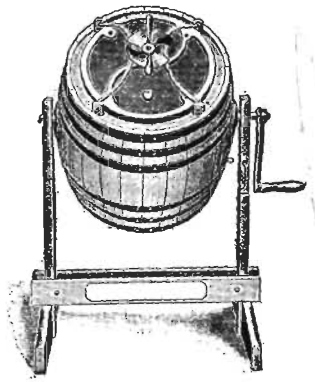


FIG. 172. — A convenient churn for use on the farm.

from milk are butter and cheese. They, like milk, are also used in nearly every household in the land. They are both nutritious foods. Formerly they were made altogether on the farms, but now are manufactured to a large extent in special factories called creameries and cheese factories.

In the making of butter, only cream is used, as butter is made from the fat of milk. Cheese may be made from cream, or the whole milk, or skimmed milk. Most of the cheese we buy at the stores is made from the whole milk.

Problem 281. How many farms in your locality produce milk for sale? Do they sell whole milk or cream? What becomes of the milk they sell? If cream is sold, what use is made of the skimmed milk?

Problem 282. If there is a creamery, cheese factory, or skimming station in your neighborhood, find out how much milk it handles every day, how many cows are required to produce the milk, how it is paid for; also, what is done with the product.

FIG. 173. — Babcock test outfit — centrifugal machine, test bottles, brush for cleaning test bottles, pipette, acid measure, sulphuric acid bottle, bottle to contain sample of milk to be tested, can of tablets to preserve the milk, scales for weighing the milk when drawn from the cow, daily record sheet for number of pounds of milk produced by each cow at each milking.

Problem 283. Write a short essay on how milk should be handled on .e farm.

Problem 284. In the evening, secure a quantity of milk and keep it ver night in a medium, but not cold, temperature. Early in the morn-ıg mix it thoroughly, and pour equal quantities into each of four pint ottles or glass fruit jars. (These jars should be thoroughly washed and scalded before the milk is poured into them.) Cover the jars or bottles with paper to prevent the entrance of dust. Then place one bottle in a dish or pail of ice-water, one in water at 55° or 60°, one at 70° to 75°, and the other at 90° to 100° Fahrenheit. It will be well to shake the bottles frequently when first put into the water, until the milk becomes the same temperature as the water. Keep the water in the dishes at the above temperatures throughout the day, and notice when the milk in each jar first tastes sour, and also when it curdles. In tasting the milk to see whether it is sour, use a teaspoon, and be sure that the spoon is held for a minute in boiling water before it is dipped into the milk. In which does the milk sour first? In which last? Why? What does this teach about the handling of milk?

Problem 285. The Babcock test to determine the richness of milk, or the percentage of fat that it contains: —

Utensils. — A hand-power centrifugal Babcock tester, at least two milk test bottles, one pipette to measure the milk, one acid measure, about one pint of sulphuric acid with specific gravity between 1.82 and 1.83, a few ounces of milk, and some hot water. All the necessary apparatus and acid can be purchased for about five dollars from any dairy supply company. They can be ordered through a hardware dealer. Sulphuric acid is sold also at drug stores. Perhaps the equipment can be borrowed from a dairy farmer in the locality. If there is a creamery or skimming station near by, the class may go there to perform the test.

Sampling the milk. — The milk to be tested should be thoroughly mixed just before the sample is taken, to make sure that the fat or cream is evenly distributed. This can best be done by gently pouring back and forth between two vessels several times. The milk should be between 60° and 70° F.

Place the small end of the pipette at the center of the milk and suc the milk up above the 17.6 cc. mark on the tube. Quickly place the ind finger (be sure to have finger dry) over the upper end of the pipette, a by releasing the pressure allow the milk to run out until its upper surfa is even with the 17.6 cc. mark when the pipette is held straight up a down.

... the point of the pipette a short distance into the neck of the t bottle, holding it against the glass and with both pipette and bottle at an angle. Remove the finger to allow the milk to flow into the bottle. Be sure to get every drop of the milk, taking care to drain the pipette and to blow the last drop into the bottle. A little practice should make any one skillful with the pipette.

