CULTURAL TRIALS AND PRACTICES OF RICE IN INDIA

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PREFACE

The Wheat and Rice Workers’ Conference held under the auspices of the Indian Council of Agricultural Research at Coimbatore observed that a large number of results for extension were available with different states as a result of trials carried out on different aspects of cultivation of rice, such as varietal, agronomical, cultural, manurial, irrigational, etc. This conference recommended that a bulletin of results obtained in different states should be prepared, to serve as a handbook for extension service. Consequently, the Government of India, at the instance of the Indian Council of Agricultural Research appointed a Special Officer for compiling the available material on cultural trials and practices in rice as obtained in India. This officer, visited important rice research stations in all the states except Assam, held discussions with the officers in charge of the stations on the various aspects of the cultural problems of the tract and obtained requisite material, which supplied the basic data for the preparation of this monograph.

The material has also been collected from the published reports of the experimental stations as also from the unpublished records obtained from the officers in charge of the different farms.

I must state that I am indebted to Dr. N. Parthasarathy, Director, Central Rice Research Institute, for his valuable criticisms and suggestions in the course of the preparation of this monograph. My thanks are due to Dr. M. V. Vachhani, Agronomist and Mr. T. P. Abraham, Statistician, Central Rice Research Institute who were kind enough to go through the manuscript and made useful suggestions and also to Shri N. A. Parasuram, Research Assistant, Central Rice Research Institute who has helped me in preparing the tables, appendices, etc., contained in this Bulletin. I must also express my thanks to the officers in charge of the research stations who were kind enough to give me whatever experimental data published or unpublished and information that was available with them. I would like to mention here that I have freely borrowed materials from the popular book on “Rice” by K. Ramiah and the published and unpublished reports and memoirs of the experimental stations. It is Shri K. Ramiah, the F.A.O. Consultant and the then Director, Central Rice Research Institute, who suggested the very idea of publishing a book of this type and I am grateful to him for the opportunity given to me to execute this idea. Last but not the least, I am highly grateful to the Indian Council of Agricultural Research for the kind encouragement and help given to me at every stage.

Since the monograph was compiled long before the States Re-organization Commission’s recommendation came into force on November 1, 1956, for purposes of our study, former boundaries of the states have been allowed to stand.

M. Subbiah Pillai.
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PART I
CHAPTER I

INTRODUCTION

ALMOST all the rice growing States had in the first instance concentrated attention on the breeding aspect of paddy i.e. evolving high yielding paddy strains by means of pure-line selection and hybridization. This was followed by manurial investigations on rice. In the programmes of rice research stations, attention on cultural problems was focused at a much later stage after it had been realised that the cultural treatments the crop received during the various growth phases had an important bearing in influencing the internal basic physico-chemical characters which constitute the vital activities of the plant, leading up to the manifestation of the yield attributes as tillering, ear-head size, etc., and which mainly determine the ultimate yield of a crop. It is an established fact that improved strains, by virtue of their high yielding inherent capacity and judicious application of fertilizers do give better and bigger crops. But, the degree of response due to the improved strains and fertilizers is largely dependent on the environmental conditions afforded to the crop by suitable cultural treatments. There are instances in which promising cultures isolated from a variety or different varieties have given different response according to the cultural treatment meted out to them. The incidence of pests and diseases and the effects of fertilizers on the rice crop are also influenced to a large extent by the cultural practices adopted. Obviously, there should be harmonious blending and integration of the work of all agricultural scientists studying different aspects of the crop. The cumulative effect of these alone can produce the desired result of maximising the crop yields.

Outstanding results have been and are being obtained in almost all the States in evolving high yielding strains suitable for the tracts whereas work on manurial problems has also been receiving great attention. Unfortunately, none of the rice growing States except perhaps Madras and Bombay had given serious attention to the cultural side of rice crop that it warranted. It is not out of place to mention here that as long as schemes on rice financed by the Indian Council of Agricultural Research were functioning in the States, a limited number of cultural investigations were carried out but, after the closure of the schemes, these investigations that needed following up were not pursued seriously in some States.

With regard to the cultural trials conducted in the early years, the faulty methods of the experiments without adequate replications, etc., did not permit drawing of valid conclusions from the data. None the less, the results of the experiments are indicative enough to be of particular value in certain cases. In the later years, when agricultural statistics and experimental designs had developed, the experiments were free from faulty designs. But, definite conclusions could not be drawn in some of the experiments conducted for over a few years due to factors such as the uncontrollable and erratic seasonal influences and pests and diseases which vitiated the results of the experiments.

It is needless to emphasise here that since the cultural practices do vary to a great extent within a tract, to a considerable extent due to wide ranges in the physical and chemical properties of the soil, it would not be quite correct to conclude that the results of the experiments obtained under certain set of conditions prevailing in the experimental farm could be applied with the same degree of certainty under farmers' field conditions. Furthermore, the experimental farms in all the States except Madras are too few to represent fully all the shades of soil types in the different rice tracts.

In view of the above limitations and drawbacks, Dr. Stewart in his report on Soil Fertility Investigations rightly emphasised that the results of the experiments conducted at the stations should be supplemented by a large number of simple trials in cultivators' fields in each climatic region. After the corroboration of the results obtained from such trials alone, the findings could be confidently recommended to cultivators for adoption. The above remark with equal
force is applicable to the cultural aspect of the rice crop as well. This bulletin records the results of the cultural experiments in the Government farms. Therefore, the information provided in it can be pursued intelligently with advantage and put into practice.

It would appear that in the cultivation of rice the practices in vogue in different parts of India are more or less same. An analytical and critical examination, however, of the details of the cultural practices in different parts in the same rice zone itself, would show great variations due to the situation of the land and the physical and chemical properties of the soil. Even within a rice zone, there are strong climatic contrasts due to the geographical features with different patterns of soils. In view of this complexity it is proposed to deal with the various aspects of cultural trials and practices in the different sections of the Bulletin, as far as possible State-wise. This mode of presentation, it is hoped, would help the extension staff and others to study the comparative merits of each trial and evaluate the results with proper perspective, determining its application according to the needs and conditions of the area concerned. The above treatment of the work would thus provide a complete, analysed and studied record of all cultural experiments and should render any reference on a particular aspect of cultural problem easy and useful for future line of investigation.

The high production of rice crop is dependent on its freedom from pests and diseases. It is, therefore, considered necessary to incorporate in this book a separate chapter giving a short account of the various pests and diseases of rice crop and their remedial and preventive measures. This would help one in taking prompt measures for eradicating them or checking the virulence of their attack thus minimising the loss due to pests and diseases.
CHAPTER II

CULTURAL PRACTICES

CULTURAL practices are the methods adopted for obtaining maximum output from a crop. The term cultural practice is a very comprehensive one embracing all operations that are connected with rice cultivation, right from the preparation of the soil, seeding, fertilizing, to the interculturing, etc. Barring the manurial aspect of the crop, attempt has been made to deal with the other aspects of the cultural problems in this monograph. What was considered to be the immediate and most pressing of all cultural problems was given priority in each State concerned. Therefore, there is no uniformity in the nature of the trials conducted on various cultural aspects of the crop in different rice growing States. Further, since the diverse soil and climatic factors determine the cultural practices adopted for a particular tract, it is not possible to have uniformity in the various cultural experiments conducted in the different States having distinct rice zones. None the less, as the basic principles remain more or less same, it is convenient to deal with the subject matter under the following broad headings:

1. Preparation of the land for rice
2. Seeding and transplanting
3. After cultivation
4. Harvesting and threshing
5. Rotations

Preparation of the Land for Rice

The crop carrying capacity of a rice field is mainly dependent on the following factors, namely, the inherent and/or added fertility of the soil, the climate represented by the mean average rainfall, temperature, humidity, sunshine etc., the suitable variety of the rice grown and last but not the least, the cultural treatments the soil and the crop received right from the start. As there is a strong interaction between these factors, bumper yields from a field could be obtained only if there is a beneficially harmonious blending of these factors and simultaneous operation to make the plants express their yield attributes to their maximum limit.

It may be mentioned here that the influence of climate alone may affect the yield of rice crop to a tune of 20—25 per cent of its normal yield. While climatic factor is not controllable it may be possible to influence other factors for favouring the vigorous growth of the crop. It is, therefore, obvious that the soil which supports the crop, is primarily responsible in determining the yield. This particular fact has to be remembered all through the life phases of the crop for good outturn. The soil may be said to be in "good heart" if all the factors of plant growth are found in optimum amounts. This aspect of the preparatory cultivation problem requires great skill and care and it may be said at once that the success or otherwise of raising a good crop rests on this important operation, namely the preparation and maintenance of the land in ideal condition through all the stages of the crop, right from the time it receives the seed or seedlings, till its maturity. In this section, the preparation of the land in the various tracts of the rice growing States and the experiments conducted thereon will be considered at length.

The preparation of the land for rice may be considered under three heads:
(i) a pure dry crop
(ii) a semi-dry crop
(iii) a pure wet crop
(a) Dry and semi-dry crop

This system of cultivation is met with in all the rice growing States but is mainly confined to tracts which get direct benefit of either South-West or North-East monsoon or both, without having adequate irrigation facilities through river fed channels or tanks. This practice prevails in about 20 and 30 per cent of the rice area in Orissa and Madras States respectively. In Bengal and Bombay though rice is grown chiefly, with the help of S. W. Monsoon rains, the dry and semi-dry crops are not raised except in high situations poor in moisture-retentive capacity and in places with inadequate rainfall. Generally, this condition for raising a crop is unsafe as the success entirely depends upon a favourable season. Since it is difficult to predict as to when the monsoon would burst, it is absolutely essential that the seeds should be sown in the wake of the premonsoonish showers or even before in the dry soil, in anticipation of rains. The lands are, therefore, ploughed in summer a number of times to get the necessary tilth and any available manure is spread, as the sowing of rice is usually done in May-June in the case of crops dependent on S. W. monsoon rains and in September for crops depending on N. E. monsoon showers. This practice of opening up the soil in the summer has to be and is invariably adopted with a view to take the best advantage of the monsoons.

(b) Wet crop

Rice is grown as a wet crop right from the start only in tracts which enjoy assured water supply from protected reservoirs. Under this condition it is invariably transplanted. For transplanting the field should be brought to a soft puddle. Rice fields of sandy to sandy loams are ploughed in summer and brought to fine tilth so that they could be brought under cultivation straight away after letting in water, or again ploughed once or twice, as the case may be, to get the requisite puddle for planting. The heavy soils of clayey nature are not generally opened in summer; these are usually ploughed with two inches of standing water a few days before transplanting.

With the above background, it is now proposed to deal with the various experiments conducted in different States on the aspects of the best time of ploughing, the number of ploughings required, the depth of ploughing and the efficacy of the tillage implements used for this purpose.

Only a few experiments on the aspects of the preparatory cultivation of the land have been carried out in some States and the salient features and points that emerged out of these are given below. Details of the results of the experiments would be discussed at length in the subsequent pages.

Dry rice

(i) In the case of the dry sown crop, it is advantageous to open the lands soon after the harvest of the rice crop, as it facilitates further tilling operations and early preparation of the soil for sowing in the right time at the wake of the monsoon.

(ii) Winter or summer ploughing is not harmful for dry paddies, irrespective of the nature of the soil whether light or heavy.

(iii) The greater the number of ploughings, the better is the tilth and this greatly facilitates drilling, dibbling or broadcast-sowing operations and gives a good start to the crop.

(iv) A greater number of ploughings say 8 to 10 at frequent intervals, especially after the receipt of showers, controls weed growth to a considerable extent.

Wet rice

(i) In the case of wet rice also, it is advantageous to plough the land soon after the harvest of the rice crop or any catch crop taken after rice, as it makes the subsequent puddling operations easy.
(ii) Summer ploughing of heavy soils of alluvial origin that crack 4-5 feet deep in summer as obtained in the deltas of Godavari, Krishna and Cauvery of Madras State is definitely harmful to the succeeding rice crop only and the amount of reduction in yield is to a tune of 10-15 per cent. This harmful effect is, however, not noticed in the heavy soils of Gangetic alluvium of Uttar Pradesh and Bihar, and the soils of Assam.

(iii) Summer ploughing of the light soils has, however, no deleterious effect on the yield of the following rice crop.

(iv) Ploughing with country plough eight times at suitable intervals has given the highest yield. However, two to four ploughings with iron plough like cooper No. II have also given satisfactory results. It seems unnecessary to give more ploughings than what is required to get an optimum and soft puddle for planting.

With regard to the depth of ploughing, both in the case of dry and wet rice, deep ploughing with 6" has given better yield than shallow ploughing of 3", by about 15 per cent. But it should be emphasised here that in certain tracts of Assam and Madras, the constant deep ploughing tends to make the soil too deep and consequently it is difficult for the bullocks to move in the soil. Deep ploughing once in three years may prove to be a good practice.

Iron mould board ploughs of cooper No. II type are found to be more efficient than country ploughs for the initial opening of the soil as well as for subsequent ploughings in the case of dry sown rice crop lands; whereas in the case of wet rice, iron ploughs are useful only for the first course of one or two ploughings. For the subsequent ploughings in wet condition, the country plough is, however, found to be better than iron plough. Country ploughs of Orissa pattern with a duck-foot bottom base seem to be more efficient than others in covering a larger area of the land.

The experiments on the different aspects of preparatory cultivation mentioned above will now be discussed in detail.

(i) The time and number of ploughings

It may be noted here that in the case of dry land paddy, experiments on the above aspects of cultivation has not been carried out in view of the fact that the soil would have to be opened as and when moisture conditions permit the working of the plough and brought to fine tilth to receive seed at the right time in the wake of the monsoon rains. This initial and early opening of the land is necessary so that as a result of weathering action, subsequent ploughings would bring the desired tilth just before the break of the regular monsoon. If this practice is not followed, it would be rather difficult to get the requisite tilth at a later stage even if a greater number of ploughings is given. There is every chance of missing the right sowing time which is an important agronomic factor to be reckoned with, in respect of yield. This aspect is dealt with in detail in the later section.

Timely and thorough cultivation of the land is all that is required. It would not only promote quick and efficient germination of seed and give vigorous start to the young crop but would also help in keeping down the weed growth. Summer ploughing is, therefore, inevitable for facilitating early sowings. It has been the experience of the cultivators that if the soil particles are desiccated to a high degree due to severe summer, the crop resulting from such land is a bumper yielder. Also the weed menace is greatly reduced.

Dry crop

In the case of pure dry crop of rice, the harmful effects of dry summer ploughing usually observed in typical wet-lands under puddle are not noticeable. An experiment conducted at Agricultural Research Station, Samalkot (Madras State) in a black heavy soil
grown to pure dry paddy has indicated that the plots that received summer digging gave 25–35 per cent more yield than the fallow plots; just the converse of the results obtained with the wet-plots. It would, therefore, be evident that for dry sown rice crop, the greater the number of ploughings even if it be in summer, and earlier the sowings, the bigger is the yield.

Wet crop

In the typical wet soil an elaborate preparation of the land is necessary. The land has to be brought to a soft puddle. This is achieved by ploughing the land under 2' of standing water at short and frequent intervals. In Madras State actual ploughing in deltaic areas commences only when water has been let in and the soil becomes soft. In Bengal, Bombay and parts of Orissa and Bihar, the rice fields are usually puddled with the impounded rain water hurriedly and transplanted as quickly as possible. In the latter case the preparation of the land cannot be thorough nor is it feasible, for the planting has to be effected as early and expeditiously as possible while the monsoon rains are active and plentiful for puddling the soil, since, earlier the planting the bigger is the yield. The holding of the monsoon rains for a short period in the season would naturally necessitate the planting to be delayed which would result in the yield of the crop being reduced. The pros and cons of early and late plantings will be discussed in detail in a later section.

Madras State. Experiments conducted in the Madras State at the stations of Samalkot, Maruturu and Aduthurai (Madras) where the soils are of heavy clay, have clearly indicated that the soils are damaged by dry ploughing in the hot weather with the result that the yield of the succeeding rice crop is reduced by about 10-15 per cent. This harmful effect, however, found only to be of temporary nature as the yield of the succeeding first crop alone is adversely affected, and not the second crop that follows shortly after the first crop. It has also been observed that this harmful effect can be counteracted by manurial application of 4,000 lb. of green manure plus 1 cwt. of bone-meal. If, however, this manure is given to the ‘fallow plots’, the yield is decidedly increased by about 10 per cent over ‘summer ploughed’ plots. It is, therefore desirable not to open the heavy soils soon after the harvest of the second crop which usually comes to maturity during the summer months of February-April. In this connection it is worthwhile to mention here that the summer ploughing of the heavy soils of gangetic alluvial origin as obtained in Bihar and Uttar Pradesh has not been found to be harmful.

The dry ploughing of wet-lands in summer is, however, not harmful where the nature of the soil is of sandy loam. This finding is clearly brought out from the results of the experiments conducted at Palur and Ambasamudram Rice Research Stations. In fact, the results of two years trial at the Ambasamudram farm indicated that the summer ploughed plots receiving treatments ‘no manure’, ‘cattle manure’ and ‘green manure’ gave an increased yield in the order of 372, 256 and 106 lb. per acre over their respective unploughed counterparts. But the increased yield of 372 lb. recorded by ploughed 'no manure' treatment alone was statistically significant.

Palamthozhi system of Tirunelveli. It is worthwhile to record here the peculiar system of preparing the wet land for rice cultivation in Tirunelveli district—one of the southernmost parts of Madras State. There exists a practice of puddling the rice soils and keeping it in that state with fresh water for a pretty long period of about 30 months in the croplands of opinion of the cultivators is that the puddle so obtained by allowing it to become 'old' produces bigger crops, besides effectively controlling the weed growth. In this system of cultivation, the
seeds are invariably sown broadcast with the same meticulous care as is taken for raising wet nursery. This enables establishment of a crop of uniform stand. It has been observed that this "Palamthozhi", i.e., old puddle system stimulates the growth of blue green algae and promotes better aeration of the puddled soil. These two factors are probably responsible for the greater yield of the crop.

There exists no experimental data to prove that the 'Palamthozhi' system is more efficient than the customary practice, yet it is apparent and easily recognized to be the superior system by the cultivators, as evidenced from the high yields invariably obtained by this practice.

'Palamthozhi' system of cultivation serves triple purpose namely, (1) covering a larger area with a minimum number of pairs, there being a latitude in time and the time lag between preparing the land to sowing being two months, (2) effective controlling of the weed, and (3) economy in expenditure on transplanting. However, as against these advantages there is one disadvantage, i.e., high seed rate of about 100—120 lbs. per acre used for broadcasting as against 40—60 lbs. required for transplanting an acre.

This system of cultivation is practised in a limited tract where there is abundant supply of water and where this water could not, otherwise, be better utilised for covering a larger area due to various reasons. It has, therefore, limited scope for large scale adoption in other rice growing tracts.

Assam. The rice cultivation of the different classes of paddy as obtained in the State of Assam is as follows:

Aman paddy, which is the main crop of the low-lying areas subjected to flood during the monsoon rains, is usually sown broadcast in the first part of April and harvested in November-December. Aman fields are generally prepared with the first showers of rain in March. But it is always advisable to open the land after harvest before the land dries up and cracks. With regard to broadcast Aus or transplanted Aus, broadcasting is done in March-April and transplanting in April-May (early). The harvesting is done in July-August. The Sail or Suti which is the important class of paddy in Assam and most widely grown on uninundated areas is sown broadcast in June-July or transplanted in July-August and harvested in November-December. These lands are also ploughed just like that of Aman fields.

Uttar Pradesh. In Uttar Pradesh, rice cultivation is started with the wake of the South-West monsoon rains. Broadcasting in June or transplanting in July is invariably practised. Depending upon irrigation facilities, the amount of rainfall and the moisture retaining capacity of the soil, suitable varieties of different durations are grown. The crop, however, is harvested in October-November before the cold sets in, as otherwise the setting of the grain is affected considerably by low temperatures. A rabi crop of wheat and of legumes is also grown in suitable lands after the rice crop in October-January. These lands are ploughed in summer. Where the growing of rabi crop is not feasible, the lands are opened up in winter itself.

With the above background, the experiments conducted on the time of ploughing in the above tracts are briefly discussed below.

Experiments on time of ploughing

Experiments conducted at Karimganj Farm in Assam for 3 years, to test the efficacy of winter and summer ploughing have proved that winter ploughing is as good as or slightly better than summer ploughing both in the case of Aman and Aman rice. Winter ploughing has, besides, certain practical advantages over summer ploughing regarding the preparation of the land; for it prevents cracking and facilitates the subsequent tillage operation so that the land could be brought to condition for early sowing with the advent of the monsoon showers.
Uttar Pradesh. The experiments carried out in Nagina Farm in Uttar Pradesh have shown that winter ploughing with pre-monsoon sowing in the first week of June is distinctly superior to ploughing in the wake of pre-monsoon showers and sowing at the time of monsoon in the first week of July by about 15 per cent. It may, however, be pointed out here that in two out of five years trial, preparing the land at the break of monsoon and sowing after in the first week of July gave as good an yield as winter ploughing with pre-monsoon sowing in June. It would, therefore, appear that two factors namely, time of ploughing and the time of sowing might seem to influence the yield differently according to the favourable conditions or otherwise of the season.

However, later experiments conducted in Nagina during the period 1949 and 1950 to determine the effect of summer ploughing on the yield of paddy have indicated that the treatment of a thorough ploughing in summer, i.e., one deep iron ploughing followed by five or six “‘desi’” ploughings, puddling and “gunning” (working an implement like “bidha”) is distinctly superior to the treatment, namely, “no ploughing in summer and ploughing just before puddling and ganning” by about 29 per cent. It has also been observed that the summer ploughing had tended to keep down the weed growth.

Orissa. The results of a similar experiment conducted at the Central Rice Research Institute in Orissa State, Cuttack, for three years, have also indicated that summer ploughing had no deleterious effect on the succeeding rice crop even in fairly heavy loamy soils of Mahanadi river.

It is clear from the foregoing discussion of the various experiments that only the heavy clay soils of Madras put under rice cultivation under transplanted conditions only, are damaged by summer ploughing while the soils of Gangegetic alluvial origin in Uttar Pradesh and Bihar are not affected by winter or summer ploughing. Curiously enough, this contradictory behaviour of the heavy alluvial soils which usually crack deeply in summer is rather inexplicable. The summer ploughing of light soils, has however, no deleterious effect on the yield of the succeeding rice crop.

(ii) The number and the depth of ploughing

Whether it be for dry or wet sowing or transplanting rice, the field should be brought to good heart for the quick establishment of the young crop. This can be achieved only by judicious ploughing operations at the right moment. In the case of dry crop, the land should have ideal tilth so that drilling or dibbling or broadcast sowing operations could be done with ease and that the seeds may germinate uniformly; whereas in the case of wet crop, a soft puddle should be created so that the uprooted seedlings may easily strike root and have a good hold in the soil and develop well. To obtain the above soil conditions, a certain number of ploughings is necessary and further, it is also essential to have the ploughing done to a certain depth say 4 to 6 inches with a view to promote better development of the root system of the crop. The time honoured country plough is the only implement used by the cultivators, though of course, iron mould board ploughs are now being introduced for preparing rice fields.

