FARM BULLETIN NO. 1

RICE CULTIVATION IN INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI

First published
August 1954
Revised Edition
November 1955
Reprinted
December 1956
Price As. 8

This is the first of a series of bulletins planned by the Indian Council of Agricultural Research to meet the paucity of literature in a simple, yet authoritative form and dealing with farming and animal husbandry subjects. Each of the Bulletins is so written as to give a general picture of farming practices in vogue in the country, and suggest improvements based on research results. The Bulletins, it is hoped, will be found useful by the farmer, the agricultural student and the Extension worker alike.

COVER PICTURE
Transplanting paddy

Editor : M. G. KAMATH

Farm Bulletin *No. 1*

RICE

CULTIVATION IN INDIA

BY

N. PARTHASARATHY, Ph.D. (Lond.), F.N.I.

Director, Central Rice Research Institute

Cuttack

CONTENTS

Page

RICE IN INDIA

Growing conditions—More than one crop—Wet and dry rices—Deep-water rices—Season—Soils—Rotations—Raising rice yields 3—10

RICE CULTIVATION

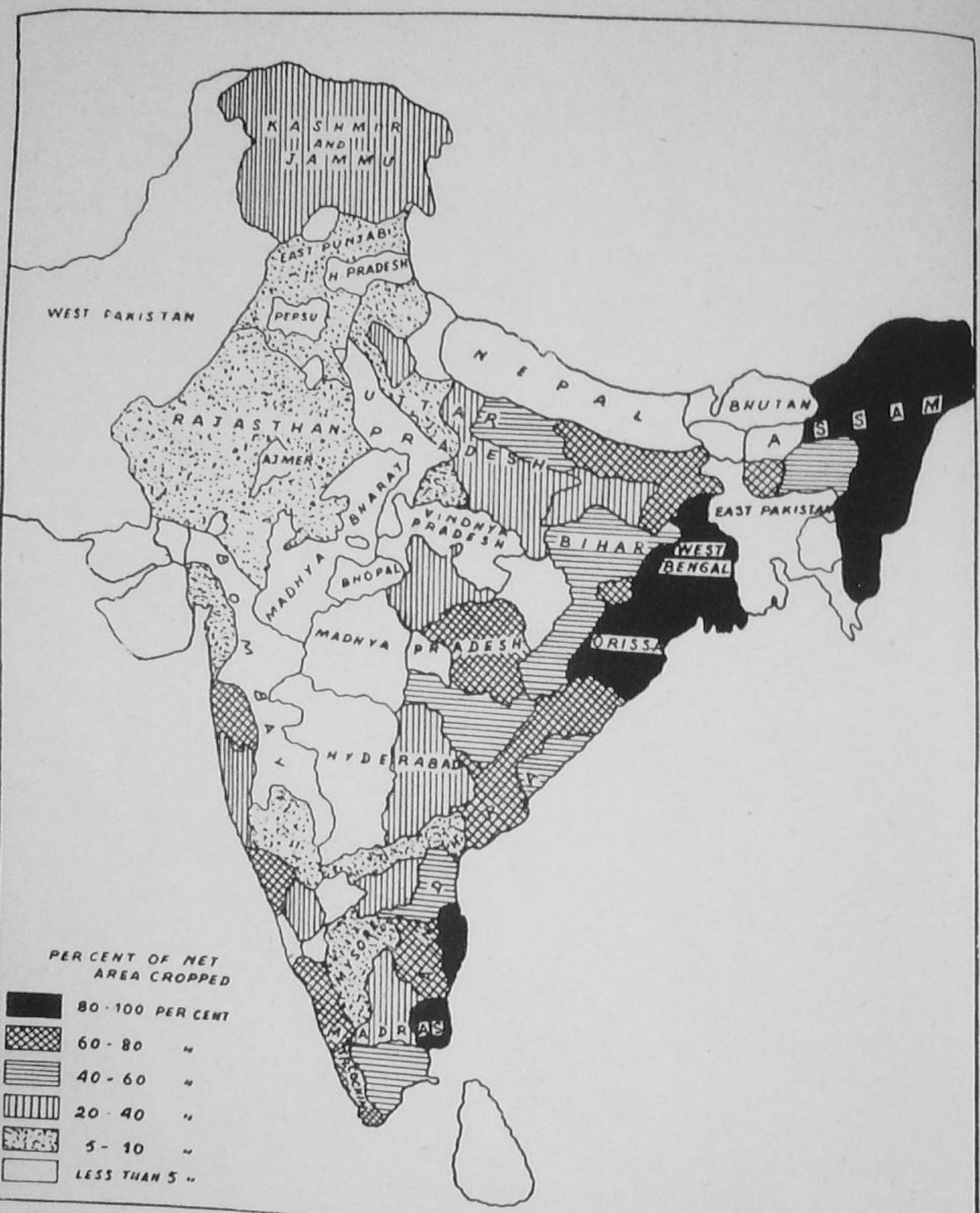
Care before sowing—Direct sowing—Transplanting—Preparation of seed-bed—Preparing the field—Care of seedlings—Planting the seedlings—Manuring—Applying fertilizers—After-care of crop—Lodging—Harvesting—Milling and processing of rice 11—25

DISEASES OF RICE 26—29

PESTS OF RICE 29—32

IMPROVED STRAINS 32—36

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI



MAP OF INDIA SHOWING AREA UNDER RICE IN VARIOUS STATES

RICE IN INDIA

RICE is the staple food of nearly three-fourths of the population in India. Its cultivation dates back to the unrecorded ancient periods earlier to 3000 B.C. The traditional use of rice in the Hindu religious ceremonials associated with birth, marriage and funeral indicates its intimate association with the life of our people.

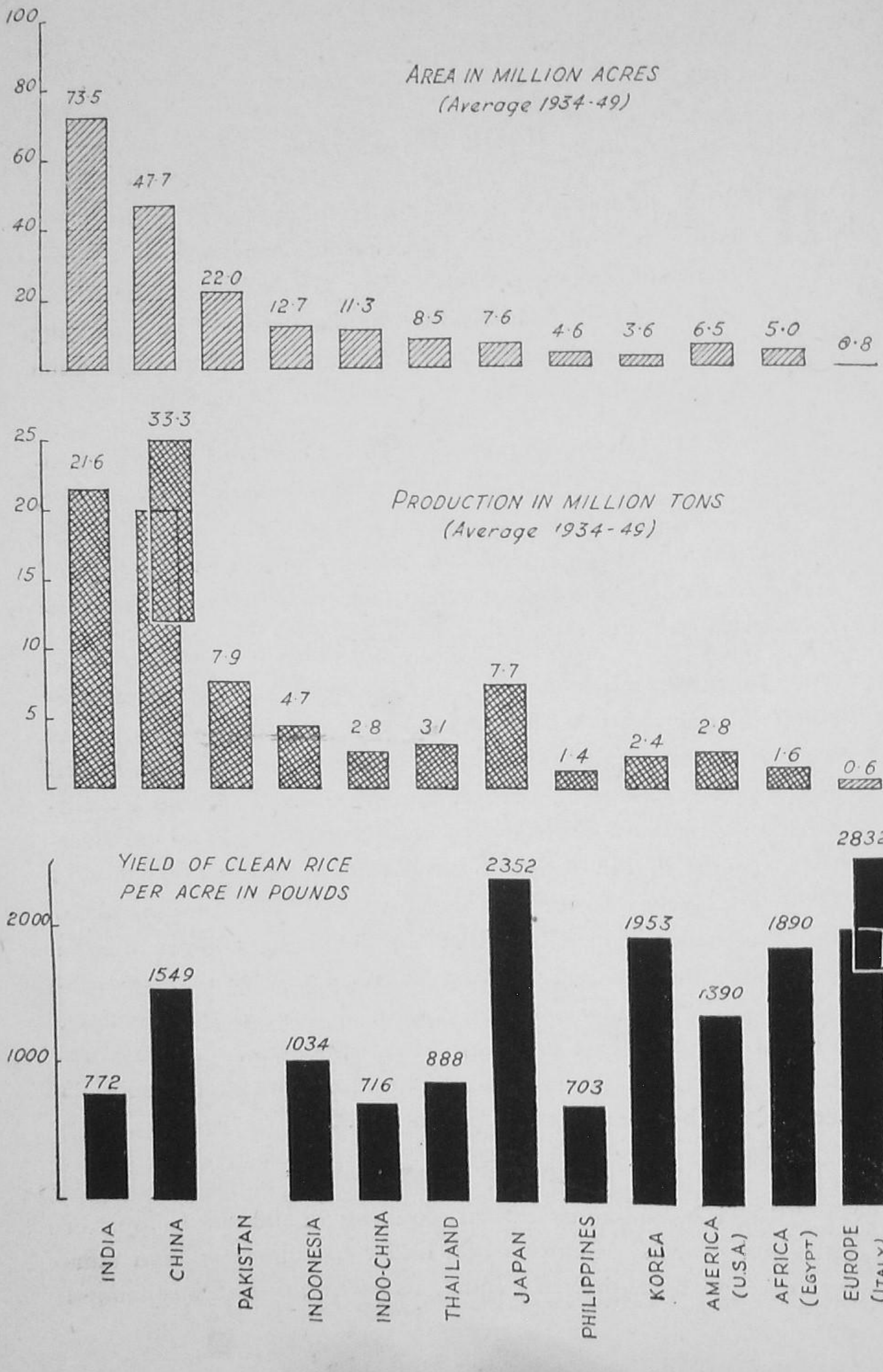
Rice is also the chief food crop for half the world's population. It occupies about 210 million acres, which on an average, annually produce about 107 million tons of clean rice. It is predominantly an Asian crop, 95 per cent of the rice being produced and consumed in South-East Asian countries, extending from the Indo-Pakistan subcontinent to Japan.