It is best always to make this test in duplicate; hence, two bottles are needed for each lot of milk.

Using the acid. — The acid is very strong and must be handled with great care. If any gets on the hands, face, or clothing, it should be washed off quickly with plenty of water. If any acid falls on the clothing, it should be washed off immediately with a little dilute ammonia. *Do not leave the acid where young children can get it.*

After all the samples of milk to be tested have been measured, the acid should be added. Fill the acid measure to the 17.5 cc. mark with acid that is between 60° and 70° F. Pour this into the bottle with the milk, holding the bottle in a slanting position. Revolve the bottle slowly as the acid is poured in so as to wash down any milk that may have remained on the neck of the bottle. The acid will follow the glass surface to the bottom of the bottle and form a layer under the milk.

Hold the bottle by the neck and give it a circular motion for a few minutes, mixing the milk and acid until no milk or clear acid is visible. By this time the contents will be dark colored and hot. This change is due to the acid dissolving all the solid materials of the milk except the fat, which it does not affect.

Whirling the bottles. — The bottles are whirled to separate the fat so that it can be measured. It is lighter than the remainder of the milk and will be forced to the surface. The bottles should be hot when whirled. If necessary they may be heated by standing in hot water before being put into the machine. A steam machine is easily kept hot when in use. Other kinds should have a small amount of boiling hot water placed in them.

Place the bottles in the machine so that each one will have another directly opposite, to keep the machine in balance. Whirl the bottles five minutes at the proper speed for the machine in use, directions for which come with the machine. Then stop it and, with the pipette or other convenient means, add hot water to each bottle until the contents come up to the bottom of the neck. Then whirl two minutes. Add hot water enough to bring the column of fat within the graduations on the neck of the bottles. Whirl one minute. The fat should then form a clear column in the neck of the bottle.

Reading the percentage. — Keep the fat warm so that it will be in a fluid condition. Hold the bottle by the upper end of the neck, allowing it to hang in a perpendicular, or upright position, on the level with the eye. Read the mark or graduations at the extreme top and bottom of the fat column. The difference between these is the percentage of fat in the milk. Most test bottles are made to read as high as 10 per cent. Each percentage has its number marked on the glass and there are five small spaces, each representing .2 per cent, between these principal marks. Thus, if the top of the fat column is even with the third short mark above the 7 mark, the top reading would be 7.6; and if the bottom is halfway between the first and second short marks above the 3 mark, the bottom reading would be 3.3; the difference is 4.3, which is the percentage of fat, or the number of pounds of fat in 100 pounds of the milk tested.

Notes. — Specific gravity means the weight of the acid compared with the weight of an equal volume, or amount, of water. The sulphuric acid should be about 1.82 times as heavy as water.

1 cc. means 1 cubic centimeter, or about 20 drops.

If the fat column is clouded with white specks, probably the acid was not strong enough, or not enough was used, or the temperature was not high enough.

If the fat column is clouded with dark specks, probably the acid was too strong, or too much was used, or the heat was too great.

Always keep the acid bottle closed when not in use, or the acid will lose strength. Remember that it is a poison and that it will burn wood or clothes that it touches.

Problem 286. If cows are kept on your farm, keep a record of how much milk each cow gives at each milking. Once a month test the milk of each cow, and put the percentage of fat beside the cow's name on the monthly record sheet. Then calculate how much fat each cow gave during the month. At the end of the year, calculate how much each cow gave during the year. Find how much more the best cow gave than the poorest. Did it cost much more to feed the best cow than to feed the poorest? Which one is earning the most money for your father? See if your father can help you to find out whether the poor cow paid for her board. Are there any cows in the herd that your father should get rid of?

CHAPTER XLI

THE IMPROVEMENT OF ANIMALS

FROM our study of farm animals we have learned that they have undergone great changes since the time when man first captured them from the wild. Some have been transformed so much that they now bear little resemblance to their ancient ancestors. The changes, or improvements, have been of such a nature as to make them more useful to man.