It is needless to emphasise here that the depth of ploughing is invariably associated with the type of the country plough or the iron plough; besides, the time, nature and condition of the soil while ploughing and the method of putting the plough on the yoke, largely determine the depth of the ploughing. Since the first two factors vary from time to time even for the same field, it is only the experience of the cultivator, who is quite conversant with the properties of the different types of soils, that could guide him in tackling the soil at the right moment. Therefore, no hard and fast rules could be laid in respect of this important operation. None the less, it would be essential to observe here that neither over-working nor under-working of the soil is to be done as none of them would provide ideal conditions for the better growth of the rice crop.
The number of ploughings required to obtain a good tilth for dry sown rice crop or a soft puddle for wet crop depends upon factors like the nature of the soil, the time of opening of the land, the degree of the weathering action of the soil during the fallow period between one ploughing and the other, the interval between one ploughing and the next and the kind of ploughs and implements, etc. With a view to note how far the number of ploughings and the extent to which the depth of ploughing is necessary, experiments have been conducted only in a few farms in States like Assam, Madras and Uttar Pradesh and the results of the trials are briefly reviewed below.

**Titabar Farm, Assam.** Experiments conducted in Titabar Farm in Assam State on the depth of ploughing for the Sale or winter transplanted crop for 3 years showed that the deep ploughing of 6" gave an average increased yield of about 5 per cent over shallow ploughing of 3". Similar experiment with *Abu* or autumn rice in Karimganj and Titabar Farm also indicated that the deep ploughing of 6" was distinctly superior to shallow ploughing of 3" by 30 and 14 per cent respectively. It has been observed that continued deep ploughing would, however, make the land too deep and, consequently, difficult for the bullocks to move in the soil.

With regard to the number of ploughings required for the rice soils of Assam, an experiment conducted at Karimganj for 3 years indicated that eight ploughings sided to be optimum for Sale or winter rice and this treatment had given statistically an increased yield of 10 per cent over the other treatments i.e., 4 or 6 ploughings. This would only show that over-ploughing is unnecessary and uneconomical too.

**Nagina and Gorakhpur Farms, Uttar Pradesh.** At Nagina and Gorakhpur in Uttar Pradesh in an experiment involving different treatments like summer ploughing, no ploughing in summer and ploughing just before the break of the monsoon, deep ploughing with iron plough was combined in the summer ploughing treatment, with a view to effecting thorough preparation of the land. The results of this experiment as has been already detailed elsewhere, show that the thorough preparation of land with one deep ploughing in summer with 5 or 6 subsequent ploughings gave an increased yield over summer shallow ploughings by about 29 per cent.

Experiment on the number of ploughings has not been conducted here, but it has been observed that a very thorough preparation of the land which could be normally effected by six ploughings seems to have given better and bigger yield of the crop than that obtained from the indifferently and inadequately prepared land.

**Madras State.** In Madras State, though experiments on the depth of ploughing have not been done, yet the results of numerous observations on trial plots laid out in chief rice growing zones in respect of 'iron plough versus country plough' have shown clearly the superiority of the former over the latter. The deep ploughing of about 4-5 inches as obtained with iron plough had given an average increased yield of about 10—15 per cent over shallow ploughing of 2-3 inches with country plough.

**Number of ploughings.** With regard to the number of ploughings in the main crop season July—January an experiment with following six treatments was conducted at Aduthurai Farm in 1943. (1) Ploughing two times with country ploughing at planting, (2) ploughing four times with country plough at planting, six days before planting, 2 ploughings two days before planting and 2 ploughings at planting, (3) ploughing eight times with country plough (2 ploughings ten days before planting, 1—2 ploughings six days before planting, 2 ploughings two days before planting and 2 ploughings at planting), (4) ploughing once with Cooper No. 11 plough at planting, (5) ploughing two times with Cooper No. 11 (one ploughing 10 days before planting and one ploughing at planting), (6) ploughing 4 times with Cooper No. 11 (1 ploughing 10 days before planting, 1 ploughing 6 days before planting, 1 ploughing 3 days before planting and 1 ploughing at planting). This experiment was conducted to determine not only the efficacy of the country and iron plough but also the minimum number of ploughings required for obtaining the best yield of the crop.
The results of the experiment showed that the treatment No. 3 i.e., ploughing the land 8 times with country plough, gave the highest yield and this treatment was found distinctly superior to the treatment No. 1 i.e., two country ploughings by 13 per cent. An increased yield of 6–7 per cent recorded by the treatment No. 3 over the other treatments i.e., 2, 4, 5 and 6 was, however, not statistically significant, nor the increased yield of 5–6 per cent of the treatments 2, 4, 5 and 6 significant over the treatment 1. This would only indicate that too many number of ploughings is not absolutely essential for the production of a good crop. Unfortunately this experiment was discontinued after a year and so the results need confirmation and the conclusions drawn above will have to be accepted with caution.

Ploughing of clayey soils. It has been observed from practical considerations that in the case of clayey soil also, it is necessary to have the initially puddled field worked up either by a wet land puddler or 'Burmese Satoon' or country or iron plough as this final touch would greatly facilitate transplanting. Mention may be made here that even the above preparation of the land is dispensed with in very heavy clayey soils of Godavari Delta in years of severe summer, without rains, as these lands on wetting become soft and the soil particles crumbling into loose condition. This condition is quite fit for planting straightaway. Further ploughings in this case, result in condition known as 'quillas i.e., looseness which is detrimental to the growth of the plants and prevents the roots taking a proper grip in the soil.

Dry ploughings. Of late, there prevails an extensive practice of dry ploughing of the heavy soils in some parts of Krishna delta for practical reasons as this helps a ryot to cover a larger area with a minimum number of pairs. Though this dry ploughing is nothing but scraping of the soil, yet it is proved to be of immense use. Immediately after letting in water, the field is levelled by passing a weighted ladder across and brought to a condition fit for planting. It remains to be seen by conducting suitable experiments as to how far this practice of surface scraping as against deep ploughing in summer is harmful or otherwise. It may be pointed here that for similar reasons the wet lands of sandy loamy nature in the southern parts of Madras are summer ploughed and kept in good tilth so that soon after letting the canal water, the field is only levelled and planted without any further puddling operations. It has also been noted that from such fields good yields comparable to those from well puddled lands are reported.

(iii) The efficacy of different types of ploughs and tillage implements

The different types of country and iron ploughs and other implements connected with rice cultivation are dealt with in another section separately. Except a few experiments on ploughing already dealt with, no other separate and elaborate trials have been carried out in the States to test the efficacy of the different implements. Under the circumstances and in the light of the experience gained so far by the use of the different implements it may however be possible to indicate here, in general, what is considered to be the best for preparing the land for rice.

Iron mould board ploughs big or small are found undoubtedly to be superior to country ploughs for the initial opening of the soil soon after the harvest of the rice crop either in the dry or wet land. In tracts where green manure crop is grown in the wet lands after the harvest of paddy in March-April the young green manure crop can be buried properly in the month of June, by working the iron ploughs. The initial ploughings with iron plough is always thorough and perfect, besides being efficient in burying the weeds and stubbles of the previous crops. However, iron plough is not suitable for subsequent ploughings specially for still clayey soils. Here the country plough does better than iron plough. Wet land puddler or 'Burmese Satoon' seems to be more efficient with greater turn-over of work. In respect of the cost of puddling too, it is found to be cheaper than country or iron plough.
Observations regarding preparatory cultivation.—It is worthwhile to record the following observation with regard to the preparatory cultivation of the land for future line of action.

The chemico-physical and biological activities that are initiated in the soil due to the different systems of cultural practice adopted for preparing the dry or wet soil has not been thoroughly and seriously studied and unless and until fundamental knowledge on the above subject is gained, it would not be possible to enunciate the broad principles that are involved in preparing the soil. The study of these alone can indicate the right method of tilling the soil of the rice lands for obtaining bigger yields of the crop.

Dry crop. It may be pointed out here, that the only criterion that has to guide one in the preparation of the land for the dry sown rice crop is to produce proper tilth for receiving the seed at the right time in the wake of the monsoon. How best this optimum tilth could be obtained is the main point that needs detailed investigation. Reasonably this could be brought about by giving a course of one or two ploughings with iron plough soon after the harvest of the rice crop and later, after allowing the soil to weathering action, by working cultivator or gawala as and when rain are received. Instead of using country plough for subsequent ploughings, the above mode of tilling the land is found to minimise the cost of cultivation as also help the cultivator to cover a larger area with a minimum number of pairs.

Wet crop. In the case of wet crop, a soft puddle is required for the transplanted seedlings to anchor themselves and establish quickly. Iron mould board ploughs should as far as possible be used for the initial opening of the land either under dry or wet conditions. But the subsequent puddling operations will have to be done preferably with the help of country plough. 'Burmese Satoon' or wet land puddler can be used here instead of ploughing the land. This would economise expenditure in the preparation of the land and expedite the planting operations in time.

As already stated above, scientific enquiry will have to be made on the basis of the above principle in preparing the soil for the rice crop and experiments will have to be carried out for each tract separately as what hold good for one type of soil under certain climatic condition may not hold good for all cases.
SEEDING THE LAND
Practices in Vogue

Next in importance to preparatory cultivation of the soil is the seeding of the land. There are two practices in vogue, e.g. (i) direct sowing, (ii) transplanting. The latter is by far the most important and is largely adopted by the ryots in preference to the former, wherever facilities for irrigation and labour exist. As a rule, broadcasting is resorted to by the cultivators under the following conditions:

(i) short duration crops especially in high level situations depending mostly on monsoon rains
(ii) where the land is poor and the yield is likely to be small
(iii) where labour is insufficient at the proper season to transplant
(iv) where water is insufficient to allow transplanting in the right season.

In Madras State, in Malabar broadcast in the first crop is invariably done as the crop has to be in before the S.W. monsoon. Similar is the case in Orissa State where, if transplanting is to be adopted, there would not be sufficient labour nor cattle power to get the whole crop on, in the proper season. In some tracts of Madras, dependent on precarious N.E. monsoon rains which are often erratic in nature, dry sowing of seed in the soil, in anticipation of rainfall, is done so that the advantage of the season is not lost. But in the high level lands of the gangetic alluvial soils in West Bengal, transplanting short rice is the rule even with 40 days old seedlings soon after the break of the S.W. monsoon rains. But in poor soils of laterite origin and in high level situations where the moisture retaining capacity of the soil is poor, broadcasting is invariably adopted with a view to making the best advantage of the early monsoon showers. In parts of Bihar and Uttar Pradesh also, broadcasting short rice is in vogue for similar reasons.

Broadcasting versus transplanting

The comparative merits of direct sowing in dry or puddled soils and transplanting have been tested in almost all the experimental farms. These will be discussed in detail in a latter section. In general, transplanting is decidedly superior to broadcasting. However, as mentioned earlier, in certain types of soil and under particular climatic and agronomic conditions, special reasons compel the practice of broadcasting over transplanting. Besides, this is the only way of raising of rice crop successfully with the available moisture obtained from monsoon rains.

In some of the areas where broadcasting is practised, there is a great scope for introducing transplanting with advantage. This can be done by adopting the practice of raising seed beds in flumes and using varieties suitable to different types of soil, as also by providing tube well or open well irrigation facilities to supplement rain water, if necessary, at the later stages of the crop when water scarcity is often felt. The chief drawback in the case of broadcasting is that all kinds of weeds take the upper hand over the young rice crop at the early stages and virtually smother it if weedicings are not done in time. This particular item of work entails heavy expenditure and is not commensurate with extra yield obtained from it as a result of weeding.

Sowing in upland

Some cultivators in parts of Orissa have abandoned the growing of rice especially in uplands as the operation of 'bushenning' which is later dealt with in detail, could not be conducted in time due to vagaries of the monsoon. Experience aimed at the Central
Rice Research Institute has, however, shown that these high lands would be puddled and transplanted at the first receipt of heavy monsoon showers with seedlings raised previously with the help of pond or well water. Since it is difficult to predict as to when the monsoon would break, it would be a sound practice to have the seed beds raised in batches with a week’s interval in the normal sowing period so that it would be possible to have seedlings of optimum age planted as soon as the heavy showers are received. The land already brought to good tillth by summer ploughing could be puddled easily. This sort of imperfect or partial puddling or even wet ploughing of the land thoroughly with little standing water with iron mould board plough, facilitates the burying of the fast growing grasses and other weeds.

Strains for uplands

It is worthwhile mentioning here that instead of growing short duration rices of 105 days in uplands, suitable medium duration rices of 140 days like T. 141 could be planted late in the middle of August as the S.W. monsoon is usually active enough for puddling the lands in August, even though the seedlings raised may be aged. The experience at the Central Rice Research Institute for two years has shown that consistently good yields ranging from 25—32 md. per acre, as against 8—12 md. got from short rices, have been obtained by adopting the above practices.

In addition, the short duration rices are affected by rains during the flowering time which generally results in bad seed setting. This is not the case with the medium duration varieties. There is, however, one difficulty in adopting this practice. If the usual late rains in September—October are held off, it would be necessary to give one or two light irrigations as otherwise the grains would be ill-filled or would become chaffy. Sinking tube wells or open wells would help a lot in getting over this difficulty as also be useful for raising cash crops after rice. This practice, would not only ensure against crop failure but help to increase the rice production two-threefold with added economy in curtailing the expenditure on weeding.

A. Dry Rice

(1) Sowing Dry rices and semi-dry rices

The following are the common methods of sowing paddy:

(1) Broadcasting the seed and then lightly ploughing the land with country plough or working the cultivator to cover the seed.

(2) Sowing the seed behind the country plough furrows or dibbling the seeds in twos or threes at approximately equal distance of 4" to 9" in the furrows according to the duration of the varieties.

(3) Drilling the seed in lines.

Broadcasting the seed

When the field is in the right condition, seed is sown as indicated above. Generally after covering the seed, a wooden ladder, weighted by the ploughman standing on it, is passed with a view to compacting the soil. This enables the sub-soil moisture to rise up to the top surface where the seeds might be lying at different levels and thereby accelerates the germination of the seeds. It may be observed here that if the seeds are soaked for 6—8 hours before those are sown, the germination is hastened. This practice would certainly prove to be advantageous if the moisture content in the soil were found to be below the optimum required for normal germination. The plumule is generally seen above the soil on the fourth day of
the sowing. Even thereafter, the ladder is gently passed for about 4 days with the object of breaking the surface soil crusts and smothering the quick growing grasses. As the plumule is tender and pliable at this stage, it is not broken during this operation.

The above practice of passing the ladder is not adopted in Malabar and South Kanara districts in Madras State where there is little fear of the seeds failing to germinate for want of moisture. On the other hand, great damage is done by the torrential rains of the S.W. monsoon if the soil is made even by laddering. It is with a view to checking this soil wash that the miniature ridges and furrows formed in the process of covering the seed are allowed to stand. These arrest the fine soil particles from being washed away by the rain water. It should be emphasised here that the ridges and furrows should be thrown along the contour lines of the field. In the above terraced system of cultivation, the small furrows act as efficient drainage channels to carry away the heavy rain water quickly but slowly without causing erosion. The absence of these close furrows is bound to cause sheet erosion resulting in the formation of gullies. Big ridges and furrows at suitable places along and across the contour lines with embankments to carry away the accumulated water from the small furrows prove to be very efficient in preventing soil erosion. Wherever soil erosion due to heavy rainfall is feared, the above practice is worth adopting in order to maintain the fertility of the soil by keeping intact the valuable top soil.

(ii) Dibbling the seed

While broadcasting is the most common method in vogue in almost all the States, there exists the practice of dibbling the seed behind the furrows of the country plough at regular intervals in some parts of Madras and Bombay States. This method is certainly an improvement over that of broadcasting in that the seed rate is generally reduced by almost 30 per cent. Besides, it has been the experience of the cultivators that the yield obtained from a dibbled crop is as a rule better than that obtained from a broadcasted crop; also, spotting out of wild paddies specially in a badly infested field becomes considerably easier. Dibbling of seeds facilitates uniform germination, resulting in an even stand of the crop. In a dibbled crop the interculturing operations are also facilitated. It has been observed that a crop dibbled in lines is found to resist drought better than a broadcasted crop, the former coming to more uniform flowering and ripening besides maturing earlier than the latter. At the Central Rice Research Institute, Cuttack, in a trial conducted in 1947 with early Aman rice (T. 1145), dibbling in lines 9 inches apart at two seed-rates of 30 and 60 lb. per acre was compared with broadcasting using 60 lb. of seed per acre and transplanting. Dibbling in lines and transplanting gave equal response and were significantly superior to broadcasting. There was no significant difference in yield between dibbling at 30 and 60 lb. seed rates per acre. The yield figures were as follows:

<table>
<thead>
<tr>
<th>Method</th>
<th>Yield in lb. per acre</th>
<th>Percent age yield on control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast (60 lb. per acre)</td>
<td>3107</td>
<td>100.0</td>
</tr>
<tr>
<td>Dibbling (30 lb. per acre) 9&quot; apart</td>
<td>3358</td>
<td>113.8</td>
</tr>
<tr>
<td>Dibbling (60 lb. per acre) 9&quot; apart</td>
<td>3548</td>
<td>114.0</td>
</tr>
<tr>
<td>Transplanting 6&quot;x6&quot;</td>
<td>3500</td>
<td>112.6</td>
</tr>
<tr>
<td>S.E. of the mean acre yield</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>C.D. at 5 per cent level of significance</td>
<td>175</td>
<td></td>
</tr>
</tbody>
</table>
In the trial with mid-4am rice (T. 812) dibbling 9" apart at 48 lb. per acre gave an increased yield of about 5 per cent only over broadcasting but the increase was not statistically significant. Transplanting 9" x 9" was found to be distinctly superior to dibbling by about 45 per cent. The results of the trial are given below:

<table>
<thead>
<tr>
<th>Method</th>
<th>Yield in lb. per acre</th>
<th>Percentage yield over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dibbling 9&quot; apart</td>
<td>2303</td>
<td>97.5</td>
</tr>
<tr>
<td>Broadcasting 48 lb.</td>
<td>2160</td>
<td>100.0</td>
</tr>
<tr>
<td>Dibbling 9&quot; apart</td>
<td>2413</td>
<td>102.8</td>
</tr>
<tr>
<td>Transplanting 9&quot; x 9&quot;</td>
<td>3469</td>
<td>146.0</td>
</tr>
</tbody>
</table>

S.E. of the mean acre yield 107
C. D. at 5 per cent level of significance 324

It would thus be seen that sowing of rice in lines has proved to be a superior method of cultivation than bulk sowing broadcasting and the advantages that accrue to this method are (i) more efficient control of weeds, (ii) increased yields per acre, and (iii) the great saving in seed requirement. To sow broadcast, 60 lb. of seed and more is usually required; this can be reduced by half in case of dibbling.

(iii) Drilling the seed

Drilling paddy is by far the most common method of sowing in South Bombay State. In the uplands of some parts of Circars in Madras State and in other States as well, where rice is grown as a dry crop or as mixture with other pulses, drilling is largely adopted. This enables to cover a large area within a limited sowing period. It requires a few number of pairs and also facilitates the sowing of pulses at definite intervals of spacing as a mixture. Drilling has the same advantages as obtained by dibbling. Drills which are commonly used for other crops can be used for rice as well.

(iv) Seed-rate for broadcast sowing and dibbling

The seed-rate generally depends upon the size of the seed and duration of the variety used. The shorter the duration of the variety, the higher is the seed rate. The smaller the size of grain, the lower is the seed rate. The cultivators, as a rule, use 100 to 120 lb. of seed per acre for broadcasting and 60 to 80 lb. per acre for dibbling or drilling. The results of the experiments on seed-rate conducted in a few farms are given below.

Results of seed-rate experiments

Pattambi Station. In Madras State, a seed rate experiment involving 40, 60, 80, 100, 120 lb. per acre was conducted for 3 seasons for broadcasting under dry condition before the onset of S. W. monsoon. Though the results of the experiment did not satisfy the Z' test, yet the general trend of the trial indicated the seed rate of 80 lb. per acre to be the best, both under manured and unmanured conditions. It would, however, appear that higher seed rate of 100 lb. per acre might be better for fields under unmanured conditions. In no case the adoption of a seed rate higher than 100 lb. or lower than 80 lb. per acre is warranted as these do not give yields better than that obtained from 80 lb. seed rate per acre. This optimum seed rate of 80 lb. per acre seems to be necessary to keep down weeds which otherwise would spring up in spite of thorough preliminary cultivation given.
With regard to the seed-rate under wet conditions where the land is puddled and levelled and germinated seed is sown, it has been observed at Pattambi that there is a similar trend of progressive increase in yield with the increase in seed-rate per acre as in dry sowing. But a seed-rate of 75 lb. per acre has been found to be the optimum as the highest seed-rate of 120 lb. may not always be economical. A factorial experiment combining time of sowing with seed-rate under dry sowing has shown that the sowing on the 7th May is the best, there being no differential response between seed-rate and time of sowings.

**Uttar Pradesh.** At Nagina station the results of a seed-rate experiment conducted over two years have shown that the seed-rate of 50 lb. per acre was ideal. Increasing the seed-rate to 60 lb. or decreasing it to 40 lb. gave only lower yield by about 100 to 140 lb. per acre as compared with the 50 lb. seed-rate. This difference in yield was not statistically significant. Under Gorakhpur Farm conditions, the two years results indicate that the seed-rate of 60 lb. per acre was better than either 100 or 40 lb. by about 29 and 43 per cent respectively. The seed-rate trials conducted in the Circle farms of the State also confirm the above finding in favour adopting a seed-rate of only 70 to 80 lb. per acre.

**Hyderabad State.** In an experiment to determine the optimum seed-rate at the Himayatsagar station in Hyderabad State (Deccan) it has been found that the seed-rate of 80 lb. per acre gave the highest yield both in the Ahi (June-October) and Tabi (December-April) seasons as compared with 60, 100 and 120 lb. per acre.

**Mysore State.** The results of the seed-rate experiment conducted at the Hebbal Farm in Mysore State for 3 seasons under manured conditions indicate that for Haine crop (June-November) the seed-rate of 73 lb. per acre gave the highest yield. This was very closely followed by 55 and 36 lb. seed-rate, the difference in the acre yield between the two being 65 lb. which was, however, not statistically significant. The seed-rate of 22 lb. per acre in one out of three years trials gave an equally good yield as 73 lb. seed-rate, but on the whole, it was seen from the results that this seed-rate was rather low, the yield being adversely affected to an extent by 10—15 per cent as compared with 73 lb. seed-rate.

**Seed-rate for summer crop.** With regard to the summer crop, there is a positive indication that the seed-rates of 73 and 45 lb. per acre which were at par—their yields being more or less the same—are distinctly superior to 33 and 22 lb. seed-rate per acre by about 15—17 per cent.

**Seed-rate for dry sown paddy**

**Habibganj Farm.**—The results of seed-rate experiments with dry-sown Aman paddy conducted for 5 years at the Habibganj Farm now in Pakistan State, indicated that under normal conditions of dry sowing, a seed-rate of 105 lb. per acre has proved to be better than 90 lb. seed-rate, the increase in yield being 115 lb. per acre. There was, however, no advantage in increasing the seed-rate to 120 lb. per acre as this did not give yield better than that obtained from 105 lb. seed-rate.