In India, rice occupies about 73 million acres, representing about 30 per cent of the annual cultivated area (the largest acreage under rice in any country in the world), with an annual production of about 22 million tons of rice. The crop is cultivated in almost all the states of India, extending from the river-delta regions of the South to the higher altitudes of 3,000 to 5,000 feet above sea level in the Kashmir valley in the North. But it is mostly concentrated in the Gangetic valley and the delta, and the low-lying coastal areas in southern and north-eastern India in the states of Assam, Bengal, Bihar, Bombay, Hyderabad, Madhya Pradesh, Madras, Orissa, Travancore-Cochin and Uttar Pradesh, which together contribute about 95 per cent of the country's rice production.

GROWING CONDITIONS

Rice is a semi-aquatic plant requiring an abundant supply of water for growth. It thrives best under conditions of high temperature and humidity. In India, its distribution mostly follows

RICE


AREA IN MILLION ACRES
(Average 1934-49)
100
80
60
40
20
73·5
47·7
22·0
12·7
11·3
8·5
7·6
4·6
3·6
6·5
5·0
0·8
PRODUCTION IN MILLION TONS
(Average 1934-49)
25
20
15
10
5
21·6
33·3
7·9
4·7
2·8
3·1
7·7
1·4
2·4
2·8
1·6
0·6
YIELD OF CLEAN RICE
PER ACRE IN POUNDS
2000
1000
772
1549
1034
716
888
2352
703
1953
1390
1890
2832
INDIA
CHINA
PAKISTAN
INDONESIA
INDO-CHINA
THAILAND
JAPAN
PHILIPPINES
KOREA
AMERICA (U.S.A.)
AFRICA (EGYPT)
EUROPE (ITALY)

the rainfall line. Where the annual rainfall exceeds 80 inches, rice is predominant as a rain-fed crop. In areas receiving a rainfall of 30 to 60 inches and where irrigation water is assured through reservoirs or other sources, rice is generally raised as a transplanted crop. While in areas receiving 25 to 30 inches, short-duration varieties are raised as an upland crop, at one extreme there are the deep-water rices of Assam and Bengal growing in 15 to 25 feet of water and at the other are the rices grown entirely rain-fed with 25 to 30 inches of rainfall. Owing to the great diversity in soil and climatic conditions, season and methods of cultivation, the number of rice varieties grown in India is very large, about 4,000.

MORE THAN ONE CROP

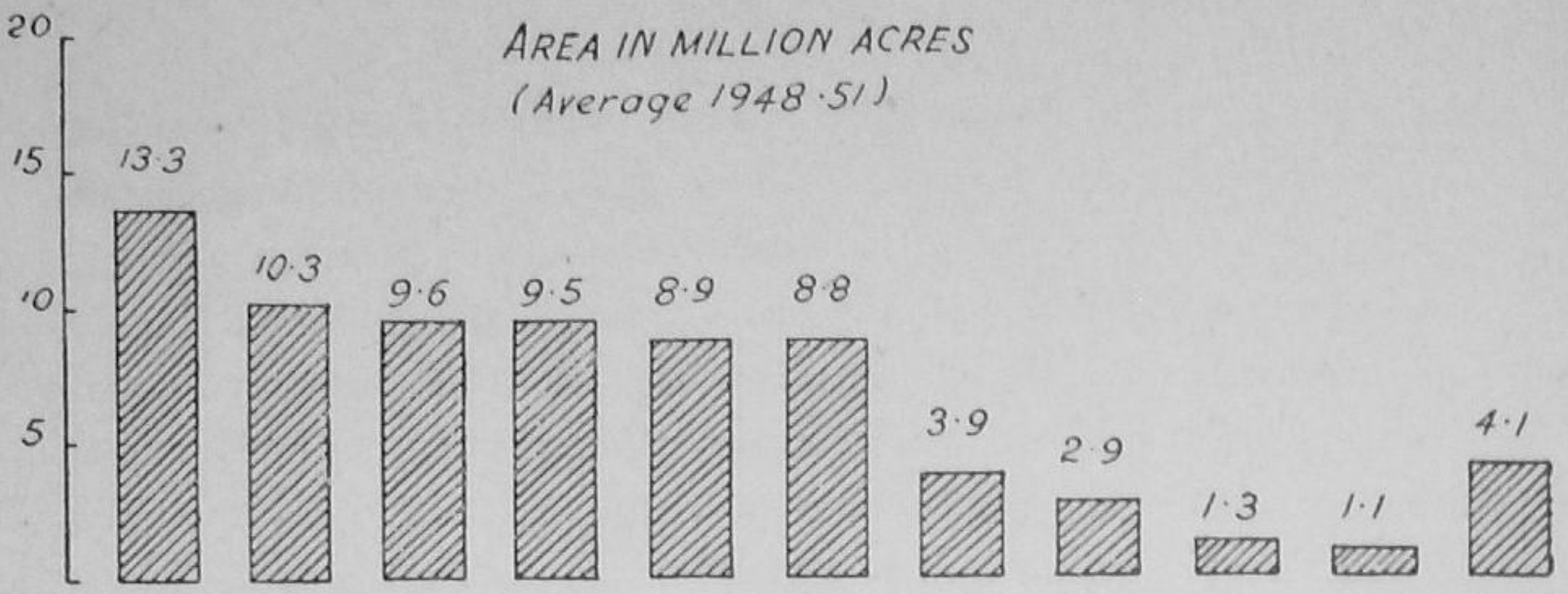
Generally, a short crop of rice is followed by a medium or long-duration one or vice versa depending on the season and availability of water. This practice is in vogue in the southern States of Andhra, Madras and Travancore-Cochin and can be extended to the eastern States of Bengal and Orissa where the winter temperatures are not low and facilities for supply of irrigation water exist. In the northern states of the Punjab, Uttar Pradesh and Bihar, where winter conditions prevail, the growing of crops like berseem, gram or peas is recommended.

WET AND DRY RICES

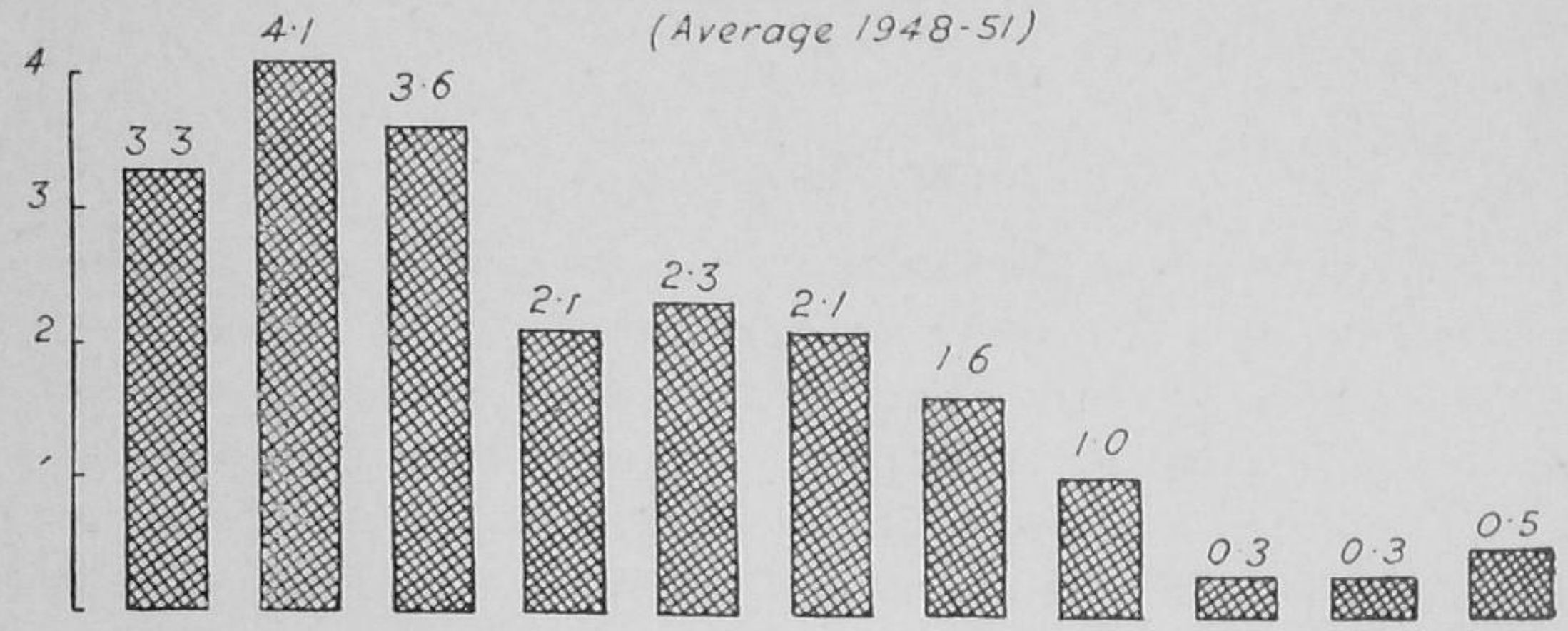
The rice crop is usually classified into two broad groups: the 'wet' or lowland and 'dry' or upland rice. There is also 'semi-wet' rice, which though sown as a dry crop, later gets enough water due to copious rains received during the growing period. The 'wet' rice occupies low areas where water is plentiful throughout the rice season, and varieties of a long duration of 140 to 170 days are grown The upland rice is usually rain-fed and varieties of a shorter duration of 90 to 120 days are grown. Lowland rice, due to a copious and more assured water supply, generally gives a better yield than upland rice.