The breeding of animals. — All animals grow old and die, or are slaughtered for food. Other animals are born and take their places. Not only is a new animal born to take the place of one that dies, but every pair of animals is able to produce more than two others. As a result, the total number of animals in the world increases.

But it is not enough that new animals and more of them shall appear. These new animals must be desirable and useful. They must possess qualities or characteristics or habits that will make them valuable or serviceable. In order to be sure that his new animals will have the qualities or characteristics that he wants them to have, the stockman chooses the parents. This choice of parents to secure offspring with particular characteristics is the first step in "breeding."

Objects of breeding. — The farmer who breeds cattle may have one of three objects in mind. He may wish to maintain, or keep, the type of his animals just as they are, without any special change; or he may desire to produce a new type or breed that will be wholly different from the parents; or he may desire to increase the "performance" of his animals. A stockman who has small red cows may desire to produce others like them; or he may wish to produce from the animals large red cows. In the former case, he desires to maintain, or continue, his type; in the latter, he desires to produce a new type. Some stockmen are endeavoring just now to produce a new type or race of animals, called cattaloes, by choosing one parent from common farm beef animals and the

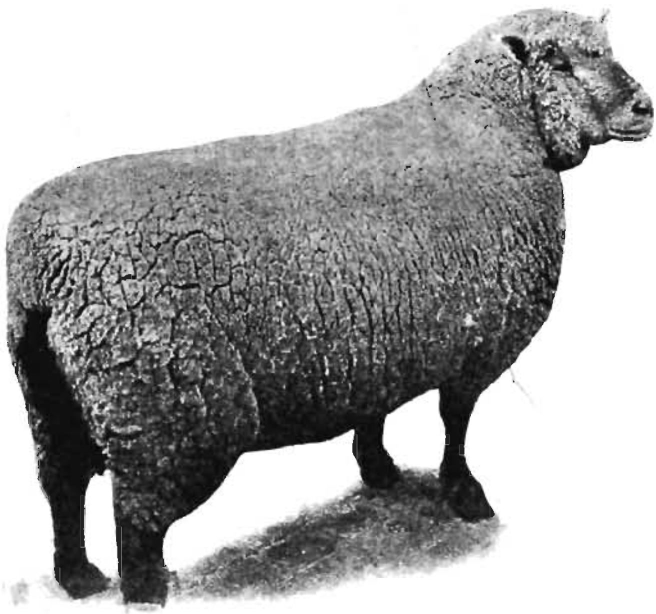


FIG. 174. — Southdown ewe. Developed as a medium wool-mutton type.

other from the buffalo tribe. By better "performance" is meant a greater result, as more milk, richer milk, more bacon, more eggs, whiter eggs, finer wool, greater speed. It is very important that the dairyman breed animals to produce more milk.

What to breed for. — A carpenter does not begin to build a house until he or the architect has drawn plans and knows just what the mpleted house should look like in all of its parts. In the same ay, the stockman should have in mind just what form or type of nimal he wants to secure, before he begins to breed. The carpen- er has in mind an ideal house that he wishes to build; the stockman must have in mind an ideal animal that he wishes to develop. This is the first step in the improvement of animals, and it is the most important because everything else in breeding will be shaped by the object, or ideal, it is desired to secure.

The choice of parents. — After the carpenter has planned his house and has his ideal in mind, he chooses such materials as will give him the appearance in the house that he wants. He does not use anything and everything that comes to hand.

Such a choice of materials, or rather of parents, is equally im- portant for the stock-breeder. If he is to secure new animals that will be like the ideal he has in mind, he must choose parents that are most likely to produce that ideal. In other words, he should look over his herd and choose for parents the animals that already are nearest to his ideal.

If a farmer's herd is comprised of small red cattle with long horns, and he desires to develop a new herd of large red cattle with short horns, he will choose for parents the animals that combine largest size with the shortest horns. He may not be able to take the largest of his cows, because she may have exceptionally long horns. And he may not be able to take the one with the shortest horns, for she may be a very small animal. He will have to choose the ones that, on the average, seem to have the best combination of siz with shorter horns. He will breed from such animals unless the have other characteristics that are undesirable.