**Cuttack, Orissa.** At the Central Rice Research Institute, Cuttack, Orissa State, it has been found from an experiment i.e., drilling or line sowing versus broadcasting with mid-Aman paddy variety, that the seed-rate of 30 lb. per acre gave a higher yield of about 14 per cent over broadcasting with 60 lb. seed-rate.

With regard to dry-sown Aman paddy in the wake of the South-West monsoon which would be subsequently treated as swamp paddy, the results of two years' trial have indicated the seed-rate of 80 lb. to be ideal. Even a smaller seed-rate of 40—60 lb. per acre has in some favourable seasons proved to be equally good or slightly better than the seed-rate of 80 lb. per acre. Thus there is a great scope of reducing the prevalent high seed-rate of 120 lb. per
acre to half. The argument usually advanced by the ryots for adopting the above high seed-rate is that in the act of *bushmiling* operation, there would be drastic thinning which might result in the thin stand of the crop. But in fact, if seed of good viability is sown uniformly at 60—80 lb. per acre, under ideal conditions and *bushmiled* as usual, it would be possible to maintain a stand of the crop similar to that obtainable from a 120 lb. seed-rate.

The results of a similar experiment carried out in Jeypore Farm have also shown that for late winter paddy the seed-rate of 60 lb. per acre gives about 19 per cent increased yield over 80 lb. seed-rate. But, in the case of medium duration variety, a higher seed-rate of 100 lb. per acre especially in poor soil was found desirable, as the lower seed rate below that level had given significantly smaller yield by about 16—25 per cent.

*Kashmir State*. In Kashmir State, the results of the seed-rate experiment conducted for five years with 3 Chinese varieties have clearly indicated that the seed-rate of 72 lb. per acre is distinctly superior to 48, 60 & 84 lb. seed-rate per acre. The increase in yield ranges from 10 to 30 per cent.

Seed-rate experiments with Sprouted seeds

*Travancore-Cochin*. The results of a seed-rate experiment with sprouted seeds of two varieties Mo1 and Mo2 conducted at Moncompu (Travancore State) Farm in puddled soil for 3 years (1947—49) have shown the seed-rate of 90 lb. per acre to be the best—its yield being as good as that obtained from the higher seed rates i.e., 110, 130 or 150 lb. per acre. The average yield of the 3 years for the different treatments was as follows:

<table>
<thead>
<tr>
<th>Seed-rate per acre</th>
<th>Yield in lb. per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 lb.</td>
<td>1654</td>
</tr>
<tr>
<td>90 lb.</td>
<td>1888</td>
</tr>
<tr>
<td>110 lb.</td>
<td>1852</td>
</tr>
<tr>
<td>130 lb.</td>
<td>1872</td>
</tr>
<tr>
<td>150 lb.</td>
<td>1895</td>
</tr>
</tbody>
</table>

*Madhya Pradesh*. The results of a similar trial conducted for three years at Labhandi Farm have indicated that the seed-rate of 80 lb. per acre was better than the seed-rate of 60, 100 or 120 lb. per acre, the amount of increase in yield ranging from 97 to 116 lb. per acre. These results were however, statistically, not very significant.

(v) **Spacing for drilling and dibbling seeds**

Experiments to determine the correct spacings required, either for drilling or dibbling seeds have not been carried out in most of the farms. However, from the experience gained from the experiments conducted on transplanting of rice, the cultivators adopt a close spacing of 3" or 6" apart either way, or 6 inches between lines and 3 inches in lines for short rice; and similarly 6 or 9 inches either way for long duration varieties.

*Madhya Pradesh*. At Adhartal Farm (Madhya Pradesh), result of an experiment with the early and medium varieties involving drilling with two kinds of spacings i.e., 12" and 6" apart either way, when compared with cultivators method of transplanting showed that 6" spacing was found to be definitely superior to 12" by 15 per cent but lower by about 4 per cent only as compared to transplanting.

The spacing to be adopted depends mainly upon the fertility of the soil too. Since spacing plays an important role in influencing the ultimate yield of the crop, it would be desirable to find out the optimum spacing required in each case under conditions pertaining to the particular tract. What holds good in one place need not prove to be equally good for the other. There is, therefore, scope to reduce the seed-rate still further as a result of more experimentation on the spacing with different seed-rates.

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(vi) Depth of sowing

As a rule even a previously well-prepared field is usually ploughed once before sowing the seed by broadcast or other methods. This is done with a view to bury the grass and other weeds that come up during the plough and fallow period. The seeds so sown in the uneven surface lie on the plough furrows, ridges and their sides. In the process of covering the seed by working in a country plough lightly and levelling the field, these seeds naturally occupy different depths ranging from surface to about 3 inches below the surface.

A study of the germination of the seeds sown at varying depths has revealed that the seeds sown at half to one inch and two inches depth would take about 4 and 6 days respectively for their plumules to be seen above the soil, while the seeds lying exposed on the surface as well as those below 2 inches depth require 6 to 10 days for the emergence of their plumules. The seeds lying at a depth below four inches from the soil germinate, but their plumules, however, do not come out of the soil and are killed.

It would, therefore, be evident that to obtain best results of uniform germination and stand, the seed should be covered and not exposed. The covering should, however, be such that the seeds do not go below 2 inches depth. This is possible, in the case of broadcasting, by only skilled sowing and judicious covering of the seed, whereas in the case of dibbling it would be possible to regulate the depth of sowing by careful opening of the furrows and covering the seed.

In drilling, uniform depth of sowing could be achieved by suitable adjustment of the type of the drill. The depth of sowing determines to a large extent the nature of the root system. Therefore, how far, and to what extent the root system would influence the future course and activity of the plant in respect of characters like lodging habit, drought resistance, absorption capacity of plant nutrients etc., has yet to be studied in detail. Actual laboratory and field experiments on this particular aspect of different depths of sowing alone can throw light on these points. This observation is of practical agronomic value in enhancing the yield of the crop.

(vii) Optimum time for sowing

As has been already pointed out in the preparatory cultivation of the land, the sowing of dry rice is mainly conditioned by the course and strength of the monsoon. Since it is impossible to forecast as to when exactly the monsoon would burst and gather strength and whether the rains would be evenly distributed or otherwise, the dry sowing of paddy is often accompanied with a great risk. None the less, the sowings should be done in the right season even under unfavourable conditions, for if once the right sowing season is missed, the yield resulting from the late and out of season crop has been found to be invariably poor. The results of the experiments on the time of sowing carried out in some of the farms are reviewed hereunder.

Assam. In some parts of Assam State, rice is grown under typical deep water conditions where the water level gradually rises up to 15-20 feet as the monsoon strengthens. The lands should be seeded in the wake of the premonsoon showers before the monsoon becomes very active and the fields get inundated so that in its growth the young crop may keep pace with the rise in level of water. Time factor is very important to establish an early crop but early sowings could be possible only if the weather conditions are favourable.

Habibganj Farm. With a view to assess the relative value of the early and late sowings, an experiment was conducted in Habibganj Farm for 5 years involving seven dates of sowing from 6th April to 18th May with an interval of one week between consecutive sowings. The results indicate that the sowings in April are, on the whole, definitely better than the sowings in May, the difference in yield in favour of April sowing being 339 lb. per acre on the control acre yield of 1998 lb. With regard to broadcast Au crop (summer and autumn rice), it has been observed from the result of monthly sowings that the Au types thrive best when sown in April and do fairly well when sown in May and June.
Pattambi Farm. Experiments with different dates of sowing were conducted at Pattambi Farm which represents a vast tract in Malabar district. Here paddy is grown purely as a dry crop with the sole help of S.W. monsoon rains. Experiments have clearly shown that early sowings done from middle of April to first week of May are distinctly superior to sowings done later than the first week of May, by an extent ranging from 19 to 21 per cent. The strain PTB2 seems to be more adaptable than PTB1 for early sowings up to 1st May as evidenced from its comparatively better yield. The results of the experiments further indicate that if optimum conditions for direct sowings are not obtainable within 7th May, it would be definitely more advantageous to raise nurseries and adopt transplanting as this has given definitely better yield than late broadcastings; the increase ranges from 10 to 35 per cent. This experiment relates to broadcast sowing in Palliyal (single cropped) lands.

Uttar Pradesh. The results of a simple cultural experiment conducted at Nagina Farm for 5 years to test the different practices of early and late sowings have revealed clearly that pre-monsoon sowings, i.e., sowing, done before the normal time, enable the crop to mature earlier besides giving an average increased yield of about 15 per cent. This practice could therefore be safely recommended in the canal irrigated areas. In the absence of early sowing, only very early varieties which cannot yield as high as T. 21 have got to be grown in order to minimise danger from drought. In order to ensure timely Rabi sowings it would be desirable to resort to early sowings of T. 21 for obtaining better yields.

At Gorakhpur Farm (Uttar Pradesh) the results of an experiment to find out the optimum date of sowing conducted over four years have revealed that the sowings done on the 10th June is the best, followed by 1st and 20th June. The sowings done later than 20th June are definitely poor, the yield being about half as much as that obtained in 10th June sowing.

Kashmir State. The experiment conducted in Kashmir State for 3 years from 1948 to 1951 involving three dates of broadcast sowing, two in May and one in June, with an interval of 10 days between the consecutive sowings, showed clearly that the yield declined progressively to the extent of 25—40 per cent as the sowings got delayed.

From the results of the various experiments discussed above, one fact emerges out very clearly. The earlier the sowing, the better and higher is the yield even under different soil and climatic conditions. Further, there is also an indication that the response of different strains varies according to the early or late sowings and so it would be useful to determine the strains that would do well under early, medium or late sowings for each distinct zone with a view to getting better output of the crops.

B. Wet Rice

(i) Sowing practices

In the case of wet cultivation, seed is either directly sown in a puddled field which is perfectly levelled before sowing or the field is transplanted with seedlings raised in a separate seed bed. Of the above two practices, transplanting is by far the more important and wherever water facilities for transplanting prevail cultivators prefer it to broadcasting. It may be mentioned here that nearly four-fifths of the rice grown in the world is transplanted and almost all countries like Spain, Italy and Japan etc., where highest acre yields are recorded, adopt only transplanting.

Broadcasting in puddle is usually practised only with early varieties in double rice crop areas in South India. This practice has a few distinct advantages of its own over transplanting in some tracts where, though ample facilities are available for transplanting, broadcasting is generally done due to the peculiar conditions which necessitate the adoption of the above system of cultivation. These have already been dealt with earlier in this Bulletin.
In the preceding section, the practices as obtained for sowing paddy have been described and it is now proposed to discuss here the relative merits and demerits, as also the principles involved in the above two practices namely, broadcasting and transplanting.

**Transplanting versus broadcasting.** Rice growers believe that transplanting, apart from helping in maintaining the purity of the varieties, makes the plants more productive. Undoubtedly, it is true that in almost all the rice growing tracts whether in India or outside, transplanting of rice ordinarily does give better yield than broadcasting. Various theories have been advanced for this increased yield. Graham in his preliminary note on the classification of rice in the Madhya Pradesh states "... Transplanting acts in a way like root pruning, i.e., the injury to the root system stimulating the growth of the subaerial portion and resulting in increased tillering". H. W. Jacks in his preliminary report on experiments with wet rice in Krian says "... the end result as far as tillering and yield are concerned, is the product of the resultant of two factors, viz., a stimulus due to shock of transplantation and a nutrition factor dependent on the richness of the soil in plant food". But the later work by Joshi at Kharjat Farm and Ramiah at Coimbatore paddy breeding station disproved the above ideas.

In recent years the results of statistically well laid out experiments on broadcasting and transplanting conducted at the various Research Stations in Madras State have unmistakably pointed out that none of the previous notions of Graham and Jacks are tenable. These experiments proved that under ideal agronomic and seasonal conditions, the dibbled plots would give as much or even higher yields than the transplanted ones.

None the less, the practice of transplanting is preferred to broadcasting for various other obvious reasons which will be dealt with in detail later in this section. The results of the various experiments on this problem in the different States are briefly discussed below.

**Research Stations, Madras State.** In Madras State at nine Research Stations an experiment with the following treatments i.e., (1) Dibbling sprouted seeds at 2—3 seeds per hole 6’ × 6’ either way, (2) dibbling seeds treated with powdered cowdung as in (1), (3) broadcasting seed at the same rate as above, (4) transplanting—was conducted for a period ranging from 3 to 5 years. It was found that in 6 out of 9 cases the treatment of dibbling seed smeared with cowdung has given increased yields over transplanting, the amount of such increase ranging from 115 to 315 lbs. per acre.

**Dibbling seeds.** It may be mentioned here that earlier work done at Coimbatore during 1931 to 1934 has pointed out that transplanting was superior to broadcasting by about 5 to 33 per cent which depends mainly upon the nature of the variety involved and the seasonal factors. However, the results of an experiment in the year 1937—39 with the strain CO.4—a very long duration variety have on the contrary shown that dibbling seed is decidedly better than transplanting by about 34 per cent.

The results of a similar experiment conducted at Pattukottai Farm (Madras) with a view to solve the problem of labour scarcity usually experienced at the time of transplanting, have clearly shown that in the case of Samba (long duration) as well as "thaladi" i.e., second crop, transplanting is found to be distinctly superior to 'broadcasting' in all the five years of the trial but with regard to the "Kuruvai" or first crop, the results of six years trial varied from year to year. In two years broadcasting was found to give higher yield than transplanting and in 3 years transplanting gave higher yield than broadcasting and in one year the result of the experiment was insignificant.

It would appear from the critical examination of the results of the experiments of various farms in different years that if timely sowings could be done and if the seasonal factors are favourable for the young crop as also the fields are prepared well, broadcasting or dibbling seed is as good as transplanting. However, all these conditions are rarely obtained. So it
is generally desirable to resort to transplanting because under this practice, the thorough preparation of the land by puddling provides ideal environs for the quick establishment of the newly transplanted seedlings. Also, clean cultivation effectively buries all kinds of weeds which would otherwise compete with the rice plants. The above mentioned factors seem to contribute mainly for the uniformly good yields obtained in transplanting.

Optimum period for sowing

The tables in Appendix No. I give the yield data of the experiments relating to the date of sowing and transplantings done in the different years at the Agricultural Research Station, Ambasamudram, Pattambi and Tiruruppam. A scrutiny of the data would suggest that there exists a critical period for the direct sowing operation for each and every variety analogous to that obtained in the case of transplanting. The varieties seem to give full expression to their yield attributes and contribute bigger yields only when they are sown in a particular period which is optimum for their maximum growth.

It would be seen from the data of the experiments at the Ambasamudram Station that in the case of bar or first crop, the direct sowings done in the first week of June in the year 1949 had given decidedly higher yield than transplanting by about 21 per cent, while it had given about 4 per cent less yield in the year 1948 when the sowing was done at the end of June. Similar indications are noticeable in the experiments conducted with the first crop variety at Tiruruppam and Pattambi. It is strikingly apparent from the results of the experiment conducted at Pattambi that if late sowing is inevitable due to the vagaries of the monsoons, it is distinctly advantageous to raise seed beds and adopt transplanting; for direct sowings done beyond the 7th May in the case of first crop have given invariably low yield as compared to transplanting. The reduction in yield ranges from 11 to 25 per cent.

Second crop trials

In connection with the second crop trials for the Godavari delta, experiments were conducted to find out (1) the optimum time of sowing the crop and (2) to see which would be better, transplanting or broadcasting. The results showed that for early sowings in December, transplanting was just as good as or slightly better than broadcasting whereas for late sowings in January, broadcasting was distinctly better than transplanting. It has also been observed that the evidence of stem borer attack in the broadcast crop seemed to be less as compared to transplanted crop. Further work on the determination of the critical period of sowing for each particular strain is needed as the information resulting therefrom would be of great practical value to the cultivator.

'Biyasi' cultivation of Orissa and Madhya Pradesh

In Orissa and Madhya Pradesh States in nearly 75 per cent of the rice area, there prevails what is known as 'Biyasi' cultivation of rice where the seed is sown broadcast in situ and the young crop after four or six weeks is cross ploughed with light country plough. This ploughing is done with about two inches of standing water in the field and planked if there are too many weeds. Following the above operation, a sort of weeding of the crop is done. Thinning it wherever the seedlings are crowded and simultaneously filling up the gaps with the thinned out seedlings is part of the operation.

This practice of 'Biyasi' or 'bushenning' as is called in Orissa State, serves the triple object of weeding, thinning and stimulating the growth of the crop to vigour. 'Biyasi' thus effects an improvement over simple broadcasting in that, the disturbance of the soil 4 to 6 weeks after sowing promotes increased root formation and the thinning of the crop induces better tillering due to the greater spacing between the plants.
It is worthwhile to observe here that the effect of 'biassing' seems to reduce the straw yield and increase the grain yield by checking vegetative growth for a period of about 12 to 18 days.

From the results of the experiment conducted in the observation plots of Labhandi Farm in the earlier years, and subsequently on the regular replicated randomised blocks for 4 years i.e., from 1935-38, both under 'Matasi' (sandy loam) and 'Dorsa' (clay loam), it is seen that 'biassing' is definitely superior to broadcasting in all the varieties whether early, medium or late duration ones. The increase in yield ranges from 5 to 40 per cent. Here too, transplanting undoubtedly has proved to be better than 'biassing', the increase in yield ranging from 6 to 73 per cent. It may however be mentioned here that 'biassing' was as good as transplanting in some years especially in the case of late duration varieties. The yield data of the experiment is given in Appendix II.

Cuttack. At the Central Rice Research Institute, Cuttack, the relative merits of 'buskenning' and transplanting were tested for four years in different situations. It is seen from the results that in 3 out of 4 years, there was no difference in yield between the above two treatments. However, it may be pointed here that at the time of transplanting, there were generally heavy rains which caused the submergence of the new transplants for about a week, thus resulting in slight mortality of the seedlings.

Where facilities for early plantings exist and where it is possible to establish the crop before it's temporary submergence occurs, it is desirable to resort to the method of transplanting. This has given better yield than 'Broadcasting and Buskenning' by about 23 per cent as seen from the result of another trial carried out at the Central Rice Research Institute under more favourable weather conditions. In connection with the second crop trials for tracts having irrigation facilities, observations made at the Central Rice Research Institute have revealed that the yield of broadcast crop is as good as transplanted ones. It is less susceptible to stem borer attack.

Assam. The results of a similar trial with the Aman crop conducted at Habibganj Farm in Assam State have shown that under deep water conditions obtaining there, the practice of broadcast sowing the field in the wake of the first monsoon showers has proved to be distinctly superior to transplanting. This is probably due to the fact that by virtue of early sowing the crop has firm anchorage with a capacity and ability to withstand the mechanical force of the onrush of flood water. It has also a greater stamina to grow quickly and keep pace with the gradual rise in the level of water. A freshly transplanted crop could not be expected to face rigours of the monsoon rains, especially if the monsoon rains happened to be strong and active soon after planting. In the circumstance, it would therefore be advantageous to adopt the method of broadcasting in preference to transplanting.

Boro cultivation

With regard to boro cultivation the results of four years trial have shown that transplanting is better than broadcasting with the added advantage that the cost of weeding in transplanting is much less as compared to broadcasting. Further, early broadcasting is not always possible due to the late recedence of water from the 'boro' field.

Kashmir State. Experiments on different dates of broadcast sowing and transplanting for five years were conducted with a view to assess their relative merits and demerits and the results of the experiments as evidenced from the yield data of 3 normal years, have given the following conclusions:

(1) The earlier the sowing, preferably in the month of May, the better is the yield. There is a progressive reduction in yield with the delay in sowing. Similar is the trend of the result with transplanting also.

(2) Curiously enough, broadcasting has given invariably higher yield over transplanting. The amount of the increase in yield, depending on the date of sowing has ranged from 100 to 340 lb. per acre. In this connection it must be pointed out here that 'transplanting' might have
given as good as or even better yield than 'broadcasting', if the spacing adopted had been less, say 4 to 6 inches, instead of 9 inches. Further, if robust seedlings from thin sown seed beds with two seedlings per hole, instead of lanky seedlings from thick sown seed bed with single seedling per hole, had been used for the experiment, the results might have been better.

Bihar. The results of an experiment involving broadcasting and transplanting as one of the treatments conducted at Kanke, Bihar for a period of 3 years (1936-38) have shown clearly that under optimum conditions of sowing, broadcasting is as good as transplanting in point of yield. A similar experiment conducted at Sabour Farm (Bihar) for a period of 5 years (1935-39) has given results which have varied a good deal from year to year depending on season, time of planting, etc. In favourable seasons the yield of broadcasted crop was found to be as good as one obtained from transplanting. In years when the transplanted crop was affected immediately after planting by heavy rains and floods, it had given lower yield as compared to broadcasting by about 25-35 per cent.

At Sabour an experiment with 2³ factorial designs involving 2 methods of sowing i.e., broadcasting and transplanting, two varieties, two cultural practices, two different doses of nitrogen and also two different doses of P₂O₅ was conducted for two years i.e., 1939 and 1940 and the results of the experiment revealed the following facts:

1. The cultural treatments broadcasting and transplanting did not show marked difference in yield;
2. Definite spacing gave higher yield than indefinite spacing in the case of broadcasting;
3. The response to nitrogen was markedly more with definite spacing for both broadcasting and transplanting, in the case of the variety 16 BK. The combined yield data of the two years are given in Appendix III.

At Bankura Farm (West Bengal), it has been observed that with early maturing varieties both dibbling and broadcasting had given better yield than transplanting. Transplanting, no doubt, gives better yield or as good as broadcasting, only when favourable seasonal conditions facilitate planting at the right time with seedlings of optimum age. But these conditions are not always obtained with the result that the late transplanting done with aged seedlings gives very poor output. Sometimes this is below even half of the yield obtained from a broadcast crop under such circumstances.

At Nagina (Uttar Pradesh), the results of a broadcasting vs transplanting experiment conducted for 4 years with the strain T. 21, a medium early type, gave the following results. In two years, broadcasting before the break of the monsoon, was superior to transplanting, the increase in the yield ranging from 11 to 43 per cent. In one year, transplanting gave higher yield over broadcasting by about 21 per cent. The yield increase in both the cases is statistically significant. In one year, however, the yield of both was practically the same. It would appear from the examination of the rainfall data that if the amount of July and August rains is plentiful, the yield of the broadcast crop is better than transplanted one, provided the sowing is done in the first week of June.

Bottlenecks in adopting broadcasting method. It is evident from the foregoing discussion on the results obtained from the various experiments that the systems of the straight sowing of the seed either in dry or puddled soils are as efficient in respect of yield as the method of transplanting, provided the soil conditions are ideal and seasons are favourable. However, there are many bottlenecks for adopting extensively the practice of broadcasting under ideal conditions and at the right sowing time. It may be mentioned that the above two important factors largely influence the ultimate yield of the crop. If broadcasting is not done under ideal conditions, the yield of a broadcast crop is usually poor as compared to that of the transplanted one.
In view of the recent developments in weedicides, there is a good scope for the large scale adoption of the practice of broadcasting or drilling or dibbling, with a view to get not only good yield but also to reduce the cost of production. However, for the present, as it is difficult to obtain always such ideal conditions for broadcasting, it is more often safe to take to the method of transplanting, for as is evident from the results of various trials, transplanting has given yields as good as or even better than broadcasting under all favourable or adverse seasonal conditions. Therefore, which system of rice growing is best and economical for a tract could only be decided on consideration of the local soil, climatic and other factors. It would thus be seen that transplanting is more a measure of expediency than a requisite condition for obtaining a bumper yield of a crop.