RICE

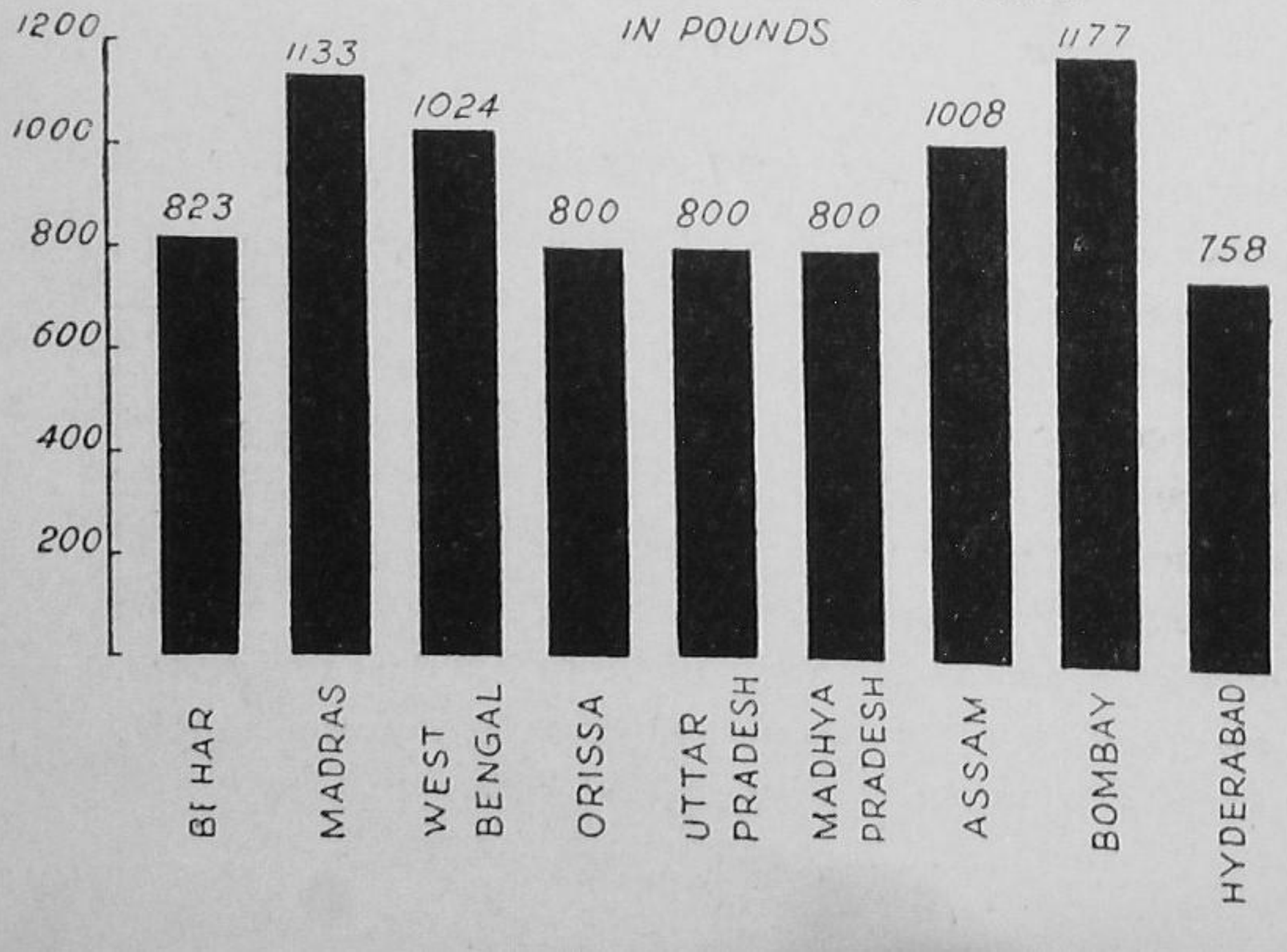
AREA IN MILLION ACRES
(Average 1948-51)



PRODUCTION OF RICE IN MILLION TONS
(Average 1948-51)



YIELD OF CLEAR RICE PER ACRE
IN POUNDS



DEEP-WATER RICES

There are also deep-water or 'floating' rices, which can withstand a water level of 6 to 15 feet and are grown over considerable areas in Assam and West Bengal, and to some extent in parts of Madras, Orissa, Uttar Pradesh and Bihar. Special varieties suitable for such conditions, are usually sown broadcast early in the season and the plant elongates with the rise of the water level.

SEASON

There are three main seasons for growing rice, and these are named according to the season of harvest of the crop. The most important is the winter or *aman* crop, sown in June-July and harvested in November-December. The autumn rice, locally called *aus*, *beali*, or *kar*, is grown in May-June and harvested in September-October. The summer [*boro* or *dalua* rice is grown in November-December and harvested in March-April. The bulk of the crop is grown as a winter crop, which is usually of a long duration. The autumn crop comprises mostly 'upland' rices, and varieties of 90 to 110 days' duration are used. The area under the summer crop is limited and mostly early-maturing varieties are grown during the season. The three crops do not necessarily occupy the same land, although double cropping is practised to a limited extent.

SOILS

Extensive areas under rice are situated in the deltas or are spread along the banks of rivers. The consideration of water supply appears to be the more important factor for deciding on the suitability of the area for growing rice than the nature of the soil. However, rice thrives well in heavy soils capable of holding water on the land. Clay and clayey loam soils with drainage facilities are best suited to getting higher yields. Provided sufficient water is available to maintain irrigation, satisfactory yields are also obtained in sandy soils if these are dressed heavily

with organic matter. Rice can be grown in soils widely ranging from slightly acidic to slightly alkaline, but higher yields are mostly obtained from soils which are slightly acidic.

ROTATIONS

In the majority of the wet land areas, particularly in low marshy fields, it is not possible to grow any other crop except paddy year after year, and the land is usually left fallow after paddy is harvested.

In the upland areas, after the harvest of paddy, a quick-growing pulse crop like gram, *mung*, *urid*, *khesari* or *kulthi* is grown in some localities. The practice of sowing quick-growing leguminous crops in sequence with rice definitely improves soil fertility, and needs to be extended.

In Madras, there is a practice of taking a catch crop of some pulse, i.e., black gram or green gram or horse gram. Usually, the catch crop is sown in the standing rice crop a fortnight before the harvest when the water is drained off. In Tanjore district, green gram or black gram is generally sown as a catch crop. A mixture of green gram and wild indigo is also sown after rice, the latter remaining in the field for use as a green manure for the succeeding crop.

In recent years, it has been found that a crop of early Punjab cotton (variety *216F*) can be grown after the harvest of rice. This practice can also be extended to Orissa. The picking of cotton is over by the end of May, after which there is enough time for the preparation of land for rice. The yield of *kapas* is 800 to 1,200 pounds per acre.

On the dry lands in Godavari district of Andhra State, rice is sown mixed with red gram in the first year, and in the second year, only red gram or horse gram is taken but not rice. In Bombay State, the rice fields remain generally fallow after the

harvest of the rice crop, except in some places where the soil is sufficiently retentive of moisture when *Dolichos lablab* or Bengal gram is grown.

In Bihar and Bengal, after the harvest of the paddy crop, legumes like *khesari*, Bengal gram and peas are grown in heavier soils. The seed of the catch crop is broadcast in the standing paddy crop in October.

In Bengal, and to some extent in Orissa, a crop of jute is raised in low-lying rice areas as a first crop in the month of April, which is followed by *aman*-planted rice crop in July-August.

In Orissa, a quick-growing legume like black gram, green gram or horse gram is grown as a catch crop.

In Uttar Pradesh, the early crop of paddy is invariably followed by *khesari* or peas. In the eastern districts, some-times red gram is sown as a mixture with paddy as a safeguard against the failure of rice in the event of drought. The late crop is usually transplanted and the lands left fallow after the harvest of the crop. The growing of berseem after the rice crop in Uttar Pradesh has resulted in improving the fertility of the soil, besides giving good economic returns.

Of late, the practice of growing a green manure crop between two rice crops and turning it into the soil has been extending in Madras State. In some parts of the State, groundnut can be successfully grown after the harvest of paddy and the inclusion of the groundnut crop in sequence with rice, besides giving a good return, benefits the succeeding rice crop.

In certain areas, especially in Orissa and Bihar, where the supply of irrigation water is assured, and in the neighbourhood of towns, potato or winter vegetables are grown after the harvest of the early-maturing rice varieties in the months of October-November.

RAISING RICE YIELDS

In spite of the large acreage under rice in this country, grain production falls below our requirements by 8 to 10 per cent. In order to be self-sufficient in our requirements of rice, it is essential that we raise the level of production. The present average yield of clean rice is only 772 pounds per acre, as against 2,350 pounds in Japan. The main cause of such a low yield is the lack of proper irrigation facilities and dependence of the crop to a great extent on the vagaries of the monsoon. Only about 25 per cent of the area under rice in India has some irrigation facilities, whereas 95 per cent of the area in Japan is under protective irrigation. Our irrigation projects, however, when completed, will bring a large additional area under assured irrigation.

Besides the lack of an assured supply of water, there are other factors responsible for low yields. These are:

(i) The use of seed which has no high-yielding properties

(ii) The low fertility of the soil due to poor manuring practices

(iii) Poor methods of cultivation

Every one of these factors is, however, remediable. Experimental results indicate that the yield can appreciably be improved by using good and healthy seeds of improved varieties, judicious application of manures and fertilizers, timely preparation of land and good after-care of the crop. The higher yields obtained on Government farms and the phenomenal yields of 6,000 to 8,000 pounds of rice achieved by enterprising cultivators in recent crop competitions by practising intensive methods of cultivation show the potentialities for increasing rice yields. Rice production can be increased if rice-growers take to improved methods of cultivation.

RICE CULTIVATION

AGRICULTURE Departments in the rice-growing states have evolved high-yielding varieties suitable for different conditions, and a large number of these improved varieties are being recommended to cultivators. Sowing good seed of improved and high-yielding varieties increases the yield by at least 10 to 15 per cent. Different varieties are available to suit different growing conditions. There are different varieties suitable for high, medium and low lands, and also for saline and flood areas. Varieties suitable for local conditions should, therefore, be selected in consultation with the Agriculture Departments.