The offspring. — The stockman cannot expect that the fir offspring will measure up to his ideal. But it will be a step towa it. Perhaps the first offspring will be larger than the parents, b have the same length of horns; or perhaps it will be of the same s as the parents, but have shorter horns; or perhaps it will co bine the two and be slightly larger, with horns that are a t shorter. Well and good; some progress has been made toward the ideal.

The second step is to use this offspring for one of the parents of a new generation, and to choose to mate with it an animal of the other sex that most nearly represents the ideal. The offspring of this pair is likely to show still further progress toward the ideal. This

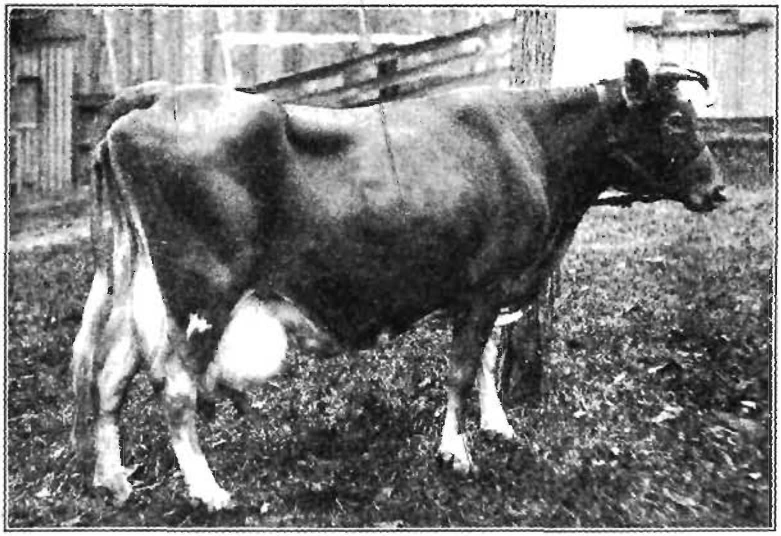


Fig. 175. — Guernsey cow. This animal has descended from parents that were bred, or developed, for dairy type.

mating of the offspring, if it is a desirable animal in other respects, with an animal of the opposite sex that most nearly represents the desired type, will be continued until the breeder secures what he wanted so far as it is possible to do so.

The stockman who sets out to improve his animals or to create a new type or breed must have patience. His results will come slowly, a little at a time. But so long as he holds to his ideal, and always chooses the parents that most closely resemble that ideal, he will make progress, unless he is trying to accomplish something that is impossible. Patience and perseverance are essential qualities in the successful stock-breeder.