**Advantages of Transplanting.** Transplanting is, however, economically advantageous for the following reasons:

1. It enables the cultivator to put fields under thorough cultivation in an economic way;
2. The puddling operation, a pre-requisite condition for planting, buries all kinds of weeds which would otherwise deprive the rice plant of its plant nutrients;
3. The seedlings on transplanting in soft puddle are invigorated and put forth fresh roots in all directions with an extended root system and thus facilitate better utilization of plant food from all round;
4. The method of transplanting affords an excellent means of tiding over the heavy rainfall conditions in the early period of the growth which is experienced in the heavy rainfall tract of Bombay State. It also helps to get over the droughty conditions in the less favoured rainfall tract. The raising of the nurseries under wells or ponds well in advance, would go a long way in curtailling the cost of the field irrigation of broadcast crop. This would also facilitate in putting the crop in the field in the right season in order to get good outturn and to reduce the maturity period of the crop;
5. It often happens that thrips and other insects attack the crop soon after sowing. When this infection occurs in the seed-bed, it is easily controllable and economical too ; whereas in the case of broadcast crop it is not so. In most cases it would be impossible to adopt control measures on a large scale;
6. The broadcast crop suffers more from the vicissitudes of weather conditions, whereas the transplanted crop is not usually affected to such an extent;
7. Broadcast crop is liable to lodge prematurely because of the poor root system whereas a transplanted crop has a better development of root system to withstand lodging etc.

By far the most important advantage is the thorough cultivation of the field which keeps down the weeds effectively and thus reduce the cost of cultivation.

**(ii) Sowing sprouted seed vs. non-sprouted seed**

It is the usual practice to sow ungerminated seed in highlands by broadcast method in fine tilth under optimum soil conditions and moisture. Sprouted seeds are sown broadcast only in puddled soils specially in certain tracts as obtained in Travancore and southern parts of Madras where the practice of broadcasting has proved to be economical. Sowing of sprouted seeds facilitates early and uniform start of the seedlings. Otherwise it has no other special merit. Experiments on the relative advantages of sowing sprouted or dry seed have not, however, been carried out in the tracts where the practice is in vogue and so it is not possible to draw any definite conclusions about the relative merits.
'Machowa' practice of sowing. There prevails in the north of Madhya Pradesh the practice of sowing sprouted seed known as 'Machowa'. In 'Machowa,' the early preparation of the land is same as that for broadcasting but the only difference between the two is that in 'Machowa', the soil is puddled subsequently, destroying the weeds etc., and the germinated seed is sown broadcast. This would naturally cause delay in sowing. None the less, it has been found that the practice has offered certain distinct advantages over broadcasting ungerminated seed in the wake of the pre-monsoon rains and they are (1) the control of wild rice—a great menace responsible for lowering the yield considerably, (2) the use of sunhemp or other green leaf brought from outside applied as green leaf manuring, and (3) the weeds are effectively destroyed.

It may, however, be pointed out here that the success of 'Machowa' is closely associated with a period of drizzling rain for some days after sowing. If conditions permit the raising of seedlings early with the help of well water or with the early monsoon showers, it would be decidedly advantageous to resort to transplanting at the time when the 'Machowa' is done as is evidenced from the results of a trial at Adhartal Farm, the increase in yield of transplanting over 'Machowa' being 28 per cent. The potentiality of adopting the above practice under similar conditions prevailing in Orissa State for increasing the yield three fold has been discussed in detail under broadcasting in earlier pages.

Jarai Practice. It is worthwhile to mention here about the practice of 'Jarai'. In this method the seeds are subjected to pre-treatment before sowing by sprouting the seeds and drying them for 2 days and storing them for a certain period ranging from 2 to 30 days. Whether or not this pre-treatment of seeds influences the ultimate yield of the crop, has been tested for two years (1940-41) at Nagina (Uttar Pradesh) and for one year (1951) at Gorakhpur (Uttar Pradesh).

At Nagina the treatments were as follows:

I. Seed soaked in water 2 days
   (1) Sown immediately
   (2) Sown after 4 days drying
   (3) Sown after 8 days drying

II. Seed soaked in water 4 days
   (4) Sown immediately
   (5) Sown after 4 days drying
   (6) Sown after 8 days drying

The treatments at Gorakhpur experiment were as follows:
   (1) Germinated seed dried for 2 days and stored for 30 days
   (2) Germinated seed sown immediately
   (3) Ungerminated seed
   (4) Germinated seed dried for 2 days and stored for 15 days

The yield data of the different treatments of the experiment at Nagina have revealed that there is no effect on the yield of paddy by the various 'Jarai' practices. But the results of the trial at Gorakhpur have shown that the yield of the treatment "Germinated seed dried for 2 days and stored for 30 days" was better than that of the treatment "Ungerminated seed" by about 21 per cent, but this increase was not statistically significant. The usefulness or otherwise of this 'Jarai' practice in enhancing the yield of the crop needs further investigation as it is not safe to judge the merits or demerits of this practice from 2 years' results which are not consistent.
Akin to ‘Jarai’ practice, there prevails in Travancore & Cochin State a similar method of germinating the seed and drying them in thin layers either under shade or in the direct sun for about an hour at noon time and the seed so treated is kept stored for a period of even 30 days after drying without detriment to their regerminating capacity. In this tract, the above pre-treatment of seed is not done for increasing the yield of the crop, but it is more often necessitated due to peculiar conditions that arise at the time of sowing. Under the conditions prevailing there it often happens that sowing is made impossible on the proposed day due to several factors beyond the control of the cultivator like the breakdown of the pumping machinery used for removing the excess water in the field before sowing, unexpected heavy rainfall etc. It is under these circumstances that the above treatment of the sprout d seed is resorted to with a view to keeping the viability of the seed unimpaired so that the same seed material could be utilised without loss for subsequent sowings. This pre-treatment of seed resembling vernalisation of seed adopted in other countries needs detailed investigation and might offer great scope for exploring the possibility of, (if not enhancing the yield of the crop), advancing the maturity of the crop by a few days and any improvement in this direction is bound to make a great leeway in influencing profoundly the yield of the crops that are often affected by drought conditions at the maturing phase.

In the preceding portion, the advantages of transplanting have been brought out and it is now proposed to deal with the various operations connected with it, namely:

(i) The preparation of seed-beds for rice and the different methods of raising seedlings;

(ii) Preparation of seed-beds for rice

There are 3 methods of raising the seed-beds (1) the dry (2) the semi-dry and (3) wet preparation. All three are adopted in different rice tracts.

The Dry Seed-bed. The dry seed-bed is invariably raised in the rice zones where a sufficient supply of moisture through rainfall is assured and where the soil is sufficiently friable to retain moisture. Such seed-beds are seen in the Konkan districts of Bombay, the West Coast of Madras and in some parts of Uttar Pradesh, Bihar and Orissa States.

The semi-dry nursery. The semi-dry nursery is a substitute for dry seed-bed commonly adopted in the Southern Districts of Madras where the seed-bed previously prepared into a fine tilth in the hot weather season is wetted with water from a well or pond and sown with seed. Here the seedlings are allowed to grow by irrigation sufficient to keep the soil moist but not wet. There is not much difference between the dry and semi-dry seed-beds; the only advantage of the latter is that it can be converted into the former type when necessity arises.

It has been observed at the Rice Research Station, Ambasamudram (Madras) that the practice of sowing sprouted seeds instead of non-sprouted seeds in the seed-bed which is prepared just like a wet seed-bed by creating a temporary puddle by working a few inches of the top soil with hand just before sowing, has given better and quite uniform germination and stand of the seedlings. It has also resulted in higher recovery of seedlings as compared with the customary dry seed-bed method. It should be pointed out here that it would be necessary to sprinkle old wood-ash alone or mixed with soil on the seed-bed after sowing just to cover the seed, lest the exposed seed be damaged by birds or squirrels etc.

In Madras State, the above two methods are invariably adopted for the first or early crops and the second crop grown in the same field. In States like Orissa, Bihar and West Bengal the method of raising wet nursery is rarely adopted. Wet seed-bed is undoubtedly the best method of obtaining quickly well grown seedlings within a short period for planting in the right season, and this is decidedly useful for the tracts with assured supply of irrigation for early
planting. But, the dry seed-bed has the advantage over the wet in places where the supply of water for the transplanting of the fields is uncertain and where immediate advantages of the available water is taken early for transplanting. It is possible to keep the seedlings in the dry seed-bed for a period longer than is usually allowed for a variety without inducing them to form nodes. This can be done by cutting off the irrigation water and thus curtailing and, or stinting their growth. The noded seedlings are found to depress the yield of the crop. In the case of wet seed-bed it cannot be allowed to dry up without serious damage to the seedlings. It may be mentioned here that the seedlings of dry seed-bed are generally harder and more capable of withstanding adverse conditions than those of the wet seed-bed. A detailed account of preparing an ideal wet seed-bed and a dry seed-bed is given below.

(a) **Wet seed-bed**

It is desirable to raise wet seed-bed if water facilities exist as the seedlings raised under this system grow very quickly and become fit for planting even after 24 to 30 days. The most fertile portion of one's holding is usually ear-marked as the seed-bed area. The seed-bed is ploughed twice either under dry or wet conditions at the first instance and thereafter it is puddled by giving two or three more ploughings. Care should be taken to see that a film of water is always kept in the field and on no account it should be allowed to dry. After ten days, the field should be ploughed twice and finally levelled perfectly with a levelling board. Before the last ploughing is done, well decomposed manure or compost may be applied at the rate of 8 to 10 tons per acre and buried under. If green leaf is available, it may be applied at the rate of 10,000 lb. per acre just after the second ploughing and buried into the soil. When the leaves have decomposed in about three weeks, the field is ploughed a number of times until the soil is stirred into a soft puddle.

When the field is thus brought to a fine soft puddle, it is conveniently divided into small raised beds of 9'-12' width. The field is marked into beds by means of laying ropes at 12 ft. apart, leaving a space 1 ft. between them for a channel. The loose soil from the demarcated channel is taken by hand to a depth of about 9 inches and thrown on either side of the beds thus raising the beds slightly. These beds are then thoroughly levelled by working the levelling board twice.

The formation of a channel all round and in between the small beds facilitates the sower to go round the beds twice or thrice for sowing the seeds quite evenly. Further, these channels facilitate the drainage of water after sowing. It may be mentioned here that the preparation of the nursery bed as described above may be done in the morning, allowing one or two inches of clear water in the bed. This helps the colloidal particles to settle down thus making the water very clear so that the sower can see the soil through the water, and do the sowing uniformly. The sowing should be done in the evening. The sprouted seeds are taken in a convenient receptacle, say a winnow or small basket. The sower, taking a handful of seed in his hand drops the seed gently through his fingers by shaking his hand and manipulating his fingers simultaneously.

Next day, the water in the seed-bed should be drained completely. If splashing rain is expected on the day of draining, it is advisable to let water remain in the nursery, otherwise the beating rain will dislodge seeds, collecting those on odd sides apart from burying those in the mud. This would result in the unsatisfactory germination and uneven stand and growth. If water accumulates in small pockets in the beds it should be drained away by means of a thin stick. This can be done by standing in the channel and drawing out the water through the trail formed by the stick, from the pocket to the channel. If this is not done the seeds lying there are likely to rot. After 3 or 4 days, depending upon the physical texture of the soil, when hair cracks are forming, the nursery should be irrigated lightly. This should be continued till the seedlings are about 2 inches high. Thereafter it is desirable to maintain always half an inch of water. However, the water should be changed frequently.
In case the growth of the seedlings is not up to the mark, it is recommended to top dress the seedlings with 50--100 lb. of ammonium sulphate per acre, a week or 10 days before uprooting the seedlings for transplanting.

Seed rate. For short duration coarse varieties, 4 lb. of seed may be sown in one cent (435.6 Sq. ft.) of land. If the preparation of the seed-bed is done ideally, the robust seedlings obtained from 10 cents of nursery may be sufficient to transplant an acre with a spacing 4' × 4' apart either way and with two seedlings per hill. However, making due allowance for unforeseen contingencies such as low germination in the field due to defective preparation of the seed-bed or the snapping of the seedlings while pulling due to faulty irrigation etc., a nursery area of 12 cents as the maximum may be assigned for transplanting an acre of land.

In the case of long duration varieties, 3 lb. of seed may be sown in a cent. Seedlings thus raised in 7 or 8 cents would be sufficient to transplant an acre of land.

It may be pointed out here that it will always prove a useful practice to adjust the seed rate according to the size of the grain. It is recommended to sow sprouted seeds as it ensures uniform stand of the seedlings in the seed-bed. This may best be obtained by adopting the following procedure.

Method of sprouting seeds. The seed required for the nursery bed is taken in a gunny bag and loosely tied at the mouth. This is put in a channel or pond say in the evening at 4 P. M. and removed the next day at about 8 A.M. The water in the bag is completely drained by keeping the bag under shade on two bamboos kept in a slanting position. After an hour or so, the bag is kept in the corner of a room, placing one or two wet gunnies over it. This ensures optimum conditions for good germination. The next day it will be found that the seeds have sprouted well. The seeds, thus sprouted should be sown in the prepared seed-bed described above. The pre-germination, gives every seed a good chance to come up and undoubtedly aids in getting a quick and even stand in the seed-bed.

(b) Dry seed-bed

The field selected for the seed-bed should be thoroughly ploughed by giving six or seven ploughings if need be, so that a fine tilth is obtained. Care should be taken in initially opening the soil. The field should be taken up for ploughing at the right time when it is neither too moist nor too dry. If it is very moist, it will throw clods but if it is too dry it will be difficult to plough. After giving 2 or three ploughings, the small clods should be broken by passing the ladder twice, weighted by the ploughman standing on it if it need be, to break the big clods.

Manuring and sowing. Well decomposed cattle manure or compost at the rate of 8 to 10 tons to an acre or 8—10 mds. of well powdered ground-nut cake may be evenly spread and incorporated by giving one or two ploughings. On the date of sowing the field should be ploughed once and perfectly laddered. After getting a fine tilth the seeds may be sown broadcast at the rate of 4 lb. to a cent if the variety is a coarse type or 3 lb. if it is a fine one. When the seed is sown uniformly, a light country-plough is worked without going deep into the soil, and then laddered. This helps in covering the seed. If it is found necessary, laddering can be done for 2 days subsequently with a view to consolidating the soil and thereby stimulating quick germination. But if there is water facility, a light irrigation is given on the third day.

Irrigation. When the sprouts have come out and are visible clearly, it is necessary to give very light irrigation once in 3 or 4 days depending upon the nature of the soil. The irrigation must be done judiciously. If the seed-bed is continuously and too frequently irrigated with
a view to attain quicker growth of the seedlings there will be difficulty in uprooting the seedlings. Due to the deeper root system caused by the above method of irrigation the seedlings are liable to break at the time of uprooting. There may be heavy mortality of seedlings which would further entail extra expenditure on labour required to pull the seedling.

It may be noted here that the seedlings raised by this method may not grow as quickly as those raised under wet seed-bed but these seedlings are hardy and establish themselves very quickly and make much headway in the growth soon after they are transplanted in the field.

(c) Raised seed-bed

It has been observed at the Central Rice Research Institute, Cuttack, that seedlings raised in raised seed-beds do come up much more vigorously than those grown on ordinary flat seed-beds. These are also easy to be uprooted. Whether or not to adopt this practice on an extensive scale depends largely on the availability of labour, the seasonal conditions and above all, time factor to get through the operation as expeditiously as possible while the favourable moisture conditions prevail at the break of the monsoon.

(iv) Comparative merits of dry seed-bed and wet seed-bed

The comparative merits of seedlings from wet and dry nursery have been studied extensively in Madras State. The results of experiments conducted at the farms of Pattambi and Pattukottai (Madras) to compare the merits of dry and wet nurseries for the first crop of short duration varieties, have shown that there is not much difference between the two. In some years the dry seed-bed gave better yield over wet seed-bed and vice versa in certain other years. It is also seen from the results of the experiment at Pattukottai and Pattambi that only certain varieties respond well to wet nursery and not to dry nursery systems and vice versa. In general at Pattambi, wet nursery seems to be preferable to dry nursery in the case of mid and long duration strains like PTB.3 and PTB.4.

An experiment of similar nature conducted for one year at Aduthurai (Madras) with short duration strains has, however, indicated strikingly that the dry nursery was distinctly superior to wet nursery; the increase in yield depending on the strains, ranged from 20 to 32 per cent. Much reliance cannot be placed on the validity of general conclusion reached in one year’s trial only.

At Coimbatore (Madras) the results of a similar trial with long duration varieties conducted over three years have not given any conclusive evidence in favour of either dry or wet nursery.

It has been observed at Samalkot Farm that, for the second crop of rice, the seedling obtained from dry nursery have proved to be better than wet nursery seedlings in point of quick establishment of the crop soon after planting. It would appear from the available experimental data that there is not much difference between the productive powers of the two kinds of seedlings. It would, therefore, be the convenience and the available facilities of irrigation and other resources that would largely determine as to what type of seed-bed the cultivator should raise so that he could do planting with seedlings of optimum age at the right planting time. This is the most important factor to be reckoned with as this influences the yield of the crop to a considerable degree.

It is worthwhile mentioning here that it is possible to reduce the maturity period of a crop by adopting a suitable method of raising seed-beds in which both the treatments of wet and dry nurseries are combined. The principles underlying this will be dealt in detail in subsequent chapters.
C. SEED-RATE FOR THE SEED-BED AND BED MANURING, ETC.

Theoretically, if an acre of land is to be planted with seedlings spaced at 4" by 4", 6" by 6", 6" by 12" and 12" by 12", with single seedling per hole, it would need about 4,00,000, 1,75,000, 87,000 and 43,600 seedlings respectively and this number could be obtained from 20 lb. and 9 lb., and 4 lb. and 2 lb. of seed respectively if it is a coarse type (one ounce of seed may contain about 1,400 to 1,500 grains of paddy). If 2 or 3 seedlings are planted per hole, the above quantity would have to be doubled or trebled as the case may be. Further, if the variety involved is of fine or superfine nature, the number of grains contained in one ounce of seed would naturally be more, nearly one and half to two times that of coarse variety. As a corollary, the seed rate would become half to 2/3rd of the coarse variety noted above.

The above calculation is based on the assumption that the germinating capacity of the cent per cent viable seed is cent per cent under field conditions. Theory and practice are always at variance. Even under ideal field conditions with cent per cent viable seeds, it would not be possible to recover seedlings from all the sown seeds. A due allowance of 5 to 10 per cent would have to be given to meet the contingencies.

It will be seen in the section under optimum spacing that in most of the rice growing tracts the best spacing for short rices is 4" by 4" and for long duration varieties 6" by 6" or 6" by 12" with two seedlings per hole. It would therefore be obvious that the quantity of seed required for planting an acre of land for short duration varieties of coarse and fine types would be about 42 and 21 or 28 lb. respectively and in the case of long duration varieties of coarse and fine types, the quantity would be much less i.e., depending on the spacing 9 lb. to 20 lb. and 6 lb. to 13 lb. respectively.

It is matter of common experience that in actual cultivation practices, various unforeseen factors such as unexpected rains at or after the sowings, heavy mortality of the seedlings during uprooting due to faulty irrigation and damage due to insect pests etc., arise and reduce the number of seedlings in the seed bed. Taking these limitations into consideration, it would be safe to adopt a seed rate of 48 lb. and 21 lb. for the short and long duration coarse varieties respectively. Having determined the optimum quantity of seed what is of major importance to a cultivator big or small is the correct seed rate to be sown in a cent of seed bed (435.6 sq.ft.) in order to obtain sturdy seedlings, that would give the best outturn of the crop. Seed rates as high as 24 lb. in one cent of land as in Kashmir and as low as 1 lb. in one cent of seed-bed as in Godavari delta (Madras) are in vogue. There seem to be special reasons for adopting varying seed rates in these tracts.

Factors such as the availability of seed-bed area, properties of the nursery soil, the irrigation resources, facilities for irrigating the seed-bed and the tenure system etc., have an important bearing in deciding the economical aspect of raising the seedlings. This would naturally lead a cultivator to use a high seed rate in the seed-bed so that he could obtain enough seedling in as limited an area of nursery as possible to cover as large an area as he could put under transplantation. This practice would minimize his cost for raising seedling. The pros and cons of using seedlings from thick sown seed bed and thin sown seed bed will be discussed in the following pages. Here, only this may be mentioned that it is a sound practice to sow 4 lb. of seed in one cent of seed-bed in the case of coarse varieties and 2 lb. of seed in the case of medium or fine varieties. Normally 10 or 12 cents of nursery for the former and 7-8 cents for the latter would be sufficient to transplant an acre of land.

1. Thick and thin sowing of seed-bed

Whether it be for dry or wet seed-bed, the seed rate adopted determines the nature and condition of the seedlings. The thinner sowings give rise to strong, sturdy and tillered seedlings

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(i) Thick and thin sowing of seed-bed

Whether it be for dry or wet seed-bed, the seed rate adopted determines the nature and condition of the seedlings. The thinner sowings give rise to strong, sturdy and tillered seedlings.
whereas the thicker sowings yield poor and weak seedlings. The relative productive power of these two types of seedlings have been reviewed briefly below.

Coimbatore. At the Paddy Breeding Station Coimbatore, three types of seedlings were planted: (1) strong and tillered, (2) strong but not tillered, and (3) weak and not tillered. These seedlings were sorted out from a seed-bed area. The final yields of these three types were in the ratio of 143: 112: 100 respectively. It is possible that the strong and tillered seedlings might have shown such a big increase due to the unfavourable rice season in that year of the trial, but none the less there was a positive indication that the condition of the seedlings at the time of planting did affect the final results.

In the year 1941, at the same station, it was seen that the grain yield of plots planted with tillered seedlings was significantly higher by 11 per cent over non-tillered strong and 17 per cent over non-tillered weak seedlings. In point of straw, tillered seedlings recorded increase of 38.9 and 36.3 per cent respectively over non-tillered strong and weak seedlings respectively.

Strong and tillered type seedlings as used in the above experiment can be obtained if a very thin seed rate of say 1/4 lb. in one cent of seed-bed is adopted, but this would mean a large area of nursery and it might not be well within the means of an ordinary cultivator to adopt the above practice at such a high cost of production of seedlings. With a view to assessing the relative merits of the thick and thin sown seedlings, experiments adopting varying seed rates were conducted at Samalkot, Maruteru and Pattambi (Madras).

The results of the experiment conducted over 4 years (1922-25) at Samalkot showed conclusively that thin sowing i.e., 300 lb. of seed per acre was always better than thick sowing i.e., 1,200 lb. per acre. It has been observed that the factors that contributed to the high yield of seedlings from thin sown seed-bed are: (i) the greater length of the ear-head, (ii) the heavier weight of the grains. It also showed that an early variety gave better yields than a late variety when the seed rate was lowered. That early varieties responded better to thin sowing was also evident in an experiment conducted at Maruteru where 'bassangi' (short duration) gave a much better response to thin sowing than 'Atragada'. The increase in yield in the case of 'bassangi' was 14 per cent, while in the case of 'Atragada' it was only 6 per cent.