CARE BEFORE SOWING

Having obtained the seed of a suitable variety, sufficient care should be taken to sow only healthy and well-filled seeds, as healthy seed will produce healthy seedlings, which in turn will give a better stand of the crop and a higher yield. The healthy and well-filled seeds should be sieved out and treated with the chemical 'Agrosan' at the rate of 1½ *chhataks* per maund of seed (one gram for one pound of seed) as a general precaution against seed-borne diseases.

DIRECT SOWING

Though it is well known that a transplanted crop gives a higher yield than a direct sown crop, nearly two-thirds of the rice crop of the country is sown broadcast. This is so because of the lack of supply of water early enough for the preparation of the puddle and also scanty labour in certain areas.

A high seed-rate of 100 to 120 pounds per acre is used generally for broadcast sowing as soon as the early monsoon showers are received. The land is, however, prepared earlier by repeated

ploughings. Generally, six to eight weeks after sowing, water is let in and the *desi* plough is worked lightly cross-wise in the standing crop and a light ladder is passed over it. Usually, women follow the plough to bury under any weeds left over and fill up the gaps with the uprooted paddy seedlings wherever necessary. This operation, known as *beaushenning* or *biasi*, serves the triple purpose of thinning, weeding and interculturing.

An improved modification on the cultural practice which results in better yields is recommended for adoption. Instead of broadcast sowing, the seed is dibbled behind the country plough with eight to ten seeds per hill spaced at a distance of about six inches (40 to 60 pounds of seed per acre). The distance from furrow to furrow may be 10 to 12 inches. Before dibbling rice, green manure seed (*dhaincha*) at the rate of 15 to 20 pounds per acre is sown. About eight weeks after sowing, water is let in or the rain water is impounded, and the *desi* or iron plough worked between the rows once or twice.

In this operation, the *dhaincha* crop, grown to a height of two to three feet, provides about 3,000 pounds of green matter which is incorporated. Besides, the soil is well aerated and the plants are, as it were, ridged. This to some extent prevents the crop from lodging. A topdressing of 100 pounds of ammonium sulphate with 75 pounds of bonemeal or superphosphate per acre is recommended at the time of this operation. The yield obtained from a 'dibble-sown' crop compares very favourably with that from a transplanted crop.

TRANSPLANTING

As a transplanted rice crop gives a higher yield than a broadcast crop, transplanting should be done wherever conditions for it are favourable. Cultivators generally use a high seed-rate in the nursery. This results in weak seedlings. The practice is wasteful and undesirable and should, therefore, be avoided. A seed-rate of 10 to 15 pounds per acre is recommended. This should be sown in

a seed-bed area of five to seven cents. Thin sowing encourages seedlings to grow sturdy and healthy, and this not only increases the yield, but also effects a considerable saving of seed.

PREPARATION OF SEED-BED

For preparing seed-beds of nurseries for the transplanted crop the following points are important:

(i) The nursery (seed-bed) area should be frequently ploughed after the harvest of the previous crop. At least six to eight ploughings should be given.

(ii) For the nursery, beds about four feet wide should be prepared, with the topsoil well-pulverized and with channels 1½ feet wide all round.

A Rice Nursery

(iii) The seed-bed should be manured with bulky organic manures like compost at the rate of six to eight tons per acre. In addition to organic manures, one to two pounds of ammonium sulphate for every cent of the seed-bed area should be applied. The manures should be well-mixed with the soil before the seed is sown.

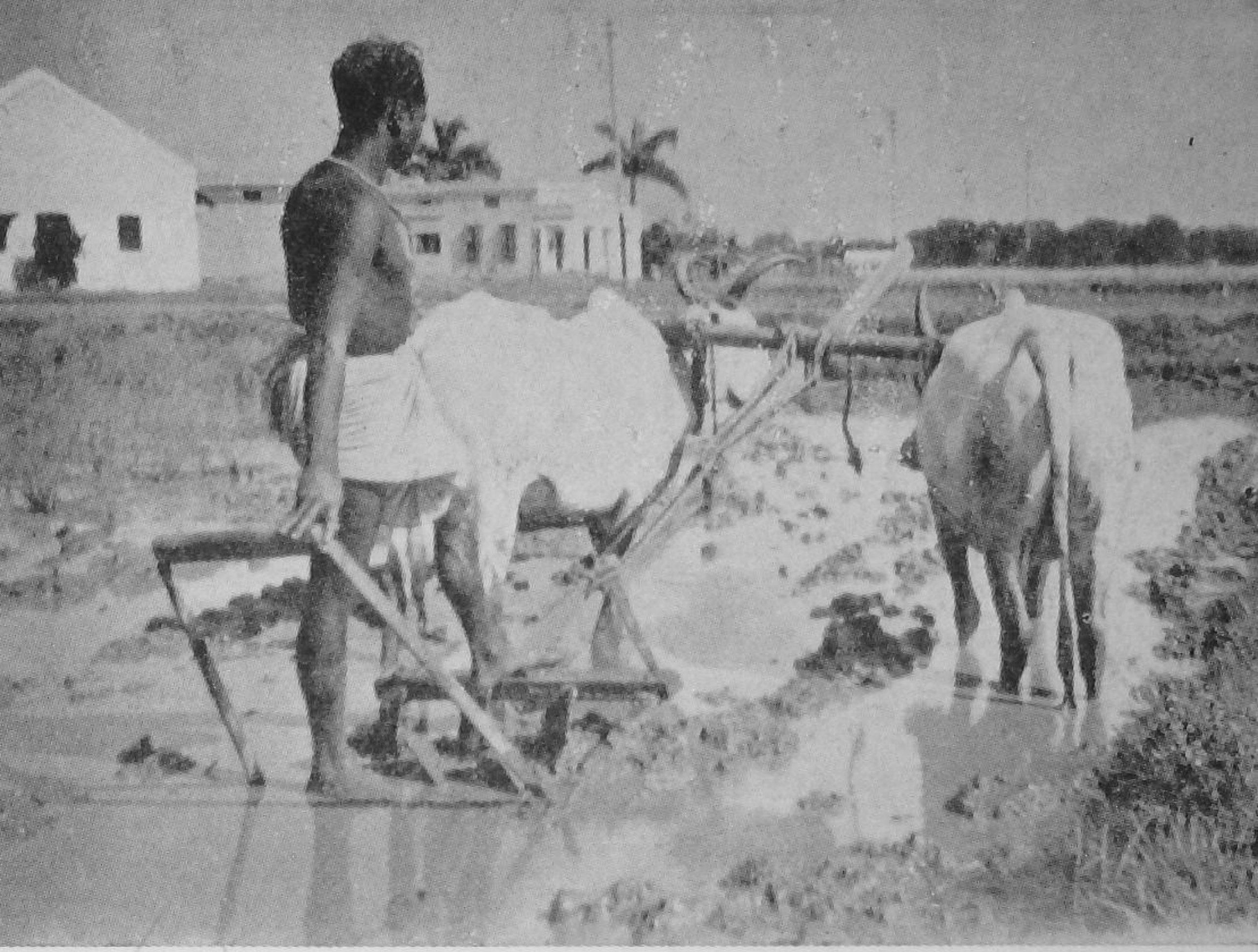
(iv) Seeds should be sown thin and covered with earth.

(v) The nursery should be irrigated whenever necessary and kept free of weeds.

In Madras and Andhra States, the preparation of wet nursery beds is the general practice. Green leaf at 8,000 pounds per acre is incorporated in the puddled seed-bed and the sprouted seeds are sown.

PREPARING THE FIELD

After the harvest of the previous crop, the land should be ploughed and reploughed during the summer months to bring it to the necessary tilth. This increases both the aeration of the soil and activities of soil micro-organisms. Wherever irrigation facilities are available, a green manure crop should be grown which should be turned into the soil before planting. Compost or farmyard manure should also be applied in advance at the rate of 15 to 20 cartloads per acre. After the commencement of the monsoon and while the seedlings are growing in the seed-bed, field embankments should be strengthened to impound water. The land should then be ploughed in standing water to get a good puddle. Puddling breaks up soil particles to a fine condition and makes the field suitable for transplanting the seedlings. The initial ploughing should be given with an iron plough and the subsequent ones with the *desi* plough. The 'wet land puddler' can be used instead of the *desi* plough for puddling, as this will economize the expenditure on the preparation of land and



A Wet Land Puddler in Operation

expedite the puddling operation. A ladder should then be passed over the field to level it.