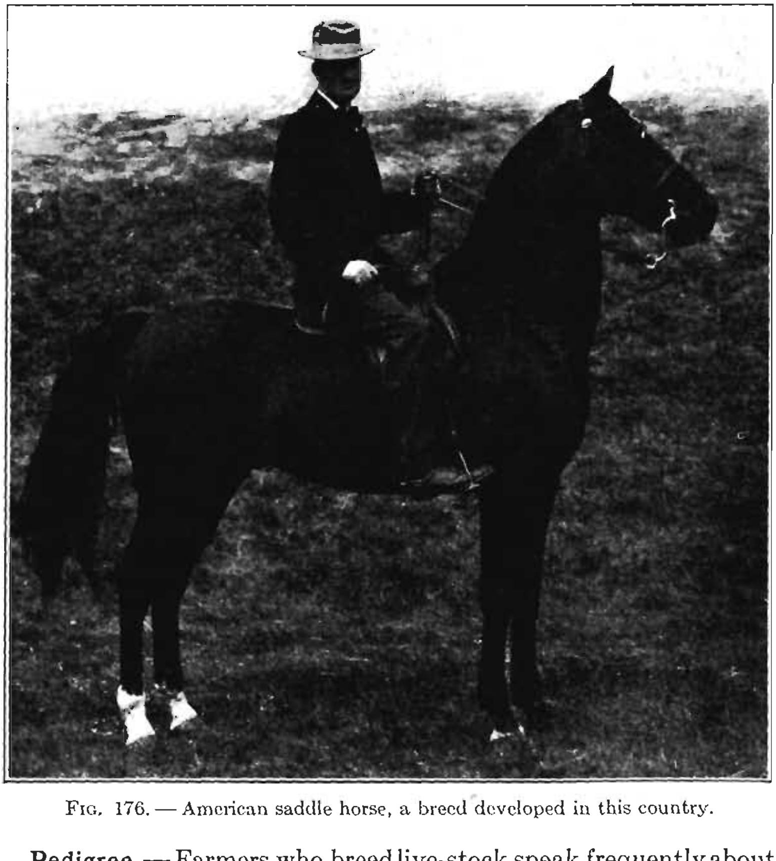


FIG. 176. — American saddle horse, a breed developed in this country.

Pedigree. — Farmers who breed live-stock speak frequently about the *pedigrees* of their animals. They do not care to use an animal for breeding unless it has a good pedigree. Let us see what they mean.

Animals, like human beings, have parents, and grandparents, and great-grandparents, and others in succession reaching away back to the beginning. Most of the characteristics of an animal now living are what it has inherited from its ancestors. If the ancestors of a dairy cow have all been of medium size, black and white, and have been heavy producers of milk, we can expect with much certainty that the present cow will show the same characteristics

FIG. 177.—Morgan. A light driving horse that the United States government is now breeding.

and that her offspring will show them. If the ancestors have not been chosen with any care, and some have been large, others small; if there has been no attention paid to the color; and if there have been both good and poor milk-producers in the list, we cannot tell what to expect from the present animal. We do not know what to expect of her offspring. In the former case, we say the cow has a good pedigree, in the latter, a poor or doubtful pedigree.

We may define a pedigree, then, as the connected record or list of all the ancestors of an animal. If the achievements or qualities of the ancestors have been almost uniformly good, the animal is said to have a good pedigree; if they have been mixed or poor, the pedigree is poor.

The longer any line, or family, of animals is bred to a certain standard or ideal, the more uniform will the offspring represent that

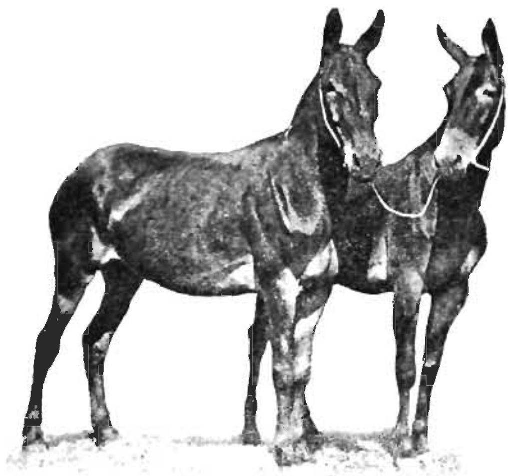


FIG. 178. — Mules are the product of animal breeding. They are hybrids, or crosses, between the horse and the ass.

ideal. For this reason, the farmer who wishes to improve his stock desires to use animals for parents that have had good pedigrees, so that their good qualities are "fixed," or established. He then has confidence that he will secure certain results. And he can do his work intelligently, as he knows what to expect from his animals.

Improving the farm live-stock. — How is the farmer to improve his live-stock if he has only poor or medium animals whose ancestry is largely unknown or whose pedigree is poor? It is not necessary for him to sell all that he has and buy good animals. He can begin with what is on hand.

Improvement in the farm herd or flocks will be brought about by breeding from the best animals only and gradually disposing of all the others. The sire of the herd is such an important part that the farmer will improve his animals much faster if he buys a male that has a good pedigree. The second generation should then be better than the first, the third better than the second, and so on. Many excellent herds have been built up in this way.

Problem 287. Are most of the farm animals in your neighborhood common stock or "grades," or are they pure-bred? What do we mean by pure-bred stock?

Problem 288. What kinds of cows, grades or pure-breds, have the farmers who are producing the most milk? If any of them have pure-bred stock, do they sell the calves? Do they receive more for the calves than the man who sells grade stock?