The results of a seed rate experiment involving 3/4 lb., 3 lb. and 2 lb. of seed sown in a cent of seed-bed, conducted at Maruteru in 1933 have shown that as the seed rate got reduced, the yield got increased, the amount of increase in yield depending on the varieties, varying from 3 to 15 per cent. The response in the case of fine varieties seems to be very perceptible for the low seed rate of 2 lb. It may, however, be mentioned here that the above experiment carried out in 1934 and 1935 did not reveal any difference in yield of the different seed rate treatments, the seed rate of 3/4 lb. being as good as 3 or 2 lb. rate. The experiment, however, did not satisfy the 'z' test and so it would not be safe to rely on the results.

The results of a seed rate experiment involving 4, 8, 12 and 16 maunds per acre in the seed-beds have indicated that the above seed rates do not seem to affect the yield in any way. At the Karinganj Farm (Assam) the results of the seed rate experiment involving 4, 8, 12 and 16 maunds per acre in the seed-beds have indicated that the above seed rates do not seem to affect the yield in any way. At the Karinganj Farm (Assam) also, the seed rates varying from 4 maunds to 7 maunds per acre in the seed-beds have not shown any difference in the yield of the crops.
It has been observed that too low a seed rate induces deep rooting and presents some difficulty in uprooting, whereas too heavy a seed rate produces weak seedlings which give way on pulling. These are unable to overcome adverse environmental conditions during and after transplanting. A seed rate of 6 maundi per acre i.e., about 5 lb. of seed in one cent of land has been found to be the most suitable one from practical consideration both for ‘Sail’ as well as ‘Boro’ paddy. It may be pointed out here that if the seedlings are raised in raised seed-beds with plenty of organic manure and wood-ash, it may be possible to reduce the seed rate to 3 lb. per cent of seed-bed without the disadvantages usually noticed in the use of low seed rate.

At Nagina Farm (Uttar Pradesh), adopting a seed rate of about 4 lb. of seed in one cent of seed-bed has resulted in giving sturdy and tillered seedlings. This has been found to give good yield of the crop too. It has been noticed that there is no material advantage in reducing the seed rate still lower than 4 lb. in one cent.

It would appear from the results of the different experiments conducted in various farms that the optimum quantity of seed to be sown in a cent of seed-bed depends largely on the local conditions of the soil and the nature of varieties. Taking into consideration the economic aspects of raising seedlings, it would be safe to adopt a mean of 4 and 3 lb. of seed in a cent of nursery, for coarse and medium type of paddy respectively. For fine varieties 2 lb. of seed would suffice.

It is now proposed to deal with the special treatment of seed-beds and the seed weight influence on yield which are adopted in some rice tracts with a view to obtaining higher yield of the crop.

(ii) Heavy manuring and rabbing of seed-bed

It is a common belief that if the seed-bed is heavily manured and the seedlings are very vigorous, these seedlings when planted would give a better crop. Whether this practice would help in dispensing with field manuring has been a point that has engaged the attention of rice workers. If it does, it would minimise the cost of manuring the field to a considerable extent.

To test this point, experiments were conducted at Coimbatore with three varieties of rice of four, five and six months duration respectively. The seed-beds were prepared in three ways:

1. without any manure,
2. the ordinary method of manuring,
3. very intensively manured.

The intensive manuring of seed-bed consisted of the application of 20,000 lb. of leaf besides 112 lb. of super phosphate and 112 lb. of ammonium sulphate per acre. The seedlings from the heavily manured seed-bed had a very good growth. These were fit to be planted about a fortnight before the other seedlings. The results of the experiment showed that in all the varieties, the manuring of the seed-bed had no effect and the manured transplant field irrespective of the treatment of seed-bed, gave a higher yield than the unmanured.

A similar experiment was conducted at the Rice Research Stations, Berhampore, Maruteru and Aduthurai. In every case the intensively manured seedlings did not prove to be superior. At Aduthurai the normal manured seed-bed received 20,000 lb. of ‘kolinji’ leaf per acre, while the intensively manured seed-bed received besides 20,000 lb. of ‘kolinji’ leaf, 1,000 lbs. of ammonium sulphate, 1,000 lb. of super phosphate and 250 lb. of potassium sulphate per acre. It may be pointed out here that the very heavily manured seed-bed produced robust and tall seedlings which fit well to be planted within 28 days. On the other hand the seedlings from that of the nonmanured seed-bed were ready on the 40th day only. Thus planting could be advanced by 12 days in the case of seedlings from heavily manured
The advantage of manuring the seed-bed heavily could be easily taken in tracts where facilities for raising early seed-bed are not available. This way the seedlings of plantable size could be obtained within a short time for planting in the right planting period without prejudice to yield. Further it was also observed that flowering in the case of heavily manured seedling plots was earlier by about a week. At planting time great differences in the stand of the crop were noticed but these were, however, levelled out nicely in the end.

Uttar Pradesh. At Nagina station in Uttar Pradesh, experiments on manuring the seed-bed with different quantities of nitrogen i.e., 0, 100, 200 lb. per acre and with two seed rates 20 and 40 lb. for planting an acre was conducted for 3 years. The experiments included three levels of field manuring i.e., 0, 25 and 50 lb. of nitrogen per acre. The results of the experiments clearly indicated that there was practically no advantage in manuring the seed-bed. Similar results were also obtained from the experiments conducted at Gorakhpur farm for 3 years.

Bihar. Trials at Sabour in Bihar on manuring of nursery with ammonium sulphate, nih-phos and farm yard manure showed that although such nursery produced healthier and more vigorous seedlings with well developed root system, the ultimate yield was not affected in normal season. However, under adverse conditions of severe drought, etc., manured seedlings were found to do better.

Madhya Pradesh. At Raipur in Madhya Pradesh manuring of seed-beds was tried in 1934 and 1935 and it was found that the average yield obtained from manured seedlings was slightly higher as compared with the yield obtained from unmanured seedlings.

The results of various seed-bed manuring trials with heavy doses of fertilizers indicate that the ultimate yield of the crop planted with seedlings from heavily manured seed-beds is not increased to any appreciable extent. Field manuring seems to be more important and essential than that of nursery manuring. It may be emphasised here that the seed-bed should be manured normally and that most fertile portion of the field should be ear-marked for raising the nursery. Since heavy manuring of seed-beds produces vigorous and tall seedlings within 20 days, this practice is useful only in hastening the planting. It also facilitates early planting in time.

This coupled with field manuring promotes the flowering of the crop a week earlier than that of normal flowering. Therefore, the combined manuring of seed bed in a transplant field—would prove to be of great economic advantage in tracts which suffer from want of water specially at the lag end of the season.

(b) Rabbing of seed-bed

Mysore. At the Nagenhally and Babbar farms of Mysore State experiments comparing manuring of nursery and rabbing of nursery were carried out in 1945. Rabbing of nursery comprises of heaping organic refuse on the prepared seed-bed and setting fire to the heap. The burnt ash is then spread over the bed on which seeds are sown. The results of the experiments indicated that whereas 'Rabbing' was effective at both the places the manuring of the nursery was not. The increase in yield of about 6 per cent, noted at Babbar farm in favour of rabbing was, however, not statistically significant. The general trend of the experiment indicated that the rabbing was advantageous.

'Rabbing' is the special feature obtained in Konkan, Bombay State. Experiments on 'Rab Substitutes' conducted at various farms in Bombay State have revealed that the wasteful method of rab i.e., burning of the seed bed with cow-dung, branches and grass, can be substituted by manuring the seed-bed with farm yard or compost at 40 cart load and by the application of cake and ammonium sulphate or manure mixture at 40—60 lb. nitrogen per acre. The useful organic material could be better utilized for manuring the transplant field.
Special treatment of seed-bed

The second cropping of rice in the Godavari delta (Madras) is always successful, if the planting is done only from the middle of January up to the first week of February. The crop of the central and some portions of the eastern delta is always affected at its maturing phase on account of the shortage of water in the canal.

With a view to overcoming the above difficulty, the Maruteru station, as a result of several trials, has evolved the following system of raising seed-bed. This has resulted in inducing the crop to flower as earlier as by about a fortnight, thus saving the crop from the bad effects of drought at the flag end of its life.

In this special system of raising seed-bed, the practices adopted for raising wet and dry seed-beds are combined. To start with, the seed-bed is prepared well, as is done for the wet nursery. Sprouted seeds are sown in mid-December and the usual wet treatment is given for about three weeks. By this time the seedlings grow to a height of 8 to 10 inches. Thereafter, the water supply is completely cut off and the seed-bed is allowed to dry up. Deep fissures and cracks appear and the seedlings look as if they are scorching up. Later, at the time of planting i.e., last week of January or first week of February the seedlings are pulled out dry and are kept heaped up in a puddled plot for about 24 to 36 hours by which time the seedlings strike plenty of roots. Such seedlings when planted in the field establish themselves comparatively quicker, and the crop matures by about 10 days earlier than the usual crop.

It has also been observed that such seedlings resist unfavourable weather conditions including stem borer attack much better than the seedlings raised in the normal wet nurseries. This special practice of raising seed-bed is worthy of adoption after trial in tracts where similar conditions are obtained to get over water scarcity and the bad effects of weather conditions and insect damage.

Seed weight influence on yield

A seed material collected from a crop grown to an improved strain contains different grades of grain as the grains situated at the top and middle portions of an earhead are always somewhat bigger and better filled than the rest. It is believed that "better seed results in better crop". In Japan, the cultivators adopt the practice of separating the heavy seed from the light ones by using a brine solution of 18% concentration as a matter of routine and use only heavy seed for sowings. This practice of using heavy seed results in better yield. Whether or not the heavy seed gives higher yield than light seed was tested in three Agricultural Research Stations in Madras with the following results:

Samalkot Station. For 4 years from 1920 to 1924 at Samalkot Station, the seed sample was separated into heavy, medium and light seed in four varieties—"Ratlachudi"; Palagumma-sari; Garika Sannavari; Kannakasompu and planted separately. There was practically no difference in the productivity of the three samples, to justify the grading of the seed for sowing.

Coimbatore. At Coimbatore, the seed from strain Co. 4, a six months crop, was separated into three classes, heavy, medium and light by actually weighing individual grains and the three groups were sown separately. There was no difference in yield.

This experiment was repeated for two years (1935 and 1936) with a short duration variety Co. 10 of 125 days and another long duration variety Co. 3 of 180 days. The separation of the grain into heavy, medium and light was done with the help of different concentrations of sugar solution in 1935 and salt solution in 1937. The results of the year 1935 indicated no significant difference in yield between the different grades of seed. But the results of the year 1937 showed that in the case of the short duration variety, heavy seeds gave significantly higher yield than...
light seeds by about 8 per cent, while there was no significant difference between heavy and ungraded seed. However with regard to the long duration variety Co. 3, there was practically no difference in yield between heavy, medium or light seeds. The results are given below:

**TABLE I**

*Seed weight influence on yield*

Yield as percentage on control

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</tbody>
</table>

Co. I—A short duration paddy strain.  
Co. 3—a long duration paddy strain.

Aduthurai. A similar experiment was conducted at Aduthurai and the results were similar to that obtained at Coimbatore. This experiment has been conducted at a number of places in foreign countries and the general result of all such experiments have indicated that if the seed is from a pure line, i.e., seed developed from the produce of a single plant, breeding true for all its characters, there cannot be any inherent difference among the individual grains.

**Heavy versus light weight seeds**

It would appear from the experiments that there is an indication in favour of using heavy seed for short duration rices only and not for long duration ones. Probably the advantage of a better start obtained by the plant from a heavy seed continues for sometime. Since the period of maturity is short in the case of short duration varieties, the advantage of the better start is reflected in the yield. In the case of long duration variety it is not so as it has a longer growing period. Since there is no significant difference in yield between the heavy graded seed and the normal seed, especially in the long duration varieties, special treatment of the seed with brine solution to separate them into two grades seems superfluous. But, thorough cleaning and winnowing may be done to get rid of chaff and ill filled seed.

In the preceding pages, the methods of raising seedlings to suit the different locations of climatic and agronomic conditions and the importance of using strong and well-tillered seedlings have been stressed. It may be emphasised here that it is not the use of sturdy seedlings alone which is entirely responsible for contributing to the higher yield of the crop. Other factors, viz., the optimum age of the seedlings, spacing, number of seedlings per hole or hill and above all, the time of planting, etc., play an important part in determining the ultimate yield of the crop. The role of these factors and their interaction according to the varying soil, seasonal and agronomical conditions on the yield of the crop, have an important bearing and will be discussed at length.
D. AGE OF SEEDLINGS FOR TRANSPLANTING

The optimum age of the seedlings used for obtaining best results under transplantation method needs full consideration, since it has a direct bearing on the yield of the crop. As a rule, the shorter the duration of the variety, the shorter is the period allowed in the nursery; the longer the duration of the variety, the longer is the period allowed in the seed-bed. As a thumb rule, for every month's duration of the variety, a week's time is allowed in the seed-bed i.e., for 3 months' duration variety—4 weeks, for 5 months' duration variety—5 weeks and so on. This generally accepted principle seems to hold good, when transplanting is done in a particular tract for a particular variety at the normal planting season.

The results of various experiments carried out in different States detailed below show that the age of the seedlings could be varied without prejudicing the yield by suitable cultural treatments. These treatments are given with a view to tiding over certain practical difficulties, namely inadequate supply of water for puddling the land at the right season, a labour scarcity at the peak period of transplanting, the incidence of pests and diseases occurring at particular periods of the cropping season, etc.

Coimbatore. At Coimbatore (Madras), the results of age of seedling experiment in a long duration variety with four ages 25, 40, 55 and 70 days showed that there was no differential response in the yield of the crop by planting seedlings of different ages under Coimbatore conditions. Even in the 70 days old seedlings, there was no indication of the formation of nodes and the seedlings were quite healthy.

Aduthurai. At Aduthurai (Madras) a similar experiment with Nellore Samba, a six months' crop with planting seedlings of age 3, 4, 5, 6 and 7 weeks indicated that the yields were likely to be the same between the ages of three weeks and six weeks, the yields however going down beyond six weeks.

Berhampore. The results of an analogous experiment conducted at Berhampore (Madras) for 3 years with a five months' duration variety, 'Bayahunda', showed consistently that there was no significant difference in yield among ages 30 to 50 days. At Pattambi Station, a second crop variety PTB. 3 of five months' duration indicated the same result as obtained at Berhampore. There is no difference in the yield obtained from seedlings of 30 and 50 days.

In the case of early sown nurseries, planting of aged seedlings up to 50 days seemed to be preferable to planting younger seedlings.

It would, however, appear that in the case of the medium duration strain PTB. 2, the best age of the seedlings was found to be 42 days whether they were from dry or wet nursery.

Ambasamudram Station. At Ambasamudram Station (Madras) it was noticed that yield of a six months' variety (Co.8) was not affected adversely even if the age of the seedlings at the time of transplanting was 66 days old, provided of course that the planting was done at the right period i.e., by 20th October.

Samalkot Station. The influence of the period of planting in relation to the age of the seedlings will be discussed in detail under 'Optimum time of planting'. One of the earliest experiments conducted on this aspect at Samalkot Station between 1908 and 1914 with three ages i.e., 25, 35 and 45 days for the sarva (first) crop, showed that there was no difference in yield among the seedling of the ages of 25, 35 or 45 days under conditions i.e., whether the seed was sown on the same date, transplanting being done on different dates or whether the planting was all done on the same date, the sowings having been done on different dates.

Palur Station. At Palur Station (Madras) it was found that seedlings of 30, 40 and 50 days old in a six months' variety gave practically the same yield. However, the oldest seedling always took longer to establish themselves and invariably suffered more casualties. In the case of young seedlings, the tillering was quick, early and more as compared to the older ones.
Tirurkuppam, Madras. At Tirurkuppam (Madras) two short duration varieties Co. 13 and Adt. 14 with 3 ages of seedlings i.e., 3 weeks, 4 weeks and 5 weeks were tried with two spacings of 4" by 4" and 6" by 6" for two years (1949 & 1950). In the year 1949, the treatment differences were not statistically significant but there was an indication in the case of Co. 13 that the 3 weeks old seedlings were superior to 5 weeks by about 9 per cent, whereas in the case of Adt.14 there was no marked difference between the 3 ages of seedlings.

The result of the year 1950, however, has brought out clearly the merit of the 3 week old seedlings in the case of Co. 13, the difference in yield between 3 weeks and 5 weeks old seedlings being 18 per cent. There was no difference in yield between 3 weeks and 4 weeks old seedlings. In the case of the strain Adt. 14, however, 5 weeks old seedlings gave an increased yield of 11 per cent over three weeks old seedlings, with no difference in yield between 3 and 4 weeks old seedlings. This distinctly brings out the differential response of the varieties to the different ages of seedlings. The results of an analogous experiment with a long duration variety at Buchireddipalayam showed that there was no significant loss in yield by planting seedlings up to sixty days.

Visveswaraya Canal Farm (Mysore). The results of a complex cultural experiment conducted in 1942 on the Visveswaraya canal farm (Mysore) with a rainy season strain No. 684 planted in August has indicated that of the 3 ages of seedlings—45 days gave highest yield of straw and grain, the increased yield of grain and straw over 35 and 25 days seedlings being about 20 and 12 per cent respectively. There was very little difference between the seedlings of 25 and 35 days. Whereas, in the case of the strain No. 705 planted during summer in the middle of March at the Irwin Canal Farm, Mandya, 25 days seedlings gave higher yield of grain than the seedlings of the ages 35, 45 and 60, the amount of increase in yield over 45 and 60 days seedlings being about 23 per cent. There was little difference in yield between 25 and 35 days seedlings. Similar was the case between 45 and 60 days seedlings.

Karimganj and Titabar Stations. At Karimganj and Titabar Stations in the case of 'Sail' paddies it was noted that the ages of the seedlings from 30 to 50 days at the former farm and from 4 weeks to 8 weeks at the Titabar Farm did not affect materially the yield. Practical considerations, however, would seem to suggest that 5 to 6 weeks old seedlings are the best, as the younger seedlings give way and the older seedlings present some difficulty at the time of uprooting. In respect of 'Boro' paddy, it has been observed that younger seedlings of 4 weeks are better for early planting to be done on or before the 4th January while older seedlings are more suitable for late plantings done after 4th January.

At Karimganj Farm (Assam). The results of an experiment conducted over two years to find out the best age of seedlings for the 'Aus' crop have shown that the 30 days old seedlings are the best out of 10, 20, 30 and 40 days old seedlings. The average yield of the different treatments is given below:

<table>
<thead>
<tr>
<th>Yield in lb. per acre</th>
<th>10 days</th>
<th>20 days</th>
<th>30 days</th>
<th>40 days</th>
<th>Mean</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>1165</td>
<td>1317</td>
<td>1525</td>
<td>1474</td>
<td>1370</td>
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</table>

Nagina Station. At Nagina Station (Uttar Pradesh), the results of a threefold experiment in which seedlings of four ages i.e. 20, 30,40 and 50 days were involved has indicated that the different ages of seedlings did not appreciably affect the yield differently, there being only a slight difference in favour of shorter ages as compared to 50 days. But, the results of a similar experiment conducted at Pachperwa (Uttar Pradesh) for over two years have shown that seedlings of 30 and 40 days old seedlings seemed to be superior to 20, 30 or 60 days, the difference in yield amounting to 112 lb. per acre, in favour of 30 or 40 days old seedlings, though the treatment differences in the experiment were not statistically significant.
Sabour and Gaya. The results of complex cultural experiments involving ages of seedlings, time of planting etc., conducted at Sabour and Gaya have shown that the optimum age of the seedlings seems to be between 4 and 5 weeks. Depending on the time of planting, the age of the seedlings could be varied and seedlings of either age, young or old could be used without prejudice to the yield. This aspect of the inter-relationship between the age of seedling and the time of planting is dealt with in detail later.

Chinsura Station. At Chinsura (West Bengal) Station the results of a complex cultural experiment involving age of seedling and time of planting have shown clearly that there is not much difference in yield among the ages of 3, 5, 7, 9 and 11 weeks old seedlings in the early plantings done within July but with later plantings done after 3rd July, the aged seedlings are found to be decidedly superior to younger seedlings.

Bankura. At Bankura (West Bengal), the results of a similar experiment conducted with ages of 2, 3, 4, 5 and 6 weeks have indicated that 6 weeks old seedlings are found to give the highest yield, closely followed by 5, 4 and 3 weeks old seedlings. The age of seedlings seems to play a little part in influencing the yield of the crop but it is closely linked with the time of planting. The inter-acting operation of these two factors i.e. the age of seedlings and the time of planting largely determine the ultimate yield. The best time of raising seedlings to be used for the different dates of planting are discussed under “Time of planting” in the pages to follow.

It would be seen from the foregoing discussion of the experiments that the yield of a variety is influenced to some extent by the ages of the seedlings. Ages of 5 to 4 weeks for the seedlings of short duration varieties and 5 to 6 weeks for varieties of 5 to 6 months duration may be considered as the optimum age for transplanting. Aged seedlings of 7 to 11 weeks could, however, be used without detriment to yield in the case of long duration varieties, provided the planting is done within the optimum period. Where planting is done late, even beyond the critical time of planting due to inevitable seasonal and other factors, the younger is the seedling, the better is the yield in most of the rice tracts.

In the case of short duration varieties, it is absolutely essential to use seedlings of optimum age of 3 to 4 weeks only, irrespective of the critical time of planting, as the short duration rice are mostly period bound. The using of aged seedlings would cause the primary tiller to form the heads shortly after planting. These are usually puny ear-heads which result in lowering the ultimate yield of the crop as the primary ear-head largely contributes to the yield of the plant. It appears there is an interaction between varieties, ages of the seedlings, time of planting and soil conditions. It would, therefore, be desirable to determine by actual experimentation the best age of the seedling for a given variety at a particular season and time of planting.

**EX. OPTIMUM SPACING AND NUMBER OF SEEDLINGS PER HOLE FOR TRANSPLANTING**

It would seem that no other agronomic practice influences the development of the plant and final yield as spacing does. Space has a considerable effect on promoting tillering in plants. It has been noticed that wider the planting, the more is the tillering per plant. However, tillering is not proportionate to the extra space given.

The number of ear-bearing tillers produced in an unit area seems to vary inversely as the square root of spacing given between plant to plant. But, the average yield per ear-head increases with the increasing spacing. It would appear that a particular spacing in which the total number of ear-bearing tillers is at maximum may be considered optimum but it is with an average length of good ear-head that the ultimate yield from an unit area is highest.
This optimum spacing, of course, depends upon several other conditions, the most important of them being the variety and fertility of the land. An early variety or one that is inherently poor in tillering has to be necessarily planted closer than a later one or an inherently good one for tillering. Likewise, in a rich soil under ideal conditions the planting has to be wider to avoid the risk of too much vegetative growth and premature lodging, whereas, in a poor land, the planting has to be closer.