CARE OF SEEDLINGS

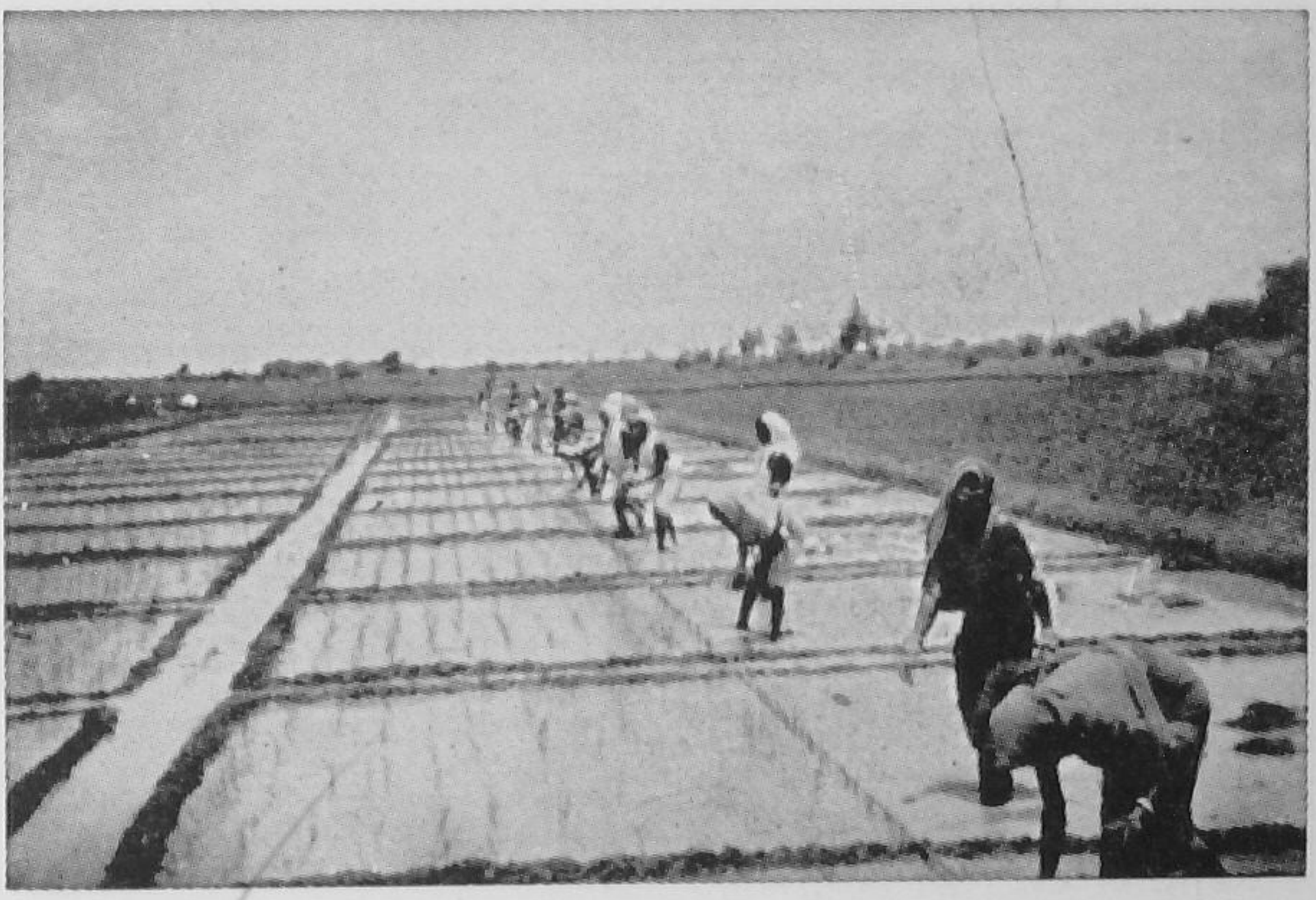
Transplanting is done in a well-puddled land with 30 to 40 days old seedlings in the case of varieties which mature in $4\frac{1}{2}$ to $5\frac{1}{2}$ months. In the case of early varieties which mature in three to four months, seedlings will have to be pulled out 20 to 25 days after sowing. A day or two before planting, the nursery bed is irrigated to soften the soil to facilitate easy uprooting of the seedlings. The seedlings are then pulled out carefully so as not to cause any injury to the roots, washed, tied into bundles, and carried to the fields and placed in rows in the fields at convenient intervals for transplanting.

Uprooting Rice Seedlings

PLANTING THE SEEDLINGS

In the field, a bunch of three to four seedlings per hole is planted. The spacing and number of seedlings planted depend on the variety, type of soil and the time of planting. For early varieties, a spacing of 4 inches × 4 inches with two seedlings per hole, and for late varieites, a spacing of 6 inches × 6 inches or 6 inches × 9 inches with two seedlings per hole, for fields of average fertility, are found to be the best. Where the soil is very fertile, a spacing of 12 inches × 6 inches with two to three seedlings per hole is recommended. Too close or too wide a spacing affects the yield adversely. In order to carry out the subsequent interculturing and weeding operations conveniently and quickly, it is desirable that transplanting is done in lines. This can easily be done by stretching a rope across the field and transplanting the seedlings equidistant from each other.

The time of planting has a profound effect on the yield of rice. Planting early in the season is conducive to a higher yield and should be done in July. To a large extent, the time of planting is determined by the outbreak of the monsoon. But as soon as water becomes available, planting should be carried out. Usually, planting is postponed because of delay in preparing the land. If the land is kept ready in advance, planting can be carried out in time. Any delay in planting beyond the first week of August, except in South India, affects the crop yield adversely. Therefore, for better yields the crop should be transplanted early in the season.



RICE SEEDLINGS BEING TRANSPLANTED IN LINES

MANURING

In importance, manuring comes next to water. An extensive use of manures and fertilizers can definitely bring about a large increase in rice production. Indian soils are generally deficient in organic matter and nitrogen. By applying organic and

inorganic fertilizers, not only the level of production can considerably be raised, but soil fertility can also be improved. The rice crop invariably responds well to nitrogen application in one form or another. In fact, it has been found that improved varieties give better response to the application of manures.

The application of farmyard manure or compost as a basal dressing before planting improves the texture of the soil. About 20 cartloads of farmyard manure or compost should be applied and mixed well with the soil.

Raising a green manure crop and burying it in the soil is the cheapest method of manuring paddy soils in areas where adequate water supply is available for raising a green manure crop. The common green manure crops are sannhemp and *dhaincha*. These should be sown broadcast at the rate of 30 to 40 pounds of seed per acre in the months of April-May on the receipt of showers. A six to eight-week old crop will supply 4,000 to 5,000 pounds of green matter, which should be ploughed into the soil about one week before planting. *Dhaincha* is particularly suitable for water-logged soils.

Sesbania speciosa could also be grown successfully in the place of *dhaincha* as it yields equally or even a greater quantity of green matter than *dhaincha* and also tolerates alkaline and water-logged conditions. Another good feature of this green manure crop is that it is not eaten by cattle like *dhaincha*. In Madras State, under the Tanjore deltaic conditions of rice cropping, the seedlings of *S. speciosa* could be planted along the fringe of the field bunds two inches apart while planting the first crop of rice in June-July ; this green manure crop would provide 3,000 to 4,000 pounds of green matter for the following second crop of rice planted in October.

APPLYING FERTILIZERS

Nitrogenous fertilizers. Among the chemical or artificial nitrogenous fertilizers, ammonium sulphate is found to be the

APPLYING AMMONIUM SULPHATE UNDER DRY SOIL CONDITIONS IN THE PLOUGH FURROW

SURFACE APPLICATION OF AMMONIUM SULPHATE

most effective for rice. A dose of 150 to 200 pounds of ammonium sulphate per acre has been found to give an increase of 400 to 500 pounds of paddy per acre.

Ammonium sulphate can profitably be applied in a dry soil condition two to three inches deep in the plough furrow a week before planting. In soils where such dry subsurface application is not possible, it can be applied as a topdressing one month after planting. Ammonium sulphate being soluble in water, the field should be drained before it is applied so that it may not be washed away by the water. The crop responds to such a treatment within a week's time, the leaves turning dark green and the tillering getting accelerated.

SUBSURFACE APPLICATION OF AMMONIUM SULPHATE IN THE FORM OF PELLETS

Phosphatic fertilizers. Rice also responds to the application of phosphatic manures in certain areas. An application of 150

pounds of superphosphate or bonemeal is recommended for the rice soils of Madhya Pradesh and Hyderabad, while for the other tracts 50 pounds of superphosphate or bonemeal is recommended.

It is a good practice to apply the superphosphate to the previous green manure crop.

A plan for manuring. A rational and general plan for manuring the paddy crop will be as follows :

(i) Apply 50 to 150 pounds of superphosphate to the soil in April-May.

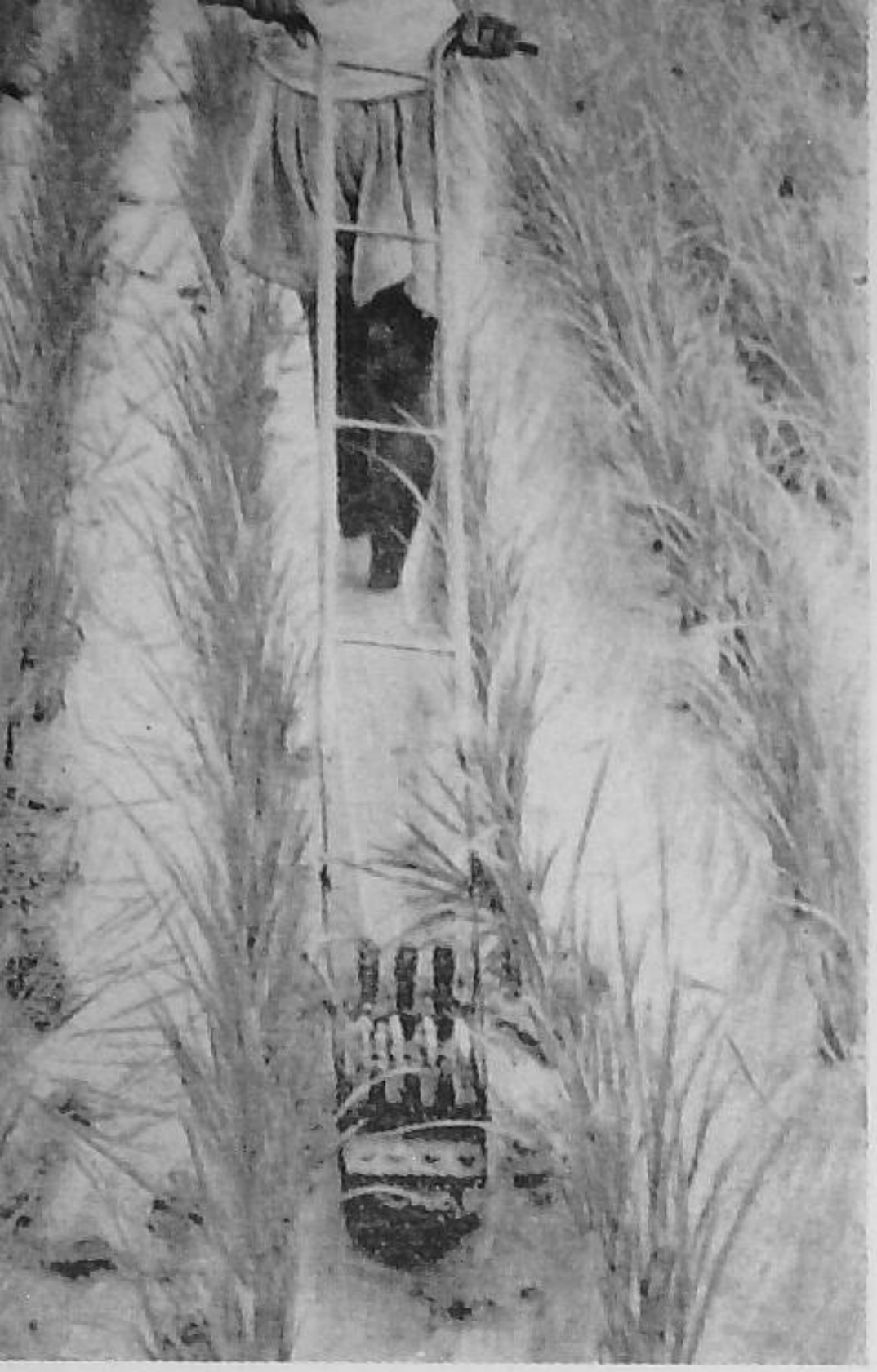
(ii) Grow a green manure crop in April-May and plough it in after six to eight weeks, i.e., one week before transplanting ; or apply about 20 cartloads of cattle manure or compost to the soil before planting.