Problem 289. Are pure-bred stock more or less expensive to keep than common grade stock?

Problem 290. If there are cattle on your father's farm or a neighboring farm, find out whether the poorest cows in the herd are as expensive to keep as the best cows. Would it pay to dispose of the poor cows and improve the herd so that all will be nearly as good as the best cows?

Problem 291. Borrow a written pedigree of one of the best animals in the neighborhood. Ask the owner to explain it to you. Find out particularly why it is a good pedigree. Then bring it to school and explain it to the class.

APPENDIX

A SCHOOL library containing, among others, books, bulletins, and reports on agriculture and country-life subjects for the use of teacher and pupils, is indispensable to the highest success in this work. The references given below will be of special assistance in the teaching of the present text. The list is not intended to be exhaustive.

Rather than to print an extensive list of bulletins, it has seemed wise to suggest that the teacher ask to be entered on the mailing-list for the *Monthly List of Publications*, from the Division of Publications, U. S. Department of Agriculture, Washington, D.C. From this list the teacher can choose the recent bulletins that will most aid in the work, and secure them on application. The Yearbooks of the U. S. Department of Agriculture, secured through members of Congress, should be in the school library; so, also, should the bulletins and reports from the agricultural experiment station of the state in which the school is located.

BOOKS:

Elementary Agriculture, with Practical Arithmetic, Hatch and Haselwood, Row, Peterson & Co., Chicago.

First Principles of Agriculture, Goff & Mayne, American Book Co., New York.

An Introduction to Agriculture, A. A. Upham, D. Appleton & Co., New York.

The First Book of Farming, C. L. Goodrich, Doubleday, Page & Co., New York.

Agriculture for Beginners, Burkett, Stevens & Hill, Ginn & Co., Boston.

One Hundred Lessons in Agriculture, A. W. Nolan, The Author, Morgantown, W. Va.

One Hundred Lessons About Plants, D. W. Dennis, Ben Franklin Printing Co., Marion, Ind.

Among Country Schools, O. J. Kern, Ginn & Co., Boston.

Elements of Agriculture, G. F. Warren, The Macmillan Co., New York.

PAMPHLETS:

Elements of Agriculture for Public Schools, W. T. Carrington, Columbia, Mo.

One Hundred Experiments in Elementary Agriculture, Riley O. Johnson, The Author, Chico, Cal.

Twelve Studies in Agriculture, Eugene Davenport; Twelve Studies in Farm Animals, Eugene Davenport; Twelve Studies in Animal Husbandry, H. W. Mumford; Twelve Studies in Farm Crops, A. D. Shamel; Eleven Studies in Horticulture, J. C. Blair; five separate pamphlets, C. M. Parker, publisher, Taylorville, Ill.

GOVERNMENT PUBLICATIONS:

Exercises in Elementary Agriculture, Bult. 186, Office of Experiment Stations, Washington, D.C.

Does it Pay the Farmer to Protect Birds? Reprint, 1907 Yearbook, U.S. Department of Agriculture.

Rural School Agriculture, Bult. No. 1, Minnesota Experiment Station, St. Anthony Park, Minn.

Practical Studies in Agriculture, Purdue University, Lafayette, Ind.

Laboratory Studies in Soils, Bult. 27, State Department of Public Instruction, Lansing, Mich.

Farmers' Bulletins, free on application to the Division of Publications, U. S. Department of Agriculture, Washington, D.C. Listed in the order in which they will be useful in supplementing the text:—

PART I:

385 Boys' and Girls' Agricultural Clubs.
185 Beautifying the Home Grounds.

PART II:

138 Irrigation in Field and Garden.
187 Drainage of Farm Lands.
192 Barnyard Manure.
278 Leguminous Crops for Green-Manuring.
245 Renovation of Worn-out Lands.
44 Commercial Fertilizers: Composition and Use.

PART III:

408 School Exercises in Plant Production.
157 The Propagation of Plants.
111 The Farmer's Interest in Good Seed.
199 Corn Growing.
409 School Lessons on Corn.