The effect of the season. The effect of the season has a profound influence on the development of the plant. Planting a variety in the proper season, compensates to a large extent in fertility of the land and if the planting is delayed unavoidably, the only way of counteracting the evil effect of late planting is to plant the seedlings closer. Similarly, robust and tillered seedlings can be planted wider than poor weak seedlings. Directly connected with spacing, the number of seedlings planted per hill seems to exercise considerable influence on the ultimate grain and straw yield of the crop. The recognition of the interactions of various factors and adjusting this important agronomical practice accordingly, helps in a great way the successful raising of a rice crop. The results of a number of spacing cum number of seedling per hill experiments conducted at the Research Stations in the different States are discussed below.

Coimbatore Station—Spacing cum number of seedlings experiments. At the Coimbatore station the results of a complex experiment involving different spacings and different number of seedlings per hole conducted for 3 years (1938—40) with a long duration variety Co. 5 have indicated that irrespective of the number of seedlings planted per hole, close spacing of 6" X 6" has invariably given the highest yield closely followed by 6" X 12" spacing.

In the case of medium, and short duration varieties, it has been observed that 4" X 4" and 6" X 6" spacings have recorded significantly higher yields of grain and straw than 6" X 12". In general, under Coimbatore conditions, a closely spaced crop is shorter in growth than a wide spaced crop. The optimum and economical for medium and short duration varieties is 6" X 6" in singles whereas in the case of long duration variety, a wider planting of 6" X 12" with 2 seedlings or 12" X 12" with 4 seedlings seems to be economical and in respect of yield as good as 6" X 6" spacing.

Aduthurai Station—Influence of spacing on the yield. At the Aduthurai station a critical study of the influence of spacing on the development of the yield attributes of the plant and the ultimate yield from an unit area of land has revealed that, though the yield per plant increases with increased spacings, the number of plants per unit area gets less and less. The reduction sometimes is even in a greater proportion than the yield. For example, the yield of a plant in 4" X 4" is 1/9th of the yield of the plant in 1" X 1" plot, but there are 13 times as many plants in the former as in the latter.

Decrease in yield with increase spacing. Since the total yield of an unit area is the multiple of the number of plants and the yield per plant, the increase in yield per plant of a wider spacing due to greater number of tillers and longer ear-heads does not sufficiently compensate for the reduction in the number of plants. Consequently the yield goes down lower as the spacing increases and the highest yields have been obtained with 3" X 3" in the case of short duration variety of 100 days.

Increased yield with spacing in—long duration varieties. However, in the case of long duration varieties, the above findings in respect of yield do not hold true and bigger spacing of more than 3" X 3" or 4" X 4" has been found to give higher yields than closer spacing as will be seen from the results of the experiments discussed below and this is perhaps due to the fact of the plants having longer vegetative phase for putting up greater number of tillers and bigger ear-heads.
The results of 2 years' trial (1942 & 1943) have shown, unmistakably, that in the case of 100 days' duration variety, the spacing of 3"×3" and 6"×6", giving more or less same yield, are definitely superior to 8"×8" or 12"×12", the amount of increase in yield being 12 and 30 per cent respectively. For the main 'Samba' crop of 6 months duration, the converse findings seem to be holding true. A wider spacing of 6"×12" has given an increased yield of 5 per cent over 4"×4" but at par with 6"×6". The spacing of 12"×12" with 2 or 3 seedlings per hole is also found to be as good as 6"×6" with one or two seedlings per hole.

Increase in straw yield with number of seedlings per hole. The results of 'thaladi' or second crop have also indicated that closer spacing of 4"×4" has given lesser yield than the spacing of 6"×6" or 8"×8" by about 12 per cent. It would appear that there is no appreciable interaction between the spacing and the number of seedlings per hole but however there is a strong indication that if the number of seedlings per hole is increased in the wider spacings, the yield is proportionately increased and further, increasing the number of seedlings per hole has been definitely increase the straw yield.

Ambasamudram Station. A similar experiment conducted at the Ambasamudram station for 3 years (1941 to 1943) has proved conclusively that in the case of short rice of 115 days' duration ASD-1, the spacing of 4"×4" per hole has resulted in good economic returns with bigger yield over 6"×6" by about 10 per cent and a wider spacing of 6"×12" or 12"×12" has given much lower yield by about 20 to 25 per cent as compared to 4"×4". For the late second crop ASD-5 of about 5 months' duration, 6"×12" singles or 12"×12" double seedlings per hole have given higher yield, the increase ranging from 2 to 13 per cent over 4"×4", the spacings of 6"×6" singles being as good as 6"×12" spacing.

Pattambi Station. The result of a similar experiment conducted at the Pattambi Station with the two first crop varieties PTB-9 and PTB-5 (June—September) of 4½ months' duration and one second crop variety PTB-4 (September-January) of 5 months' duration showed that there was not much difference in yield between the different spacings, but 12"×12" appeared to be definitely too wide. In the case of first crop PTB-5, the spacing of 4"×4" with two seedlings per hole seemed to be best in obtaining bigger yield of grain and straw both under manured and unmanured conditions.

Whereas, for the strain PTB-9 the spacing of 3"×6" with two seedlings per hole was found to be ideal.

For the second crop variety PTB-4 also, the spacing of 4"×4" closely followed by 6"×6" and 8"×8" was observed to be optimum. The using of more than two seedlings per hole except in the wider spacing of 8"×8" did not materially contribute to higher yields. The general trend of a trial conducted at Buchireddipalayam with 3 spacings 6", 9" and 12" and with seedlings 1, 2, 3 & 4 per hole indicated that 6" was better than 9" and 12" and one seedling better than 2, 3 or 4 seedlings per hole. The spacing of 0"×6" single recorded the highest yield followed by 12"×12" three seedlings.

Berhampore Station—Expt. on 5 months' duration variety. A spacing experiment with 3"×3", 6"×6" and 10"×10" spacing conducted at Berhampore station for 3 years with a five months' duration variety has indicated that there was no difference in yield between 3"×3" and 6"×6" and the above spacings were found to be distinctly superior to 10"×10". In the same experiment the interaction of the manures by the application of 150 lb. of ammophos per acre at planting time was investigated on the different spacings. While the effect of the manure was generally significant, it did not influence differently the different spacings. Even here, 10" was the poorest and there was no difference between 3" and 6".

Spacing experiments with different strains. Maruteru Station. At Maruteru Station where the soil is very fertile and richer than that of Berhampore or Pattambi Station, a number of complex experiments involving spacings, number of seedlings per hole and manuring has been conducted with different strains. The results of the experiment were varying from year to year due to
factors such as premature lodging of the crop and incidence of diseases. A careful scrutiny of the data along with other causes affecting the yield has shown that under Maruteru conditions for the first crop, a closer spacing of $4' \times 4'$, $7\frac{1}{2}' \times 7\frac{1}{2}'$, $6' \times 12'$ or $12' \times 12'$ spacing.

In the case of the strain MTU.10 the yield obtained from the spacing of $6' \times 6'$ singles per hole, $6' \times 12'$ doubles per hole and $12' \times 12'$ with four seedlings per hole is more or less same, and it would, thus indicate that where planting operation is handicapped due to labour scarcity or economic consideration, a wider spacing could be adopted with increased number of seedlings without detriment to yield.

In the case of strain MTU.3 the spacing of $7\frac{1}{2}' \times 7\frac{1}{2}'$ with 2 seedlings per hole is the optimum for getting highest yield, wider spacing of $6' \times 12'$ or $12' \times 12'$ giving a lower yield by about five per cent as compared to $7\frac{1}{2}' \times 7\frac{1}{2}'$. For the second crop variety MTU.15, it has been observed that the close spacing of $9' \times 6'$ doubles closely followed by $6' \times 6'$ with 3 seedlings and $9' \times 9'$ with 3 seedlings per hole has given the highest yield.

**General results of spacing experiments.**—The general trend of the results of the spacing experiments done in Madras is, that the optimum spacing for the short rice of 100 to 115 days duration is $4' \times 4'$ with 2 seedlings per hole and for the five months duration variety grown as main Sambha or the thaladi (second crop), the spacing of $6' \times 6'$ singles or doubles or $6' \times 12'$ with 3 seedlings per hole may be considered optimum. But where the soil is very rich as in Godavari Delta, a wider spacing of $7\frac{1}{2}' \times 7\frac{1}{2}'$ is absolutely essential for the first crop like MTU.3, and for the strain MTU.10. $6' \times 12'$ or $12' \times 12'$ with 2 to 4 seedlings per hole, and for the second crop MTU.15, $3' \times 6'$ or $6' \times 6'$ with 3 seedlings is the best.

The yield data of the spacing-cum-number of seedlings per hole in the farms of Ambasamudram, Coimbatore and Maruteru are given in tables (i), (ii), (iii) of Appendix IV.

**Result of cultural experiment in Mysore Vinueswaraya central farm.**—The result of a complex cultural experiment conducted in 1942-43 at the Vinueswaraya central farm (Mysore) with the strain No. 684, planted in August has indicated that the spacing of $9' \times 9'$ with 3 seedlings per hole gave the highest yield of grain, closely followed by $6' \times 6'$ with double seedlings the difference in yield between them being about 0 per cent. The spacing of $6' \times 6'$ with single seedling per hill gave about 11 per cent less yield as compared to $9' \times 9'$ triples; whereas for the summer crop planted in the middle of March with the strain No. 705, the results have shown that the spacing of $6' \times 6'$ double seedlings and $9' \times 9'$ single seedlings giving more or less similar yield was superior to $9' \times 9'$ or $12' \times 12'$ spacing with single, double or bunch seedlings per hole by about 7 to 10 per cent.

It would, therefore, appear that from practical consideration, seedlings of 45 days old planted with a spacing of $6' \times 6'$ doubles per hole for the rainy season varieties and seedlings of 25 or 35 days of age planted with a spacing of $6' \times 6'$ doubles per hill for the summer varieties may be deemed to be the best for getting maximum out-turn of rice crop under conditions obtainable in Mysore.

**Optimum spacing for soil conditions of Cuttack.**—At the Central Rice Research Station, Cuttack, (Orissa) the spacing trial conducted for 2 years with 2 varieties under 6, 12 and 18 inches spacing has shown that the relationship between spacing and yield was linear, the yield decreasing with increase in spacing. Further trial with 3, 6, 9 inches of spacing has revealed that three inches spacing gives significantly lower yield than 6 and 9 inches, the difference between the latter two not being significant. The interaction between varieties and spacing is not significant. It would thus seem that under Cuttack soil conditions, the spacing between $6' - 9'$ is the optimum for the varieties of 5-5 1/2 months' duration. The optimum however may be less for varieties of shorter growing periods.

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Experiments on alluvial tracts.—The results of a complex cultural experiment conducted at Chinsura (West Bengal) representing the alluvial tract in general for 3 years have indicated that a spacing of 6 inches apart either way with one or two seedlings per hill gave significantly higher yield than 9’ or 12’ and specially in the years when the rainfall was much below normal the close spacing had a telling effect in increasing the yield by 10 to 20 per cent over 9’ and 12’ respectively.

In normal years, however, it has been noted that in the early plantings done from middle of July to middle of August, a wider spacing of 9’ or even 12’ between plant to plant with single or double seedlings were found to be as good as 6’×6’ with single or double seedlings. There was no appreciable interaction between spacing and number of seedlings but however there was the strong indication that increasing the number of seedlings per hole with the increasing spacings seemed to have given better yields. The wider spacing was found definitely harmful, should the planting be delayed due to unfavourable seasonal or other factors and in such cases close spacing of 6 inches with 2 or 3 seedlings should invariably be adopted for obtaining maximum yield out of the crop.

Spacing experiments on different situations.—The results of a spacing experiment carried out in 1933 at the Suri farm (West Bengal) in 3 situations ‘Bad’ (Upland), ‘Kanali’ (Medium) and ‘Shole’ (Lowland) with four varieties have indicated that there was no significant difference among the four spacings i.e., 3’, 5’, 7’ and 9’ adopted in the trial. However, it would appear that for the varieties Badakumati 65 and Jhangasail 24, 5’ seemed to be the ideal spacing for all the three situations while for the varieties Boldar and Singumukhi, the spacing of 9’ has proved to be as good as the close spacing of 3’, 5’ or 7’ in the case of the situation No.1 and better in the case of situation Nos. 2 and 3 in respect of grain yield. From practical considerations it would be advantageous to adopt a spacing of 5’ for ‘Bad’ lands and 7’ to 9’ for ‘Kanali’ and ‘Shole’ lands.

Results on laterite Tract.—The results of a trial conducted at Bankura farm (West Bengal) with regard to number of seedlings planted per hole, representing the laterite tract, have indicated that planting different number of seedlings whether 1, 2, 3, 4 or 5 per hole made no difference in the yield of Jhangasail when the spacing between the holes was 9’ apart.

Advisable spacing for Late planting—Gaya Farm. At Gaya Farm (Bihar) the results of a complex cultural experiment have indicated that for plantings done from the middle of July to second of August, 6’ or 9’ spacing with single or three seedlings per hole either from normal sown (15th June) or late sown (30th June) seed-beds gave similar yields which were not differing very much from each other. But if the plantings were done beyond 2nd August, 6’ spacing with three seedlings per hole whether from normal or late sown seed beds was found to be distinctly superior to 9’ spacing by about 10 per cent.

Uttar Pradesh.—The results of a spacing experiment conducted for two years (1949-50) at the Tiswahi and Pachperva Farms (Uttar Pradesh) have shown that the spacing of 6’ was distinctly superior to 9’ or 12’ spacing; the yield increase recorded in the two farms in favour of 6’ spacing was in the order of 44 and 26 per cent respectively.

Experiment on spacing-cum-number of seedlings.—Gurdaspur Farm. At Gurdaspur Farm (Punjab) the results of a spacing-cum-number of seedlings per hole experiment conducted in the Kharif season 1952 has revealed that 6’×6’ with two seedlings per hole gave the highest yield and this was superior to 9’×9’ or 12’×12’ with single, double or treble seedlings per hole by about 42 and 50 per cent respectively. It was also observed that increasing the number of seedlings per hole in the wider spacings had resulted in increasing the yield to an extent.
Spacing experiment in Kashmir State.—In the Kashmir State, spacing experiment conducted with 3", 6" and 9" spacings in the year 1950 with the Chinese variety No. 1039 revealed that 3" spacing gave significantly increased yield of 25 per cent over 6" spacing which in its turn was found to be superior to 9" by about 34 per cent. However, in the trial of the year 1951, the yield from 3" spacing was found to be significantly superior to 9" spacing only, but was at par with 6". There was no significant difference in yield between 6" and 9" spacing. In the above trial seedlings raised from a very thick sown seed bed i.e., 24 lb. of seed in one cent of nursery were used for planting with single seedling per hole. It may be pointed out here that the general yield of the plots might have been enhanced if seedlings from thin sown seed beds with 2 or 3 seedlings per hill for the wider spacing of 6" or 9" had been used.

Spacing-cum-number of seedlings experiments in Bombay.—At five Rice Research Stations in Bombay State, an experiment on spacing-cum-number of seedlings per hole was conducted for 4 years except in one station (2 years only) with a view to find out the best combination of the spacing between bunches and number of seedlings per bunch which would give the maximum yield of transplanted paddy under varying soil and climatic conditions of that State. The average results of the 4 years are given in Table IV of the Appendix IV and from the scrutiny of the pooled data the following conclusions could be drawn and they are given hereunder.

**General conclusions from experiments in Bombay.**—The yield of paddy is found to decrease with the increase in spacing between the bunches at Karjat, Igatpuri, and Bulsar Farms, and so the existing spacings i.e., 10" × 10" at Karjat and Igatpuri Farms and of 9" × 9" at Bulsar Farm can be suitably reduced to 8" × 8" with 8 seedlings and 6" × 6" with 8 seedlings respectively.

In the case of Ratangiri farm, however, the local practice of 10" × 10" with 8 seedlings per hole has been found to be optimum. At Vadgaon farm, the spacing of 6" × 6" with 4 seedlings has been observed to be the best for getting good outturn of the crop. Unlike his counterpart in the Godavari Delta of South India, the cultivator in Bombay State resorts to planting the seedlings in bunches and this is being deliberately done with a view to giving a due allowance for the loss that occurs due to crab damage.

**Best spacing for transplanting ' Aus'.**—Experiments conducted both at Karimganj and Titabar Farms to determine the best spacing for transplanting ' Aus' seedlings showed that four inch spacing was found to be the best. The result of another experiment with a further reduced spacing of 3 inches showed that the yield increased as the spacing decreased at both the farms. However, for practical reasons, 4 inch spacing may be considered as optimum. The results of the experiments are given below.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Average yield in lb. per acre</th>
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</tbody>
</table>
Higher Yields with increased number of seedlings.—The results of another simple experiment conducted to determine the optimum number of seedlings per hole at the above stations showed that there was a tendency for higher yields with the increase in number of seedlings but for practical purposes, the optimum number of seedlings per hole may be taken as, four. The yield data are given below:

<table>
<thead>
<tr>
<th>Seeding Numbers</th>
<th>Acre yield in pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Average yield of 2 years Titabar Farm</td>
<td>2565</td>
</tr>
<tr>
<td>Seeding Numbers</td>
<td>2</td>
</tr>
<tr>
<td>Average yield of 3 years (1943—45) Titabar Farm</td>
<td>2162</td>
</tr>
<tr>
<td>Average yield of 2 years (1944—46) Titabar Farm</td>
<td>1395</td>
</tr>
</tbody>
</table>

Karinganj and Titabar Farms.—Experiments with regard to ‘sail’ paddy conducted at Karinganj and Titabar Farms to determine the best spacing among the number of seedlings at different dates of planting showed that at Karinganj Farm, the yield was higher as the spacing was closer but at Titabar there was no difference in yield for 6", 9" and 12" spacings. Wider spacing of 18" or 18" was found definitely to depress the yield. The results are shown below:

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Acre yield in pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>2922</td>
</tr>
<tr>
<td>9&quot;</td>
<td>2481</td>
</tr>
<tr>
<td>12&quot;</td>
<td>2347</td>
</tr>
</tbody>
</table>

Karinganj Farm

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Acre yield in pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>3140</td>
</tr>
<tr>
<td>9&quot;</td>
<td>2940</td>
</tr>
<tr>
<td>12&quot;</td>
<td>2405 (Average of 3 years (1936—38))</td>
</tr>
</tbody>
</table>

Titabar Farm

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Acre yield in pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>2317</td>
</tr>
<tr>
<td>9&quot;</td>
<td>2272</td>
</tr>
<tr>
<td>12&quot;</td>
<td>1954 (Average of 3 years (1943—45))</td>
</tr>
</tbody>
</table>

Optimum number of seedlings per hole.—With regard to the optimum number of seedlings per hole, the results of the factorial experiments conducted at both the Farms showed that 2, 4 and 6 seedlings per hole would be good for 6", 9" and 12" spacing respectively. For earlier plantings on the 15th June and 5th July, it would be desirable to plant only two seedlings per hole, while for later plantings 4 to 6 seedlings per hole would be necessary. The yield data is presented in page 58 under ‘Time of Planting’ where the influence of the time of planting on yield is discussed in detail.

Spacing and number of seedlings for ‘Boro’ paddy.—Experiment on spacing and number of seedlings per hole for ‘Boro’ paddy showed very clearly that 6" to 9" with 4 seedlings per hole would be the best for obtaining highest yield. The average of three years’ results is given below:

<table>
<thead>
<tr>
<th>Yield in lb. per acre</th>
<th>Number of seedlings per hole</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1746</td>
</tr>
<tr>
<td>9&quot;</td>
<td>1663</td>
</tr>
<tr>
<td>12&quot;</td>
<td>1471</td>
</tr>
</tbody>
</table>
General conclusions from spacing-cum-number of seedlings experiment.—A careful review of the various experiments on spacing-cum-number of seedlings per hole, conducted in the different States under varying soil and climatic conditions, would seem to suggest that it is not possible to lay down that such and such spacing and/or number of seedlings per hole is the optimum. It will have to vary according to the variety, fertility of the soil and top of all, the time of planting and it can be determined only by actual experiments in the particular tract.

While the varietal and soil fertility differences are apparent with regard to different spacings, the fairly uniform results got from year to year at each centre of trial for particular spacings would suggest that the season has apparently no influence on spacing. In general, it may be stated that for short rice of 105—110 days duration, a close spacing of 4' x 4', and for medium and long duration varieties of 4½ to 6 months, 6' x 6' may be considered optimum.

In rich soils, however, for longer duration varieties, 6' x 12" or 12' x 12" with 3 or four seedlings per hole would appear to be as good as 6' x 6' in respect of grain yield, if the planting is done in the normal planting season, as varieties have their own range of optimum planting periods when they manifest the full expression of their yield attributes giving maximum output. The adoption of the wider spacing would help in the expeditious transplanting operation being carried out within the normal planting period and with the help of limited labour. It would also prevent premature lodging of the crop due to luxuriant vegetative growth. Further, it is also noted that wider spacing of 12" between lines and closer spacing of 6' in the lines seems to favour greater output of the crop. If late planting is inevitable due to unavoidable reasons, close plantings of 6' x 6' with 2 seedlings should invariably be adopted. Again, if the field is infested with foul and rank growth of weeds, close planting should be done to suppress the weed growth. Where it is desired to advance the flowering period by about a week with a view to tiding over shortage of water at the maturing phase of the crop in view of difficulties which often arise in areas served by rainfed tanks, close spacing should be adopted as it induces early flowering of the crop by about a week as compared to wider spacings.

In tracts where the synchronisation of the onset of heavy winds at the ripening phase of the crop causes violent shaking of the plants, resulting in the shattering of the grains, close planting would minimise this defect, whereas in wide planting this would be aggravated. The advantage of adopting wider spacing as explained above is, that it not only saves labour required for planting but also helps in expeditiously finishing up planting in the right season.

To obtain maximum output of the crop under a particular set of conditions one should be judicious and careful in the application of the above agronomic practices after studying the special conditions, obtaining at the time of the operation and the needs of the special tract to the best economic advantage.

F. Optimum Time of Planting
Yield increases with right time of planting.—The time of planting, ipso facto, is the most important and deciding factor in influencing the yield of the crop and it is the pivot around which the other factors discussed above, are closely linked, playing as it were a subsidiary role only in modifying the yield of the crop one way or the other to a certain extent. The outturn of a variety entirely depends upon the time of its planting. The influence this factor exerts on yield is very profound and marked and this may mask the variations which occur by changes in other cultural practices such as age of seedlings, spacing, number of seedlings, etc. Whether the yield of a crop in a tract is above or below its normal level of production, could be known from the study of the 'time of planting' of the crop. If a variety is planted in its right planting time, the resultant yield of the crop would be at its high water-mark. If the plantings fall outside this critical range, the yield drops below its normal. The amount of decrease in yield increases progressively with the delay in planting.

Ergo, the success or otherwise of rice-cropping in respect of yield rests primarily on this important cultural aspect and it is dealt in detail for each distinct rice zone as far as possible state-wise.
Madras.—A complex cultural experiment was conducted for 2—4 years at the Rice Research Stations, Ambasamudram, Pattambi and Aduthurai representing different rice zones in the South Madras to find out the optimum planting time for the varieties and also to determine how far and to what extent the yield and other characters, to wit, flowering, etc. of the paddy is affected due to early or delayed planting.