(iii) Apply a topdressing of 100 to 150 pounds of ammonium sulphate one month after the planting of the crop.

AFTER-CARE OF CROP

Irrigation. After the crop has been transplanted, the field is kept under water. It should not be allowed to dry up and crack. Occasionally, the field is drained off and fresh water is let in till the seedlings get established. The water is then kept to a depth of two inches till the dough stage of the crop.

Weeding and interculturing. Weeding, an important operation for rice, is often ignored by cultivators. Usually, greater weed-infestation is seen in the broadcast crop than in the transplanted crop. Weeding can only be done by hand. Occasionally, in a broadcast crop, however, a tined harrow, locally called *bidha*, is passed through the field. In a transplanted crop, two to three weedings should be given and the soil near the roots of the plants also stirred. The first weeding should be given one month after planting, and immediately afterwards ammonium sulphate applied to the crop and the soil stirred up. Two or three subsequent



A Rice Rotary Weeder Being Worked in a Paddy Field

Another View of Inter-Culturing the Crop With the Rotary Weeder

weedings should be given at intervals of 20 days. If the crop is planted in lines, a rotary weeder of the Japanese model can be run between the lines, which besides removing the weeds also stirs up the soil. This also induces more tillering.

LODGING

Most of the rice varieties generally lodge when the crop is getting ripe for harvest. The loss due to lodging depends on the stage at which the crop lodges. The problem of lodging is important especially when improved methods of cultivation by manuring and the growing of high-yielding varieties are recommended for increased yields. With such practices the crop may lodge even before flowering. The loss in yield in such cases amounts to more than 50 per cent. The loss progressively becomes less if the lodging occurs after flowering.

The best way of solving this problem, which is now engaging the attention of rice breeders, is to breed non-lodging varieties. Till such varieties are available, it is recommended that six to eight plants may be tied together near the base of the ears.

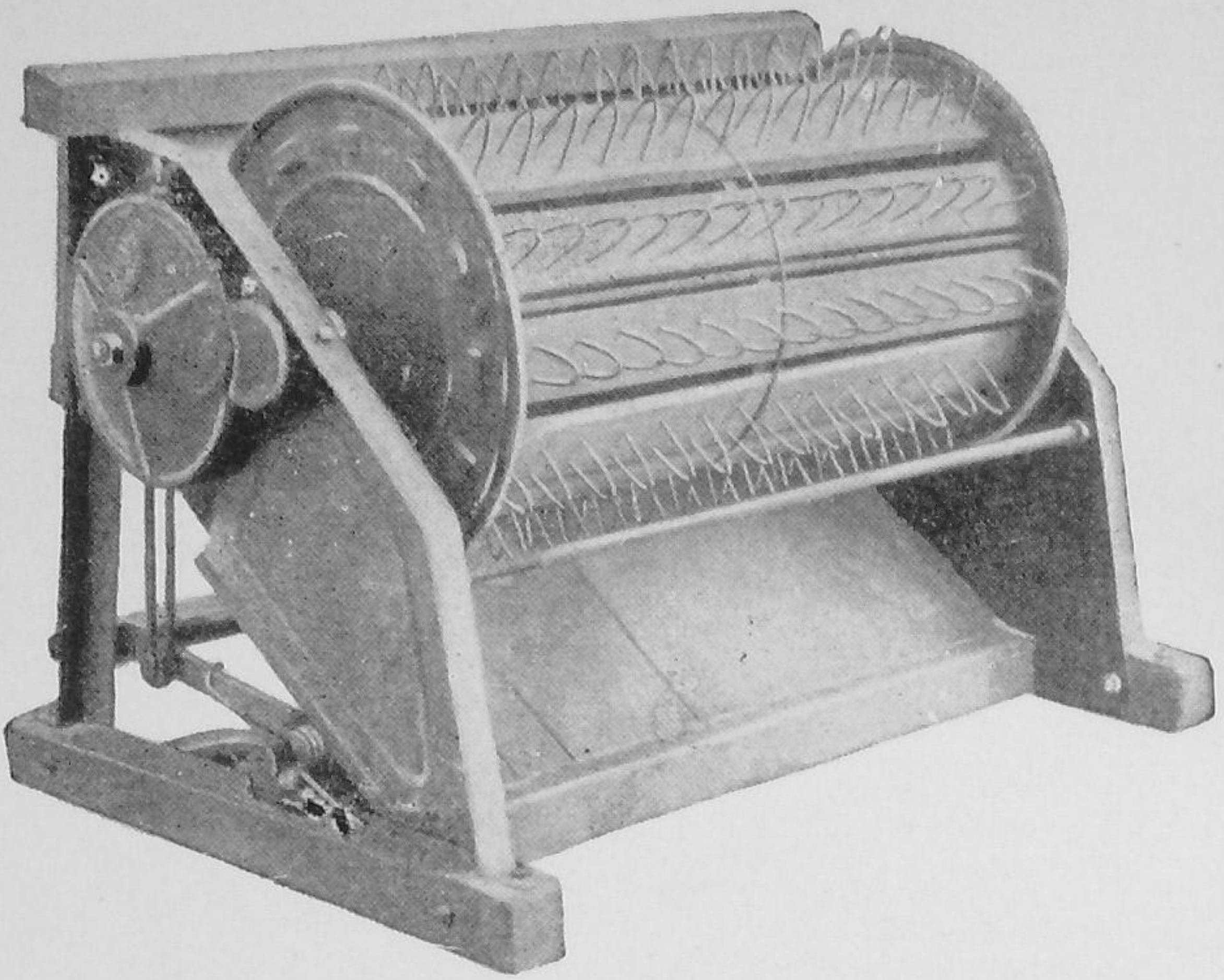
If there is rank growth during the early stages of the crop, topping the leaf six to nine inches about six weeks before the normal heading period is also beneficial. Planting the crop 1 foot to 1½ feet apart with four to six seedlings per hill, is also recommended. If the crop is planted in lines, ridging the crop six to seven weeks after planting prevents the crop from lodging to some extent.

HARVESTING

The right stage for harvesting paddy is just when the ear is nearly ripe and the straw is still slightly green. If harvesting is delayed till the crop is dead ripe, grain is lost due to shedding, and the milling quality of the grain is also impaired.

Rice is always harvested by human labour in India. The crop is cut and allowed to dry in the field for three to four days and then brought to the threshing yard, and threshed either by hand