229 The Production of Good Seed Corn.
253 The Germination of Seed Corn.
313 Harvesting and Storing Corn.
339 Alfalfa.
89 Cowpeas.
35 Potato Culture.
154 The Home Fruit Garden.
87 Orchards, Cover-Crops, and Cultivation.
113 The Apple and How to grow it.
181 Pruning.
218 The School Garden.
255 The Home Vegetable Garden.
228 Forest Planting and Farm Management.
173 Primer of Forestry. Part I.
358 Primer of Forestry. Part II.
134 Tree Planting on Rural School Grounds.
28 Weeds: and How to Kill Them.
127 Important Insecticides: Directions for their Preparation and Use.
155 How Insects Affect Health in Rural Communities.
243 Fungicides and Their Use in Preventing Diseases of Fruits.
283. Spraying for Apple Diseases.

PART IV:

22 Feeding Farm Animals.
170 The Principles of Horse Feeding.
55 The Dairy Herd.
106 Breeds of Dairy Cattle.
205 Pig Management.
51 Standard Varieties of Chickens.
141 Poultry Raising on the Farm.
41 Fowls, Care and Feeding.
287 Poultry Management.
236 Incubation and Incubators.
64 Ducks and Geese.
200 Turkeys, Varieties and Management.
397 Bees.
54 Some Common Birds in their Relation to Agriculture.
42 Facts About Milk.
63 Care of Milk on the Farm.
348 Bacteria in Milk.
363 The Use of Milk as Food.

INDEX

BOOKS ON AGRICULTURE

On Selection of Land, etc.

Thomas F. Hunt's How to Choose a Farm	$1 75 net
E. W. Hilgard's Soils: Their Formation and Relations to Climate and Plant Growth	4 00 net
Isaac P. Roberts's The Farmstead	1 50 net

On Tillage, etc.

F. H. King's The Soil	1 50 net
Isaac P. Roberts's The Fertility of the Land	1 50 net
Elwood Mead's Irrigation Institutions	1 25 net
F. H. King's Irrigation and Drainage	1 50 net
William E. Smythe's The Conquest of Arid America	1 50 net
Edward B. Voorhees's Fertilizers	1 25 net
Edward B. Voorhees's Forage Crops	1 50 net
H. Snyder's Chemistry of Plant and Animal Life	1 25 net
H. Snyder's Soil and Fertilizers. Third edition	1 25 net
L. H. Bailey's Principles of Agriculture	1 25 net
W. C. Welborn's Elements of Agriculture, Southern and Western	75 net
J. F. Duggar's Agriculture for Southern Schools	75 net
G. F. Warren's Elements of Agriculture	1 10 net
T. L. Lyon and E. O. Fippin's *The Principles of Soil Management*	1 75 net
Hilgard & Osterhout's Agriculture for Schools on the Pacific Slope	1 00 net
J. A. Widtsoe's Dry Farming	1 50 net

On Garden-Making

L. H. Bailey's Manual of Gardening	2 00 net
L. H. Bailey's Vegetable-Gardening	1 50 net
L. H. Bailey's Horticulturist's Rule Book	75 net
L. H. Bailey's Forcing Book	1 25 net
A. French's How to Grow Vegetables	1 75 net

On Fruit-Growing, etc.

L. H. Bailey's Nursery Book	1 50 net
L. H. Bailey's Fruit-Growing	1 50 net
L. H. Bailey's The Pruning Book	1 50 net
F. W. Card's Bush Fruits	1 50 net
J. T. Bealby's Fruit Ranching in British Columbia	1 50 net

On the Care of Live Stock

D. E. Lyon's How to Keep Bees for Profit	1 50 net
Nelson S. Mayo's The Diseases of Animals	1 50 net
W. H. Jordan's The Feeding of Animals	1 50 net
I. P. Roberts's The Horse	1 25 net
George C. Watson's Farm Poultry	1 25 net
C. S. Valentine's How to Keep Hens for Profit	1 50 net
O. Kellner's The Scientific Feeding of Animals (trans.)	1 90 net
M. H. Reynolds's Veterinary Studies for Agricultural Students	1 75 net