Ambasamudram Farm.—At the Ambasamudram Farm, a six months duration second crop (Co. 8) variety was planted on 14 different dates representing early, normal and late period of planting, at an interval of 5 days between each planting with seedlings of varying ages from 26 days to 66 days. The yield data presented in Table II revealed a clear-cut demarcation line in the period of planting and pointed out that the plantings done from 25th September to 20th October gave more or less similar outturn with a difference in yield ranging from 19 to 92 lb. per acre which was not however significant. But a progressive decline in yield was observed in the subsequent plantings, the drop in yield was sharp with each delay of planting. The longer the planting, the greater was the depression in yield, the amount of decrease in yield of the 26th, 30th October, 5th, 10th and 15th November plantings was in the order of about 2, 7, 13, 25 and 31 per cent respectively as compared to the optimum date of planting i.e., 20th October. The three years' average yield figures with particulars are set out in table II.

<table>
<thead>
<tr>
<th>Treatment Number</th>
<th>Date of sowing seed-bed</th>
<th>Date of planting</th>
<th>Date of harvesting</th>
<th>Age of the seedlings</th>
<th>Yield in lb. per acre</th>
<th>Percentage on control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16th Aug.</td>
<td>23rd Sept.</td>
<td>10th Feb.</td>
<td>46 days</td>
<td>2259</td>
<td>100.0</td>
</tr>
<tr>
<td>2</td>
<td>25th Aug.</td>
<td>30th Sept.</td>
<td>17th Feb.</td>
<td>36 days</td>
<td>2273</td>
<td>100.9</td>
</tr>
<tr>
<td>3</td>
<td>30th Aug.</td>
<td>5th Oct.</td>
<td>10th Feb.</td>
<td>36 days</td>
<td>2334</td>
<td>103.4</td>
</tr>
<tr>
<td>4</td>
<td>25th Aug.</td>
<td>10th Oct.</td>
<td>18th Feb.</td>
<td>46 days</td>
<td>2321</td>
<td>102.8</td>
</tr>
<tr>
<td>5</td>
<td>10th Aug.</td>
<td>15th Oct.</td>
<td>16th Feb.</td>
<td>66 days</td>
<td>2213</td>
<td>98.0</td>
</tr>
<tr>
<td>6</td>
<td>10th Sept.</td>
<td>16th Oct.</td>
<td>23rd Feb.</td>
<td>36 days</td>
<td>2272</td>
<td>100.9</td>
</tr>
<tr>
<td>7</td>
<td>25th Aug.</td>
<td>20th Oct.</td>
<td>23rd Feb.</td>
<td>36 days</td>
<td>2258</td>
<td>100.0</td>
</tr>
<tr>
<td>8</td>
<td>25th Sept.</td>
<td>21st Oct.</td>
<td>23rd Feb.</td>
<td>26 days</td>
<td>2314</td>
<td>102.5</td>
</tr>
<tr>
<td>9</td>
<td>10th Sept.</td>
<td>20th Oct.</td>
<td>23rd Feb.</td>
<td>46 days</td>
<td>2204</td>
<td>97.6</td>
</tr>
<tr>
<td>10</td>
<td>25th Aug.</td>
<td>30th Oct.</td>
<td>23rd Feb.</td>
<td>66 days</td>
<td>2101</td>
<td>93.0</td>
</tr>
<tr>
<td>11</td>
<td>25th Sept.</td>
<td>31st Oct.</td>
<td>1st Mar.</td>
<td>36 days</td>
<td>9150</td>
<td>95.2</td>
</tr>
<tr>
<td>12</td>
<td>10th Sept.</td>
<td>5th Nov.</td>
<td>1st Mar.</td>
<td>36 days</td>
<td>1099</td>
<td>86.6</td>
</tr>
<tr>
<td>13</td>
<td>25th Sept.</td>
<td>10th Nov.</td>
<td>1st Mar.</td>
<td>46 days</td>
<td>1796</td>
<td>75.1</td>
</tr>
<tr>
<td>14</td>
<td>10th Sept.</td>
<td>15th Nov.</td>
<td>1st Mar.</td>
<td>66 days</td>
<td>1556</td>
<td>68.9</td>
</tr>
</tbody>
</table>

TABLE II

Particulars showing the date of seed-bed sowing, date of planting, date of harvesting and the yield of the second crop variety Co.-8 (average of 3 years)
Seedlings of 46 to 56 days of age ideal for transplanting.—Since the different ages of seedlings involved in this experiment did not interact with the dates of planting, the time of planting is the prime factor of importance in determining the yield of the crop. From practical agricultural point of view, it may be recommended for this tract that seedlings of 46 or 56 days of age could be used for planting, without any loss in yield, provided that the planting is done within 5th to 20th October. Even 66 days old seedlings could be used without much reduction in yield. Another interesting fact that emerged out of the trial is that even seedlings of 26 days old could be used in case planting is done within 20th October.

Effects of early planting.—Early planting done within 5th October even with 56 days old seedlings resulted in advancing the flowering of the crop by about a fortnight as compared to 20th October planting. This advantage of being able to hasten the maturing of the crop is of practical value and of economic importance especially for the tail-end reaches of the tract where water scarcity is often felt and result in reduction in yield.

If this is not feasible to carry out this cultural practice for any practical difficulties, the next alternative would be to go in for the choice of another suitable variety like ASD.5, GEB.24 and PTB.2 which will admirably fit in for late and very late planting conditions in the period, November-December which are often found specially in the areas that entirely depend upon the tanks, fed by the North East monsoon rains. Experiments regarding determination of the optimum time of planting for the late varieties like ASD.5, GEB.24 and PTB.2 etc., need following up and information on this agronomic aspect will prove to be of great economic value to the cultivator.

Optimum date for planting under Pattambi conditions.—At Pattambi similar experiments with 4 dates of planting with varying ages of seedlings raised under different systems of seed-bed was conducted for 3 years and it will be seen from the yield data given below that for the second crop variety PTB.3, the optimum date of planting seemed to be somewhere 10th to 20th October. The early planting of 10th October gave an average increased yield of about 9 per cent over 20th October planting. The plantings done, however, after the 20th October showed distinct progressive drop in yield just as was found at Ambasamudram.

Under Pattambi conditions, the optimum date of planting for PTB.3 may be considered to be 10th October. Here it will be advantageous to use seedlings of 40 to 50 days, provided the planting is done within 10th October. Since the difference in yield between the 10th October and 20th October was not statistically significant, planting up to 20th October could be done without much loss in yield, should the agricultural condition warrant such a course. Planting later than 20th October was definitely harmful and should be avoided.

The yield data of different dates of planting together with other particulars are given below:

| TABLE III |
| Parciculars showing different dates of seed-bed sowing, seed-bed treatment, age of seedling, date of planting and the yield (average of 3 years) |

<table>
<thead>
<tr>
<th>Treatment Number</th>
<th>Date of sowing in seed-bed</th>
<th>Seed-bed treatment</th>
<th>Age of seedling</th>
<th>Date of planting</th>
<th>Average yield in lb. per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12th August</td>
<td>Wet</td>
<td>60 days</td>
<td>10—12th Oct.</td>
<td>3084</td>
</tr>
<tr>
<td>2</td>
<td>12th August</td>
<td>Semi-wet</td>
<td>60 days</td>
<td>10—12th Oct.</td>
<td>3022</td>
</tr>
<tr>
<td>3</td>
<td>22nd August</td>
<td>Wet</td>
<td>50 days</td>
<td>10—12th Oct.</td>
<td>3101</td>
</tr>
</tbody>
</table>
### Treatment Number

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Date of sowing in seed-bed</th>
<th>Seed-bed treatment</th>
<th>Age of the seedling</th>
<th>Date of Planting</th>
<th>Average yield in lb. per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>22nd August</td>
<td>Semi-wet</td>
<td>50 days</td>
<td>10–12th Oct.</td>
<td>925</td>
</tr>
<tr>
<td>5</td>
<td>1st September</td>
<td>Wet</td>
<td>40 days</td>
<td>10–12th Oct.</td>
<td>712</td>
</tr>
<tr>
<td>6</td>
<td>1st September</td>
<td>Semi-wet</td>
<td>40 days</td>
<td>10–12th Oct.</td>
<td>324</td>
</tr>
<tr>
<td>7</td>
<td>9–11th September</td>
<td>Wet</td>
<td>30 days</td>
<td>10–12th Oct.</td>
<td>98</td>
</tr>
<tr>
<td>8</td>
<td>9–11th September</td>
<td>Semi-wet</td>
<td>30 days</td>
<td>10–12th Oct.</td>
<td>348</td>
</tr>
<tr>
<td>9</td>
<td>9–11th September</td>
<td>Wet</td>
<td>40 days</td>
<td>20–22nd Oct.</td>
<td>84</td>
</tr>
<tr>
<td>10</td>
<td>9–11th September</td>
<td>Semi-wet</td>
<td>40 days</td>
<td>20–22nd Oct.</td>
<td>77</td>
</tr>
<tr>
<td>11</td>
<td>9–11th September</td>
<td>Wet</td>
<td>50 days</td>
<td>1st Nov.</td>
<td>58</td>
</tr>
<tr>
<td>12</td>
<td>9–11th September</td>
<td>Semi-wet</td>
<td>50 days</td>
<td>1st Nov.</td>
<td>140</td>
</tr>
<tr>
<td>13</td>
<td>9–11th September</td>
<td>Wet</td>
<td>60 days</td>
<td>11th Nov.</td>
<td>34</td>
</tr>
<tr>
<td>14</td>
<td>9–11th September</td>
<td>Semi-wet</td>
<td>60 days</td>
<td>11th Nov.</td>
<td>95</td>
</tr>
</tbody>
</table>

**Optimum date under Aduthurai conditions.**—At Aduthurai Farm, experiments conducted with two first crop short duration varieties of 100 days for 2 years (1926 and 27) with 8 dates of sowing commencing from 13th July to 4th October have revealed that early sowing was distinctly superior to late sowings in both the cases. The optimum date of sowing for Kuruvai crop under Aduthurai conditions, is the middle of July. The fall in yield with the subsequent sowing was enormous. The yield of late sown crop was hardly 50 per cent of that obtained in July sowing. In Tanjore Delta, the sooner the first Kuruvai crop is planted the better is the yield. In the upper portion of the Cavery Delta where water is received early and planting can be done early, better yields are recorded than in the lower portions.

**Nellore Rice tract of Madras.**—In the Nellore Rice tract of Madras, the period of transplantation is protracted from July to October, the cultivation under the channel fed areas usually commencing from July onwards, and those under areas fed by tanks which get filled up by Northeast monsoon rains from August to September. As the supply of water is not assured unlike in the other well protected reservoirs of the River Cauvery and Tamberaparni in the South Madras, the transplanting operation could not be carried on in the scheduled periods, but had to wait for propitious periods of plentiful rainfall.

**Early planting yield more over medium planting.**—At Buchiredipalayam the results of ‘time of planting’ experiment conducted in 1938–39 showed that the differences in the yield of the different ‘time of plantings’ were overwhelmingly significant. Early planting on 10th August gave nearly 40 per cent more yield over medium-planting i.e. 7th October.

In another experiment the differential response of the varieties under early and medium plantings has been noted. The strains Co.2, Co.3, Co.5, Co.7, No. 10905 and Atragada (bulk) gave definitely lower yield in the early planting but significantly higher yield of 9 per cent in the medium planting over the standard local Atragada.

It has been observed that MTU.7 is the best for early and medium plantings, while MTU.11 for medium and late planting and Co.2 is preferable to all other varieties in all the 3 seasons followed by Co. 3 in medium and late season and Co. 7 in all the 3 seasons.
Early Plantings yield better results under Yellore Condition.—It must be pointed out that Molagulukulu is easily and undoubtedly the best high yielding variety in seasons of no ‘blast’. Later trials in 1945-46 showed that seedling of ages of 30 to 75 days sown up to the end of August and planted before 15th October gave normal yields and even in later plantings beyond 15th October younger seedlings had given higher yield than aged seedlings. The delayed plantings are often subject to the dread of the deadly disease ‘blast’. The earlier the plantings done even under adverse soil and seasonal conditions, the better is the yield under Yellore conditions.

Influence of time of planting in Godavari Delta.—It is a matter of common experience in the Godavari Delta of Madras that high acre yields are usually recorded in the Western Delta where plantings are done in June immediately after the opening of the canal, whereas the Central or Eastern delta where plantings are done later due to late receipt of water in the canal, records lower yield as compared to the Western delta; the influence of the time of planting is thus reflected on the yield of the crop.

Samalkot Station.—As early as 1914, an experiment was conducted at the Samalkot Station to find out the influence of the time of planting on yield. Periodical plantings with three varieties of different durations, Rasangi, a short term rice, Sanma Atagada, a medium duration rice, and Konanam, a long term rice at fortnightly intervals commencing from July to September were done both under manured and unmanured conditions in unreplicated plots. The results of the experiment conducted for four years in observation plots, showed conclusively that once the proper season for planting was lost, the yield was bound to fall.

In the trial of the year 1917, the yield of grain was about 5,000 lb. per acre for the first planting in 15th July and it gradually went down and reached a level of about 1300 lb. for the planting in the 23rd September. Even the manuring did not have any material effect on improving the yield for the later plantings.

Maruteru Station.—At the Maruteru Station, detailed investigation in the manner carried out at Pattambi and Ambasamudram Farms, on the optimum time of planting combined with other factors like the age of seedling, spacing etc., for the different strains, evolved at the Station for the first crop, has not yet been carried out. It will certainly benefit the cultivator if he is posted with information as to how far and to what extent the yield would be affected by delayed plantings, and whether or not the ill effects of late plantings could be mitigated by adopting cultural practices by way of double transplanting or close spacing and using more seedlings per hole etc.

With regard to the second crop, however, complex cultural experiments had been carried out for a number of years in which ‘time of planting’ was one of the chief factors. The result of the experiments showed in general that the early planting in December to January was not conducive to obtaining bigger yields. These results were converse of the findings registered for the first crop. It had been observed that the plantings done between the 8th and 10th of February gave the best yield, closely followed by 30th January planting. The plantings earlier than 30th January gave lower yields probably due to the greater incidence of stem borer attack. Since the 9th January planting flowered about a week earlier than the 10th February planting, it is desirable to have the planting done on 30th January with a view to escaping the water difficulty at the later stage of the crop which is often felt at its maturing phase.

However, where water scarcity is not felt, February planting may be done with a view to getting a heavier crop. In this connection it is worthwhile to point out here that seedlings from thin sown and heavily manured seed-beds even with aged seedlings of 45 to 60 days planted at a spacing of 5"<6" or 6"<6" with 2 or 3 seedlings per hole in a manured field come to flower a week to ten days ahead of seedlings from thick sown and unmanured seed bed, planted in an unmanured field. The special way of raising the seed-bed and treating it first as a wet nursery and later as a dry one also contributes the early flowering of the crop.
Effect of planting strains at different times—Coimbatore.—Experiments conducted at Coimbatore for 5 years to determine the effect of planting some of the strains at different times of the year showed in the case of GEB.24, a most prolific yielder of 5-6 months duration, that July to September sowings gave normal yields, while in the case of another strain Co.5, a selection from a popular variety of that tract of similar duration, the early sowings in July and August only gave high yields and there was a definite fall in September sowings in all the five years. October and November yields of GEB.24 were very varying, November sowings giving average yields in some years and rather poor yield in others. Subsequent sowings gave very poor yields. In the case of the strain Co.3, the late sowing from September onwards was poor. It would, thus, be seen that to get satisfactory crop under Coimbatore conditions, GEB.24 should not be sown later than September and with regard to Co.5 it should be sown as early as possible in the season July to August, the sooner the better.

Ambasamudram Farm.—A similar observation as to the influence of seasonal plantings made at the Ambasamudram Farm with GEB.24 showed that this strain gave poor yield when planted in July to September, but the yield improved very considerably with the December plantings, being comparable to Manavari varieties or even to the late pishanam variety Co.2 or ASD.5. It may be mentioned that the duration of this strain was shortened by about a month and a half as compared to its duration in the July to December season.

Central Rice Research Institute, Cuttack.—At the Central Rice Research Institute, Cuttack an experiment was conducted for 3 years with two popular varieties T.1145 and T.90 to find out their optimum date of planting. There were 5 dates of planting, which included early, normal and late periods of planting for each concerned variety with two ages of seedlings. All the treatments were tested under both manured and unmanured conditions. The particulars of the experiment with yield data are given in Tables IV & V.
### TABLE IV

Particulars showing the yield data (3 years average yield) of the different dates of planting-cum-age of seeding of the variety T. 1143

<table>
<thead>
<tr>
<th>Treatment Number</th>
<th>Age of seeding</th>
<th>Date of planting</th>
<th>Grain yield in lbs. per acre</th>
<th>Straw yield in lbs. per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unmeasured Average yield per acre in lbs.</td>
<td>Unmeasured % over control (T.4)</td>
</tr>
<tr>
<td>1</td>
<td>40 days</td>
<td>20th July</td>
<td>1591</td>
<td>95.67</td>
</tr>
<tr>
<td>2</td>
<td>30 days</td>
<td>Do</td>
<td>1578</td>
<td>100.4</td>
</tr>
<tr>
<td>3</td>
<td>40 days</td>
<td>30th July</td>
<td>1656</td>
<td>105.4</td>
</tr>
<tr>
<td>4</td>
<td>30 days</td>
<td>30th July</td>
<td>1571</td>
<td>100.0</td>
</tr>
<tr>
<td>5</td>
<td>40 days</td>
<td>9th August</td>
<td>1760</td>
<td>112.0</td>
</tr>
<tr>
<td>6</td>
<td>30 days</td>
<td>Do</td>
<td>1671</td>
<td>116.3</td>
</tr>
<tr>
<td>7</td>
<td>40 days</td>
<td>19th August</td>
<td>1577</td>
<td>97.2</td>
</tr>
<tr>
<td>8</td>
<td>30 days</td>
<td>Do</td>
<td>1599</td>
<td>101.8</td>
</tr>
<tr>
<td>9</td>
<td>40 days</td>
<td>29th August</td>
<td>1395</td>
<td>88.8</td>
</tr>
<tr>
<td>10</td>
<td>30 days</td>
<td>Do</td>
<td>1299</td>
<td>82.7</td>
</tr>
<tr>
<td>Treatment Number</td>
<td>Age of Seeding</td>
<td>Date of Planting</td>
<td>Grain Yield in lb, per acre</td>
<td>Straw Yield in lb, per acre</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</td>
<td>------------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unmanured</td>
<td>Manured</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average yield per acre in lb.</td>
<td>% over control (T. 5)</td>
</tr>
<tr>
<td>1</td>
<td>45 days</td>
<td>25th July</td>
<td>2062</td>
<td>118.8</td>
</tr>
<tr>
<td>2</td>
<td>35 days</td>
<td>Do</td>
<td>2117</td>
<td>120.5</td>
</tr>
<tr>
<td>3</td>
<td>45 days</td>
<td>9th August</td>
<td>2093</td>
<td>114.3</td>
</tr>
<tr>
<td>4</td>
<td>35 days</td>
<td>Do</td>
<td>1842</td>
<td>105.1</td>
</tr>
<tr>
<td>5</td>
<td>45 days</td>
<td>24th August</td>
<td>1759</td>
<td>100.0</td>
</tr>
<tr>
<td>6</td>
<td>35 days</td>
<td>Do</td>
<td>1832</td>
<td>105.7</td>
</tr>
<tr>
<td>7</td>
<td>45 days</td>
<td>8th September</td>
<td>1719</td>
<td>97.7</td>
</tr>
<tr>
<td>8</td>
<td>35 days</td>
<td>Do</td>
<td>1647</td>
<td>94.0</td>
</tr>
<tr>
<td>9</td>
<td>45 days</td>
<td>23rd September</td>
<td>1675</td>
<td>95.6</td>
</tr>
<tr>
<td>10</td>
<td>35 days</td>
<td>Do</td>
<td>1668</td>
<td>91.8</td>
</tr>
</tbody>
</table>

**TABLE V**

*Particulars showing the yield data (3 years average yield) of the different dates of planting-cum-age of seedling of the variety T. 90*
Seedlings of 40 days superior to 30 days.—It will be seen from the results of 3 years trial that the strain T. 1145 did not suffer much in grain yield by late planting. The plantings done in the second or third week of August gave in respect of grain as good an yield as that of the earlier plantings i.e., 20th or 30th July. The yield of straw of the plantings done in the last week of August decreased sharply, the amount of the decrease in yield ranging from 35 to 50 per cent as compared with July plantings. It was also observed that irrespective of the time of plantings the seedlings of 40 days old were definitely superior to 30 days old seedlings. This strain would, thus, seem to be useful for even late plantings in the medium high lands. But plantings done later than third week of August gave poor grain and straw yield and were often subjected to the attack of paddy blast.

Trials with long duration strain T. 90.—In the trial with the long duration strain T.90, the results of the 3 years were not consistent as the yields of late planting in one year gave a yield as good as the early plantings. In other years it was not so, thereby indicating the differential response of the strain to seasonal conditions. It would, however, appear that the period 25th July to 9th August seemed to be ideal for getting maximum out-turn from this variety. Fairly satisfactory yields were obtained up to 24th August but beyond that date the yield dropped suddenly; the decrease in yield amounted to about 20 per cent as compared to July plantings.

Relative effects of cultural operations at Binsura.—At Binsura complex cultural experiments to study the relative effects of cultural operations such as different dates of plantings, different spacing, number of seedlings per hill and the age of seedlings with 2-3 varieties were conducted in 2 series for three years. The effect of the age of seedlings, spacing and the number of seedlings per hill has been dealt with in their appropriate places in the preceding sections and it is proposed to discuss here the important role the different dates of planting play on the ultimate yield of the crop in the 2 sets of experiment. The yield data (average of the 3 years) of the different dates of planting of the 2 sets of experiment relating to the best variety Basamallik, are set out in Table VI(a) and (b), VII and VIII.