A Rice Harvest in Progress



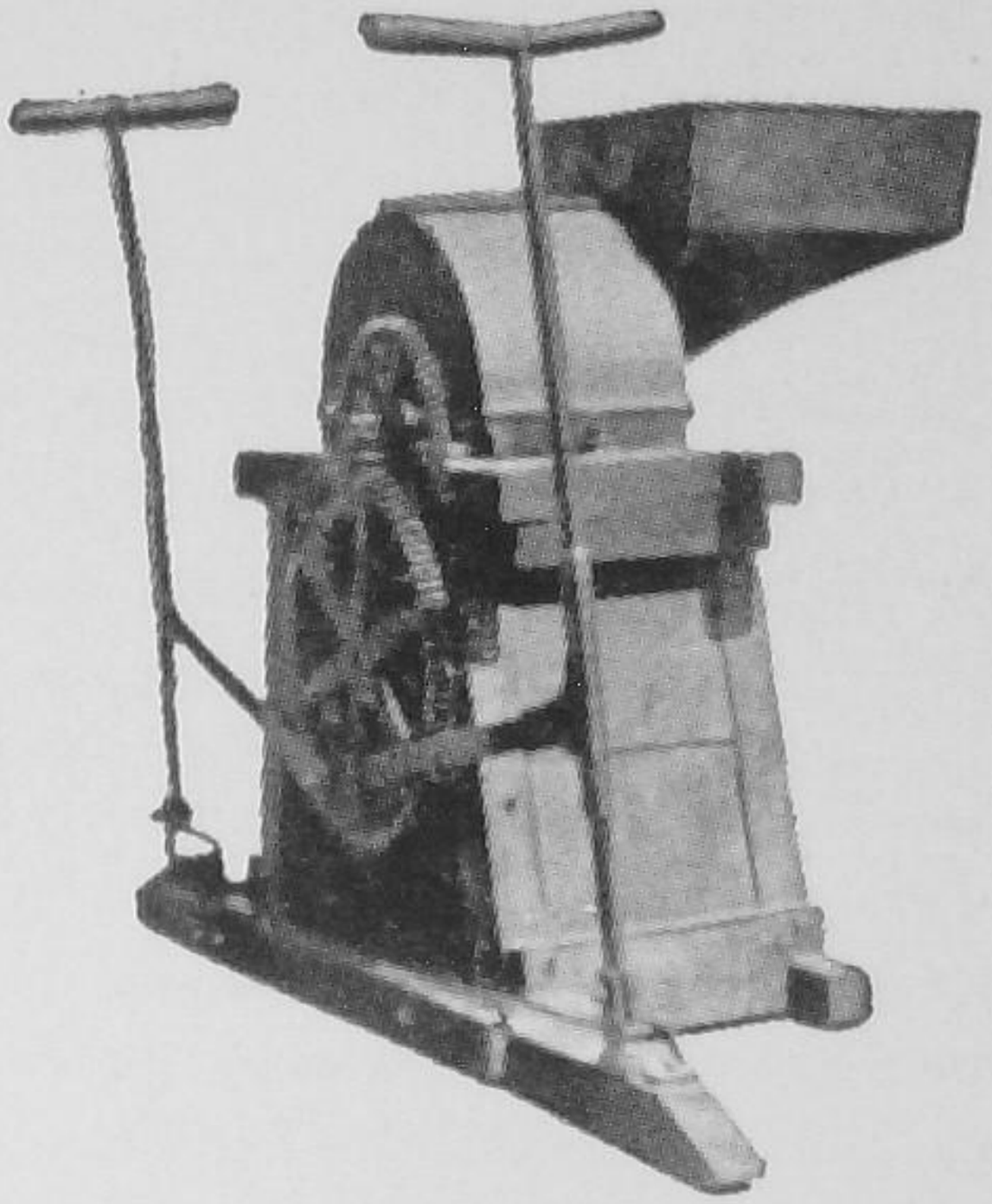
A Japanese-type Rice Thresher

or by treading the sheaves under the feet of cattle. The Japanese pedal-thresher has been found to be economical and time-saving, and is recommended to cultivators for threshing their rice crop.

MILLING AND PROCESSING OF RICE

A large percentage of rice produced in this country is hulled by the indigenous process in village houses and consumed as hand-pounded rice. The rest of the produce is used by rice mills which are well established in the country. The milled rice is mostly consumed by the urban population.

The outturn of clean rice is about 70 per cent in hand-pounding, while the recovery in power mills is three to four per cent less. Besides, hand-pounded rice is more nutritious than milled rice.



A Rice Huller

In the southern and eastern states, rice is generally parboiled while in the northern and western states mostly raw rice is consumed. Parboiling is an indigenous process where unhusked rice is soaked in water for 24 hours, boiled or steamed, and then milled after drying. Such parboiling prevents breakage of rice and parboiled rice is also more nutritious than milled raw rice.

Freshly harvested rice when milled is not immediately fit for consumption. Such a rice gives a pasty mass on cooking. Storage for at least four to six months is necessary to improve the cooking quality of rice. Parboiling of freshly harvested rice, on the other hand, gives as good quality of cooked rice as stored raw rice. However, in large-scale parboiling, due to insanitary conditions, the parboiled rice develops an odour and colour which are not to the taste of consumers. The production of parboiled rice is very important in view of the nutritional needs of the rice-eating population.

DISEASES OF RICE

A NUMBER of diseases attack the rice crop and reduce its yield. The following are some of the diseases and the measures to be taken to control them.

BLAST

Symptoms. The disease affects the leaves, leaf sheaths, nodes, inflorescence and grain. In the leaf, spindle-shaped spots with pale ashy grey centres are seen. When the attack on the leaves is severe, several spots appear on them causing the leaves to wither. Sometimes, black spots or a black ring covering the nodes are found on affected plants. This is especially prominent at the nodes below the panicle. Infection occurring at this node, which is commonly called ' neck infection ', results in chaffy and unfilled grains, and the breaking off of the ear takes place at this point.

Control. (i) Grow disease-resistant varieties like *T. 608*, *T. 141* (Orissa strains) ; *Co. 4*, *Co. 25*, *Co. 26*, *Adt. 25* (Madras strains) ; and *A. 67*, *A. 90*, *A. 200*, *A. 249* (Bombay strains).

(ii) Avoid excessive nitrogenous manuring.

(iii) Adjust planting dates (plant early by a week or ten days which helps in avoiding the disease in some localities).

(iv) Spray the crop three to four times with fungicides.

BROWN-EYE SPOT (*Helminthosporium*)

Symptoms. Like Blast, this disease also attacks the leaves, nodes, inflorescence and grain. The spots caused by this disease are, however, different. They are brown, irregularly circular with a dark centre, and have a smaller width.

Control. (i) Grow disease-resistant varieties like *Ch. 13, Ch. 45* (Chinese varieties), *T. 141, BAM-10* (Orissa strains) and *T. 498-2A* (Bihar strain).

(ii) Treat the seed with a suitable fungicide at one ounce of the fungicide for every 25 pounds of grain.

FOOT ROT

Symptoms. Seedlings affected by the disease grow tall, become pale and yellow and remain lanky. In the field, the affected plant will be much paler and taller than the rest of the plants.

Control. This disease is controlled by treating the seed with a suitable fungicide before sowing (dosage as in the case of the Brown-eye Spot disease).

TEM ROT

Symptoms. In this disease, the leaf tips begin to turn yellow. Black discoloured areas appear at the leaf sheaths, especially at the water level. As the disease develops and spreads inside, the leaves wither and the plants die, or they remain pale and stunted. If the attack starts in older plants, excessive side-tillers are produced. These side-tillers remain green for long. On splitting open the dying plants, small mustard-like bodies, with or without cotton growths of the disease-producing organisms, will be seen.

Control. (i) Uproot the diseased stubbles and burn them.

(ii) Grow only disease-resistant varieties like *DCA. 5, Bara 62, PB. 2, PB. 3, PB. 13* in fields where the disease regularly appears.

Besides these diseases, other diseases, but of minor importance, are sometimes found attacking rice. They are:

(i) The *Uffra* disease, caused by a worm (nematode)

(ii) Leaf Smut

(iii) Bunt

(iv) False Smut

(v) The *Udbatta* disease

These diseases, however, are not very serious.

Following are some trace names of new fungicides useful for seed treatment and spraying against paddy diseases.

Dust chemicals. (i) ' Agrosan G.N.'

(ii) ' Ceresan '

(iii) ' Cuprocide '

(iv) ' Harvesan '

(v) ' Tillex '

Spray chemicals (i) ' Coppesan '

(ii) ' Perenox '

(iii) ' Wetcol '

Rice-growers can also follow some general control measures which will reduce the incidence of diseases to a great extent. These are :

(i) Burning of the affected stubbles

(ii) Paying attention to proper irrigation and drainage

(iii) Avoiding excessive use of fertilizers

(iv) Using disease-resistant varieties

Seed-treatment. Treat seeds either in earthen or wooden containers. One ounce of fungicide should be thoroughly mixed with 25 pounds of seed (1/400th of seed weight). *Most of these fungicides are poisonous, and should be handled very carefully. Particular care should be taken to see that they are not inhaled while handling.*

Spraying. Necessary directions for spraying and the dose of the fungicide to be used are given by the suppliers of the

chemical. Bordeaux mixture, which is a very good fungicide (' Wetcol ' or ' Perenox ' in the above list), can be easily prepared. Dissolve five pounds of copper sulphate in water and keep overnight in a wooden or earthen container. Dissolve five pounds of quicklime in water separately and mix the two solutions. Add water to make up 50 gallons. The mixture is then ready for spraying. Dip a bright knife in the mixture ; if it turns brown, add more lime.

PESTS OF RICE

ABOUT 30 different species of insects are known to cause damage to the rice crop in the field in India. Some of them cause appreciable damage, while others are known as occasional pests. Insect pests and diseases together cause losses to an extent of 5 to 10 per cent of the entire crop. The more common insect pests and the methods to be employed in controlling them are given below.

STEM BORERS (*Schaenobius incertellus*)

Stem Borers are some of the most destructive pests of rice. Four types of borers cause damage to the crop, but the Yellow Stem Borer is the commonest among them. The pest bores into the stem and kills the rice plants. In the early stages of the crop, the attack results in the death of the central shoot, which is called the ' dead-heart '. When the crop is attacked at its flowering stage, ' white ' earheads with chaffy grain are formed. The pest can be controlled by

(i) spraying 0·2 per cent BHC or DDT when plants in the seed-bed are attacked and

(ii) dipping seedlings in 0·2 per cent BHC at the time of transplanting and by dusting the crop with five per

cent BHC at the time the insects come out, if the attack is noticed in the field.

SWARMING CATERPILLAR (*Spodoptera mauritia*)

The Swarming Caterpillar, also known as Armyworm, is one of the most destructive pests of rice. Usually, it is sporadic in its appearance. The caterpillars of the insect feed on the leaves of the rice plant by night and hide during the day, and generally escape the notice of the cultivators until considerable damage has been caused to the crop. The caterpillars are seen moving in swarms from one field to another and spreading the damage. Hence the name Armyworm.

In the early stages of the attack leaves are found eaten. In severely infested fields, the crop is destroyed by caterpillars to such an extent that the fields get an appearance of having been grazed by cattle. Sometimes the pest appears in the seed-bed, devastating the entire seed-bed.

These insects are very effectively controlled by spraying with 0·2 per cent DDT or BHC or by dusting with five per cent DDT or BHC.

GALL FLY (*Pachydiplosis oryzae*)

This is a small fly, like a mosquito, with long legs. The damage caused by this pest results in the central shoot turning into a long, hollow, white or bluish outgrowth commonly known as the 'silver shoot'. Consequently, the central shoot dies.

Dipping the seedlings in 0.2 per cent BHC at the time of transplanting and dusting the crop with five per cent BHC when the insects emerge, reduce the damage to some extent.

STINK OR *Ghandi* BUG (*Leptocorisa acuta*; *Leptocorisa varicornis*)

This is known as Stink Bug on account of the characteristic odour it gives out. The adults are greenish yellow with long

legs. Both the young ones and adults damage the crop. The young insects feed on the tender shoots of the crop and migrate from field to field as they develop wings. They appear on the crop when the plants have flowered and the grains are in the milky stage. They suck the milk from the grains and render them chaffy.

Stink Bugs are effectively controlled by dusting five per cent BHC on the crop.

RICE HISPA (*Hispa armigera*)

The Hispa is another important pest of the rice crop. It is a small, bluish-black beetle with numerous short spines all over the body. The adults attack young rice plants, eating the green matter of the leaves and causing characteristic parallel lines on them. The young ones burrow into the leaf tissue, feeding on the green matter and causing the withering of leaf tips.

The pest is effectively controlled by dusting five per cent BHC on the crop. The young Hispa can be controlled by cutting the tops of the plants and burning them.

PADDY GRASSHOPPERS (*Hieroglyphus banian*; *H. oryzivora*; *H. nigroreplates*)

There are three kinds of grasshoppers which cause damage to the crop. Both the adults and the young feed on the leaves of the top shoots. When the attack is very severe, the whole crop in the field may be eaten up or reduced to mere midribs and stalks.

Dusting the crop with five per cent BHC is very effective in controlling the pest.

RICE CASEWORM (*Nymphula depunctalis*)

The caterpillars of this moth damage paddy grown under swampy conditions. The caterpillars which are green in colour, cut the leaf blades into short lengths, and after constructing

tubular cases remain inside them. Hence the name Caseworm. These cases remain attached to the leaf blades.

Spraying with 0.2 per cent BHC effectively controls the pest.

RICE LEAF-HOPPER (*Nephotettix bipunctatus*)

This is a small, green insect, commonly called the Leaf-hopper, and causes serious damage to the rice crop. It sucks the sap from the tender shoots, as a result of which plants wither, presenting a blighted appearance. The adults are commonly attracted to light in large numbers.

Setting up of light traps controls the pest to some extent, but effective control can be had by dusting the crop with five per cent BHC.

RICE THRIPS (*Thrips oryzae*)

These are minute insects with fringed wings and are found in large numbers in a young rice crop. They suck the plant sap which causes rolling up and fading away of leaf tips. The insects are found inside the rolled up tips. The attack is often serious in seed-beds when the leaves wither.

Spraying with pyrethrum product ('Pyrocolloid') in the proportion of one ounce in two gallons of water keeps the insects completely under control.

N.B. 0.2 per cent BHC is prepared by mixing 0.6 ounce of 50 per cent wettable BHC in one gallon of water.

IMPROVED STRAINS

A LARGE number of improved strains of rice to suit varied soil and climatic conditions have been evolved by the State Departments of Agriculture. Some of the improved strains

recommended for growing to rice farmers in various states are given below. A fuller list of improved strains can be had from the Departments of Agriculture of the respective states.

ASSAM

Early	Medium	Late
Kmj. D. 136-6	*Kmj. As. 3*	*Kmj. S.C. 1177-6*
Kmj. M. 36-30	*Kmj. As. 46*	*Kmj. S. 22*
Kmj. As. 536-143 (Hybrid 1)		*Kmj. S.C. 94-97 (Hybrid 2)*
TTB. As. 86		*TTB. SL. 70*
		TTB. SL. 240
		TTB. SG. 308-51 *(Hybrid)*
		HBj. Boro I. Boro
		HBj. Boro II. Tupa

ANDHRA

Autumn	Winter 'sarva'	Spring 'dalua'
MTU. 3, MTU. 4,	*AKP. 3, AKP. 4, AKP. 11*	*SLO. 12*
MTU. 20, MTU. 17,	*BAM. 3* and *BAM. 6*	*SLO. 16*
AKP. 1	*SLO. 11* and *SLO. 13*	*MTU. 9*
	BCP. 2 and *BCP. 4*	*MTU. 15*
	MTU. 1 MTU. 5, MTU. 6	*MTU. 20*
	MTU. 7, MTU. 10, MTU. 19	
	GEB. 24, S.R. 26 B	

BENGAL

Early	Medium	Late
Dular (Hybrid)	*Bad Kalamkati 65*	*Bhasamanik*
Dhairal	*Nagra 41/14*	*Indrasal*
Bhutmuri 36	*Latisal*	*Jhinga Sail*

Early	Medium	Late
Ashkata		*Asra 108/1*
		Raghusal
		Kumargore
		Patnai 23
		Indrasal
		Jhinga Sail
		Asra 108-1

BIHAR

Early	Medium	Late
BR. 16	*BR. 1*	*BR. 5*
BR. 17	*BR. 2*	*BR. 6*
	BR. 3	*BR. 7*
	BR. 4	*BR. 8*
	13-S-16	*Aman 11 /S-10*

BOMBAY

Early	Medium	Late
Kolamba 184	*Zinia 31*	*Kolamba 42*
Patni-6	*Kolamba 540*	*Zinia-149*
Kado-68-1	*Krishnasal-1*	*Warangal-487*
	Panvel-61	*Ambemohar-157*
		Mugad-141

HYDERABAD

Early	Medium	Late
HR. 8	*HR. 5*	*HR. 35*
HR. 19	*HR. 12*	*HR. 38*
HR. 67	*HR. 33*	*HR. 39*
	MTU. 9	*RDR. 4*
		MTU. 19

MADHYA PRADESH

Early	Medium	Late
R. 2	*R. 4*	*Cross No. 19*
R. 3	*R. 5*	*R. 6, R. 7, R. 8, R. 15*
Cross No. 1.	*Cross No. 116*	
	R. 10, R. 11, R. 12	

MADRAS

(a) Tamil districts

'Kar' or first crop	Second crop, 'thaladi' or main 'pishanam'	'navari' or 'manavri' crop
ASD. 7, ASD. 1, Adt. 3, Adt. 9, Adt. 20	*ASD. 6, Co. 12 Co. 25, ASD. 5, Adt. 2, Adt. 11, Adt. 25* and *Co. 19*	*Co. 20, Co. 13 Adt. 12, MTU. 15 PTB. 2* and
TKM. 6	*TKM. 1*	*TKM. 6*

(b) West Coast

'Kar' or first crop	Second crop	Third crop
PTB. 10, PTB. 2, PTB. 7, MGL. 1	*PTB. 18, PTB. 20, PTB. 4* and *PTB. 16*	*PTB. 10*

ORISSA

Early	Medium	Late
N. 136	*T. 608*	*T. 90*
B. 76	*T. 635*	*T. 1242*
Benibhog	*T. 1145*	*BAM 9*
J 1	*T. 56*	
	T. 141	
	BAM 3	

PUNJAB

Early varieties

for the plains	for the hills
349 Jhona	*100 Ram Javain*
370 Basmati	*72 Phulpattas*
246 Palman Suffaid	*41 Lal Nakando*

TRAVANCORE-COCHIN

Early	Medium	Late
MO. 1	*C. 1*	*UR. 19*
MO. 2	*SIAM 3*	*Adt. 67*
PTB. 10, ASD. 1		

UTTAR PRADESH

Early	Medium	Late
Ch. 10	*T. 3*	*T. 9*
T. 136	*T. 21*	*T. 17*

Early	Medium	Late
T. 43		*T. 23*
N. 22		*T. 36*

VARIETIES SUITABLE FOR SPECIAL CONDITIONS

Flood-resistant varieties

Assam	*Kmj. Ar. 108-1* *Kmj. Ar. G. 353-148* *Kmj. Ar. G. 614-25B*
Bihar	*BR. 14* *BR. 15*
Orissa	*FR. 43-B* *FR. 13-A*
Madras	*MTU. 16* *PTB. 15*
Uttar Pradesh	*Dudhalchi* *Jaisuria*

Salt-resistant varieties

Orissa	*SR. 26-B*

Summer paddies

Assam	*TTB. AS. 35* *TTB. AS. 48* *TTB. AS. 86*
Orissa	*DI. 4* *DI. 3*
Madras	*SLO. 16* *MTU. 9* *MTU. 15* *Co.* 13 *PTB. 10*

Some early-maturing Chinese varieties

Ch. 2	(Maturing in about 85 days)
Ch. 45	(,, ,, ,, 105 days)
Ch. 62	(,, ,, ,, 110 days)
Ch. 63	(,, ,, ,, 110 days)

OTHER FARM BULLETINS IN THE SERIES

ALREADY PUBLISHED

GROUNDNUT CULTIVATION IN INDIA	As. 4
ONION AND GARLIC CULTIVATION IN INDIA	As. 4
GOAT-KEEPING FOR PROFIT	As. 4
COTTON CULTIVATION IN INDIA	As. 4
THE MANGO IN INDIA	As. 4
MANURES AND MANURING	As. 4
POTATO CULTIVATION IN INDIA	As. 4
CASHEWNUT CULTIVATION IN INDIA	As. 4
TOBACCO CULTIVATION IN INDIA	As. 4
THE CHIKU IN INDIA	As. 4
GRAPE CULTURE IN INDIA	As. 4
BEE-KEEPING FOR BEGINNERS	As. 4
ARECANUT CULTIVATION IN INDIA	As. 4
ORANGES, LEMONS AND LIMES IN INDIA	As. 4

Many more under preparation

If you like to be kept informed of these publications as and when they are out, please write to:

The Business Manager

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI

National Printing Works, Delhi (India).