### Table VI(a)

<table>
<thead>
<tr>
<th>Date of planting</th>
<th>Mean yield</th>
<th>Percentage of increase or decrease over the 24th July planting (as control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 14th July</td>
<td>74.5</td>
<td>103.2</td>
</tr>
<tr>
<td>2 29th July</td>
<td>69.3</td>
<td>100.0</td>
</tr>
<tr>
<td>3 13th August</td>
<td>62.3</td>
<td>99.0</td>
</tr>
<tr>
<td>4 28th August</td>
<td>29.2</td>
<td>92.4</td>
</tr>
<tr>
<td>5 12th September</td>
<td>6.7</td>
<td>9.7</td>
</tr>
</tbody>
</table>
### TABLE VI (b)

Interaction of date of planting and age of seedling (mean-yield of grain in ounces, average of 3 years) of the variety Basamanik

<table>
<thead>
<tr>
<th>Age of seedling</th>
<th>Dates of planting</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>July 14</td>
<td>July 29</td>
<td>Aug. 13</td>
<td>Aug. 28</td>
<td>Sept. 12</td>
</tr>
<tr>
<td>3 weeks</td>
<td>75.1</td>
<td>63.9</td>
<td>61.1</td>
<td>14.4</td>
<td>0.6</td>
</tr>
<tr>
<td>5 weeks</td>
<td>71.1</td>
<td>66.7</td>
<td>55.7</td>
<td>24.3</td>
<td>1.7</td>
</tr>
<tr>
<td>7 weeks</td>
<td>75.3</td>
<td>72.3</td>
<td>61.0</td>
<td>33.2</td>
<td>0.0</td>
</tr>
<tr>
<td>9 weeks</td>
<td>73.1</td>
<td>67.7</td>
<td>63.0</td>
<td>37.6</td>
<td>11.5</td>
</tr>
<tr>
<td>11 weeks</td>
<td>74.9</td>
<td>72.4</td>
<td>65.7</td>
<td>43.1</td>
<td>16.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>366.5</strong></td>
<td><strong>348.0</strong></td>
<td><strong>306.5</strong></td>
<td><strong>132.4</strong></td>
<td><strong>37.9</strong></td>
</tr>
</tbody>
</table>

### TABLE VII

Mean yield of grain in ounces of 3 varieties for the different dates of planting in the experiment involving different spacing and number seedlings per hole (Average of three years)

<table>
<thead>
<tr>
<th>Date of planting</th>
<th>Mean yield</th>
<th>Percentage of the increase or decrease over 1st August planting (as control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 16th July</td>
<td>185.9</td>
<td>102.9</td>
</tr>
<tr>
<td>2 1st August</td>
<td>187.7</td>
<td>100.0</td>
</tr>
<tr>
<td>3 16th August</td>
<td>132.4</td>
<td>83.3</td>
</tr>
<tr>
<td>4 1st September</td>
<td>81.3</td>
<td>45.5</td>
</tr>
<tr>
<td>5 16th September</td>
<td>34.0</td>
<td>19.0</td>
</tr>
</tbody>
</table>

### TABLE VIII

Particulars showing the date of seed-bed sowing, date of planting, age of the seedlings and the average yield of 3 years (1936-37 to 38-39) of the variety Basamanik in the age of seedling experiment

<table>
<thead>
<tr>
<th>Serial No. of Treatment</th>
<th>Date of seed-bed sowing</th>
<th>Date of planting</th>
<th>Age of seedling</th>
<th>Average yield per plot in ounces</th>
<th>Percentage of control (T. 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27th May</td>
<td>14th July</td>
<td>7 weeks</td>
<td>75.3</td>
<td>104.1</td>
</tr>
<tr>
<td>2</td>
<td>Do.</td>
<td>19th July</td>
<td>9 weeks</td>
<td>67.7</td>
<td>95.6</td>
</tr>
<tr>
<td>3</td>
<td>Do.</td>
<td>13th August</td>
<td>11 weeks</td>
<td>65.7</td>
<td>90.8</td>
</tr>
</tbody>
</table>
It will be seen from the data presented in the three tables that the first two dates of planting namely the 14th July and 29th July gave more or less similar yield and were statistically superior to the third (13th Aug.) and the fourth (28th August) dates of planting. The last date of planting was, however, a clear failure. The following conclusion emerged out from the critical examination of the data given in the tables.

July 29th ideal planting time under Chinsura conditions.—The earlier the planting, the higher was the yield. The period July 29th, August 1st seemed to be ideal for planting under Chinsura conditions for getting maximum out-turn of the crop. The yield decreased progressively as the transplantings became late. There was a marked difference in the yield of grain between July 29 (or 1st August) and 13th August planting. The drop in the yield, depended on the seasonal conditions ranging from 10 per cent to 20 per cent. The 28th August date of planting gave only about half the yield of the early plantings i.e., 14th or 29th July and the September planting was virtually a failure.

It is thus clear, that the date of planting is the most important factor. Other factors like age of seedlings, spacing and number of seedlings per hill play a secondary role in mitigating the ill effects of the time of planting to a certain extent.

Considering various possibilities from the practical agricultural point of view, it is recommended to raise thin dry seed-bed on 10th June as this would seem to be ideal for many reasons. Since one cannot forecast well in advance as to when the monsoon rains would break and be active, the time of planting operation which has to depend solely on the monsoon rains for puddling the land, usually fluctuates within a wide range and it varies from middle of July to middle of August even in years of normal rainfall. The seedlings from the seed bed sown on 10th June can reasonably be uprooted and planted within 14th July using 5 weeks old seedlings to obtain high yield. If land is prepared for transplanting only in the later half of July or in early August due to late receipt of rains, seedlings from the 10th June sown seed-bed can be used to obtain normal yields even though the age of the seedlings might be 7 or 9 weeks. It has been established that the yields from such plantings were as good as those obtained from earlier sown (27th May) seedlings and slightly better than later sown (24th June) or (9th July) seedlings of 3 to 5 weeks of age.

<table>
<thead>
<tr>
<th>Serial No. of Treat- ment</th>
<th>Date of seed bed sowing</th>
<th>Date of planting</th>
<th>Age of seedling</th>
<th>Average yield per plot in ounces</th>
<th>Percentage of control T.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>10th June</td>
<td>14th July</td>
<td>5 weeks</td>
<td>71.1</td>
<td>98.3</td>
</tr>
<tr>
<td>5</td>
<td>Do.</td>
<td>29th July</td>
<td>7 weeks</td>
<td>72.3</td>
<td>100.0</td>
</tr>
<tr>
<td>6</td>
<td>Do.</td>
<td>13th August</td>
<td>9 weeks</td>
<td>63.0</td>
<td>87.1</td>
</tr>
<tr>
<td>7</td>
<td>14th June</td>
<td>28th August</td>
<td>11 weeks</td>
<td>43.1</td>
<td>59.6</td>
</tr>
<tr>
<td>8</td>
<td>24th June</td>
<td>14th July</td>
<td>3 weeks</td>
<td>75.1</td>
<td>104.0</td>
</tr>
<tr>
<td>9</td>
<td>Do.</td>
<td>29th July</td>
<td>5 weeks</td>
<td>66.7</td>
<td>92.2</td>
</tr>
<tr>
<td>10</td>
<td>Do.</td>
<td>13th August</td>
<td>7 weeks</td>
<td>61.0</td>
<td>84.3</td>
</tr>
<tr>
<td>11</td>
<td>9th July</td>
<td>29th July</td>
<td>3 weeks</td>
<td>69.0</td>
<td>95.4</td>
</tr>
<tr>
<td>12</td>
<td>Do.</td>
<td>13th August</td>
<td>5 weeks</td>
<td>56.0</td>
<td>77.5</td>
</tr>
<tr>
<td>13</td>
<td>24th July</td>
<td>13th August</td>
<td>3 weeks</td>
<td>61.1</td>
<td>84.3</td>
</tr>
<tr>
<td>14</td>
<td>28th July</td>
<td>28th August</td>
<td>5 weeks</td>
<td>24.3</td>
<td>33.6</td>
</tr>
</tbody>
</table>
It was also evident from Table VIII that where late sowings and plantings were inevitable, it was advantageous to use seedlings of young age of 3 weeks and expedite the planting within the middle of August, for the date of planting largely influences the yield, the earlier the seedlings put in the field irrespective of their age, the better was the yield.

Cultural Trial with 'Jhinga Sail' at Bankura Station.—A similar complex cultural trial with a variety 'Jhinga sail' was conducted at Bankura station for 5 years in 2 sets of experiments. In one set of experiment five dates of planting with five ages of seedlings were involved, while in the other, five dates of planting with 5 different number of seedlings per hole were tried, the spacing remaining the same in all cases i.e., 9” apart either way. The yield data of the experiments are set out in the following Tables IX, X and XI.

TABLE IX

Mean yield of grain in ounces of 100 plants (average of 4 years 1935-36 to 1938-39) of the different dates of planting with their respective ages of seedlings of the variety Bhasamanik.

<table>
<thead>
<tr>
<th>Age of seedling</th>
<th>Date of planting</th>
<th>16th July</th>
<th>9th July</th>
<th>13th Aug.</th>
<th>27th Aug.</th>
<th>10th Sept.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 42 days old</td>
<td></td>
<td>46.7</td>
<td>33.8</td>
<td>27.9</td>
<td>26.6</td>
<td>20.8</td>
</tr>
<tr>
<td>2 35 days old</td>
<td></td>
<td>45.6</td>
<td>37.2</td>
<td>26.1</td>
<td>25.2</td>
<td>20.4</td>
</tr>
<tr>
<td>3 28 days old</td>
<td></td>
<td>45.0</td>
<td>35.2</td>
<td>27.6</td>
<td>27.4</td>
<td>21.0</td>
</tr>
<tr>
<td>4 21 days old</td>
<td></td>
<td>43.7</td>
<td>33.2</td>
<td>23.4</td>
<td>22.5</td>
<td>16.4</td>
</tr>
<tr>
<td>5 14 days old</td>
<td></td>
<td>40.0</td>
<td>31.4</td>
<td>22.8</td>
<td>23.8</td>
<td>17.1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>219.0</td>
<td>169.8</td>
<td>127.8</td>
<td>125.5</td>
<td>92.7</td>
</tr>
</tbody>
</table>

TABLE X

Mean yield of grain in ounces of 100 plants (average of 5 years 1934-35 to 1938-39) of the different dates of planting with their respective number of seedlings of the variety 'Jhinga Sail'.

<table>
<thead>
<tr>
<th>Number of seedlings per hole</th>
<th>Date of planting</th>
<th>16th July</th>
<th>5th Aug.</th>
<th>25th Aug.</th>
<th>14th Sept.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 47'1</td>
<td></td>
<td>51'3</td>
<td>41'1</td>
<td>31'3</td>
<td>25'4</td>
</tr>
<tr>
<td>2 46'9</td>
<td></td>
<td>39'9</td>
<td>33'9</td>
<td>33'4</td>
<td>27'7</td>
</tr>
<tr>
<td>3 47'1</td>
<td></td>
<td>40'2</td>
<td>33'4</td>
<td>38'6</td>
<td>28'8</td>
</tr>
<tr>
<td>4 45'8</td>
<td></td>
<td>40'5</td>
<td>31'3</td>
<td>27'9</td>
<td>27'9</td>
</tr>
<tr>
<td>5 45'9</td>
<td></td>
<td>40'3</td>
<td>32'2</td>
<td>25'9</td>
<td>25'9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>232'4</td>
<td>202'0</td>
<td>162'1</td>
<td>135'7</td>
</tr>
</tbody>
</table>
TABLE XI

Particulars showing the date of seed-bed sowing, date of planting, age of seedling, and the average yield of grain in ounces (100 plants) for 4 years (1935-36 to 38-39) of the variety Bhasanmik

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Date of seed bed sowing</th>
<th>Date of planting</th>
<th>Age of seedling</th>
<th>Average Yield in ounces per plot</th>
<th>Percentage on control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5th June</td>
<td>16th July</td>
<td>42 days</td>
<td>49.2</td>
<td>105.8</td>
</tr>
<tr>
<td>2</td>
<td>17th June</td>
<td>16th July</td>
<td>35 days</td>
<td>43.5</td>
<td>100.0</td>
</tr>
<tr>
<td>3</td>
<td>19th June</td>
<td>16th July</td>
<td>28 days</td>
<td>45.0</td>
<td>103.0</td>
</tr>
<tr>
<td>4</td>
<td>Do.</td>
<td>30th July</td>
<td>42 days</td>
<td>33.8</td>
<td>77.4</td>
</tr>
<tr>
<td>5</td>
<td>26th June</td>
<td>16th July</td>
<td>21 days</td>
<td>43.7</td>
<td>100.0</td>
</tr>
<tr>
<td>6</td>
<td>Do.</td>
<td>30th July</td>
<td>35 days</td>
<td>37.2</td>
<td>85.1</td>
</tr>
<tr>
<td>7</td>
<td>3rd July</td>
<td>16th July</td>
<td>14 days</td>
<td>40.0</td>
<td>91.6</td>
</tr>
<tr>
<td>8</td>
<td>Do.</td>
<td>30th July</td>
<td>28 days</td>
<td>35.2</td>
<td>80.6</td>
</tr>
<tr>
<td>9</td>
<td>Do.</td>
<td>15th August</td>
<td>42 days</td>
<td>27.9</td>
<td>69.9</td>
</tr>
<tr>
<td>10</td>
<td>10th July</td>
<td>30th July</td>
<td>21 days</td>
<td>32.2</td>
<td>73.7</td>
</tr>
<tr>
<td>11</td>
<td>Do.</td>
<td>15th August</td>
<td>35 days</td>
<td>26.2</td>
<td>60.0</td>
</tr>
<tr>
<td>12</td>
<td>17th July</td>
<td>10th July</td>
<td>14 days</td>
<td>31.4</td>
<td>71.9</td>
</tr>
<tr>
<td>13</td>
<td>Do.</td>
<td>15th August</td>
<td>28 days</td>
<td>27.6</td>
<td>63.1</td>
</tr>
</tbody>
</table>

It will be seen from th seals that earlier the planting, the better was the yield of the crop. The 16th July planting gave the highest yield followed by 30th July or 5th August planting. The difference in yield between the two, ranging from 15 to 21 per cent during the different years under trial. If planting was delayed beyond 5th August and done on 25th August or so, the yield was considerably reduced, being 57-70 per cent of the early plantings (16th July).

Facts of practical importance—The following facts of practical importance emerged out of the experiments.

Raising the seed-bed on the 5th June and planting on 16th July with 42 days old seedlings would give highest yield.

However, under conditions obtaining at Bankura, raising seed-beds on 26th June would seem to be preferable to very early sowing for the reason that if conditions are favourable for transplanting on 16th July, planting could be done with 3 weeks old seedlings from the 26th June sown seed-bed without detriment in yield, as the yield obtained from this would be as good as that obtained from the plantings done with seedlings sown on 19th June. Further advantage would be that if planting could be possible only on the 30th July due to late receipt of rains, 35 days old seedlings from the 26th June seed-bed could be utilised without too much reduction in yield.

If late plantings beyond 30th July are inevitable it is advantageous to use seedlings of young age of 4 weeks from late sown seed-beds (July). The result of this experiment is in conformity with that obtained at Chinsura Station where, however, a greater range in the age of seedlings (3-11 weeks) was used for the trial.

The above complex cultural experiments of the two farms bring to light without question of doubt, the profound influence of the time of planting on the yield of the crop. The over-all rice production in Bengal, whether high or low, will therefore, depend mainly upon this factor which is influenced by the vicissitudes of monsoon. It may be possible to mitigate the ill effects of unfavourable monsoon if transplanting could be done within 30th July, with the help of filter-point pumps installed in suitable centres. There is a great scope of exploring the above avenue to stabilise the crop production in this State.

Another cultural practice that may be advantageously put into practice for enhancing the yield under late planted condition is that of double transplantation. The results of double transplanting experiments conducted in other States have shown that the yield of late planted crops improves by this practice. This possibility should, however, be tested at the Research Stations before recommending it to the cultivators.

**Factorial Experiments in Assam**

**Karimganj and Titabar Farms (Assam).**—The results of factorial experiments involving time of planting, spacing, age of seedlings, number of seedlings per hole, etc., conducted for 3 years proved that July planting was best for 'tall', while August and September plantings gave progressively decreased yield. As the yield obtained from September planting is very poor, being about half of July planting, it should as far as possible be avoided.

However, if late planting is inevitable in the double cropped lands, recourse to the method of double transplantation should be resorted to for maintaining the yield at a high level. The yield data of the 'time of planting' of the two stations are given below:

**Karimganj Farm**

<table>
<thead>
<tr>
<th>Time of planting</th>
<th>Average yield of 3 seasons (1935-38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15th June</td>
<td>3146</td>
</tr>
<tr>
<td>5th July</td>
<td>3210</td>
</tr>
<tr>
<td>25th July</td>
<td>3049</td>
</tr>
<tr>
<td>15th August</td>
<td>2933</td>
</tr>
</tbody>
</table>

**Titabar Farm**

<table>
<thead>
<tr>
<th>Time of planting</th>
<th>Average yield of three seasons (1936-37, 1938-39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th July</td>
<td>3084</td>
</tr>
<tr>
<td>25th July</td>
<td>2916</td>
</tr>
<tr>
<td>15th August</td>
<td>2644</td>
</tr>
<tr>
<td>5th September</td>
<td>1854</td>
</tr>
</tbody>
</table>

**End of December best for planting 'Boro'.**—The results of an experiment conducted with two varieties to determine the best time of planting for 'Boro' (spring paddy) showed that last week of December i.e., 28th to 31st December was ideal for high production of the crop. It would
appear that early planting is detrimental to the yield of 'Boro' strain while it is reverse in the case of 'Tupa' strain. So 'Tupa' is to be selected for early planting and 'Boro' for late planting. The average of two years' results are given below:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Boro</td>
<td>1333</td>
<td>1356</td>
<td>1310</td>
</tr>
<tr>
<td>Tupa</td>
<td>1792</td>
<td>1853</td>
<td>1908</td>
</tr>
</tbody>
</table>

Experiment with 4 ages of seedlings and 3 dates of Transplanting, Sabour, At Sabour (Bihar) in the year 1936, a complex cultural experiment involving 4 ages of seedlings and 3 dates of transplanting with a variety of 16 BK was conducted adopting a uniform spacing of 9" apart either way with 3 seedlings per hole. The important conclusions of practical value that could be drawn from the yield data of the experiment are as follows:

(1) Raising seedlings on the 27th June and transplanting the field on the 25th July with 4 weeks old seedlings would give higher yields but there would be a sharp drop in yield to an extent of 21 per cent if seedlings of 6 weeks of age from the above seed-bed were to be planted on the 8th August.

(2) In case late planting is inevitable due to seasonal and other causes in the 3rd week of August, the raising of seed-beds on the third week of July and transplanting it with four weeks old seedlings is recommended for obtaining satisfactory yield. This yield is comparable to that obtained from 27th July planting with 5 or 6 weeks old seedlings. For practical reasons sowings may be done in two batches i.e., 20th and 27th June and seedlings of 4, 5 and 6 weeks of age for the plantings to be done on the 25th July or 8th August as the case may be. This practice would be able to meet either situation of normal or late plantings arising out of the vagaries of the monsoon.

Factorial Experiment in Bihar

Gaya Farm. At Gaya Farm (Bihar) a four factorial experiment involving four dates of planting, two kinds of spacing, two kinds of seedlings, i.e., from normal and late sown seed-beds and different number of seedlings per hole was conducted in the year 1938 with the variety 36BK. The results of the trial indicated the following facts:

(i) June 15th, was the best time for raising seed-beds.

(ii) The planting on the 2nd August gave the highest yield, being very closely followed by 19th July planting.

(iii) Seedlings of 63 or 77 days of age could be used for late transplanting on 16th August or 30th August respectively from the 15th June nursery with advantage, if necessitated by the fickleness of the monsoon, though the yield might be pulled down by 10-20 per cent. This has proved to be better than using relatively younger seedling from the late sown nursery i.e., 30th June.

(iv) For early planting, 9" with 3 seedlings per hole was found as good as 6" with 3 seedlings per hole. However, for the late plantings on 16th and 30th August, 6" with 3 seedlings per hole should be adopted for getting higher yield.
Modified complex cultural experiment. The above complex cultural experiment was modified slightly and carried out for 3 years. The changes in the treatments were as follows:

1. Using two varieties instead of one
2. Reducing the dates of plantings from five to two
3. Altering the seedbed sowing for normal (15th June) and late sown (30th June) nursery to 20th June and 10th July respectively.

The following conclusions emerged out of this trial:

i. The seedlings, raised from 20th June seed-bed were superior to that of 10th July seed-bed both under normal (3rd August) and late (23rd August) plantings to a tune of 9 and 14 per cent respectively.

ii. The spacing of 6" was better than 9" spacing in the case of the variety 36BK by about 7 per cent, while for the variety 62BK, the 6" spacing was only at par with 9" spacing.

iii. The varieties 36BK and 62BK gave more or less same yield.

The results of the experiment were in conformity with that of the earlier trials. It will thus be seen that under Gaya conditions, the optimum time for raising seed-bed seems to be 15th—20th June for planting in 3rd August.

Complex cultural experiment with three sets of factors Nagina Farm. At Nagina Station (Uttar Pradesh) a complex cultural experiment with three sets of factors involving 2 varieties T. 21 & T. 17 four dates of planting (9th June, 5th and 31st July and 26th August) and four ages of seedlings (20, 30, 40 and 50 days) was conducted in the year 1939 and the results of the trial showed that

i. The 9th June planting gave the highest yield. The yield dropped suddenly by about 20 per cent with the next planting on 5th July. There was not much difference in the yield between 5th and 31st July plantings, but the yield of delayed plantings in August was definitely poor being less than half the yield of July plantings.

ii. The different ages of seedlings did not appreciably affect the yield differently, there being only a slight difference in favour of shorter ages as compared to 50 days.

Best time for planting in Uttar Pradesh. At Gorakhpur, Tushri and Pachperwa Farms (Uttar Pradesh) a simple experiment was conducted for three years at Gorakhpur (1948-50) and for 2 years at the other 2 stations, to determine the best time of planting. The results of the trial proved conclusively that the best time for planting was between 10th and 20th July at all the 3 stations. There was a sudden and progressive drop in yield if the plantings got delayed beyond 20th July. The August plantings gave very poor yield being one-third to half of the July plantings.

Planting before middle of July yields higher results. Under Uttar Pradesh conditions, the earlier the plantings before the middle of July, the higher is the yield. Especially with early varieties June planting is the best.

Significant difference in yield due to different dates of planting. Two-fold complex cultural experiment in Kashmir. At Kashmir State, the results of a two-fold complex cultural experiment with four different dates of planting (from May to July), the actual dates of planting slightly varying from year to year due to seasonal conditions and four different ages of seedlings (3, 4, 5 and 6 weeks) conducted for 6 years showed that the plantings carried out in May and in the first week of June gave the highest yield and were distinctly superior to the later plantings. The yield decreased progressively as the plantings got delayed; the difference in yield amounted to about 150 lb. per acre between the planting of 1st week of June and the 2nd week of June. The difference in yield between 2nd week of June and 3rd week of June was about 170 lb. per acre. Although four weeks old seedlings gave highest yields, there was no significant difference due to ages.
Later experiments conducted for 4 years (1947-50) on a similar line but combined with different dates of broadcast sowing treatments, also confirmed the above findings i.e. the earlier the planting, the higher was the yield.

The plantings done between the first and second week of June gave the highest yield and the yield of the subsequent plantings on 3rd and 4th week of June decreased by about 12 per cent, while the July planting was distinctly low by about 25 per cent as compared with the earlier plantings in the first week of June.

It may be pointed out here that in the above experiments, seedlings from thick sown seed beds with single seedling per hole distanced at 9 inches apart were used and this might have naturally affected the overall yield of the plots. This was perhaps the only plausible reason for the low yield recorded by transplanted crop as compared with broadcasting. The yield of the transplanted crop would have been high if a close spacing of 3” or 6” with 2 seedlings per hole obtained from thin sown nursery had been used for the trial. This trial indicates that under Kashmir conditions the early planting in the first week of June should be carried out for obtaining good yields.

General conclusions on time of planting of crop. Experiments relating to transplantation in all its aspects have been discussed in the preceding pages and the results unmistakably point out that for obtaining good crops, varieties suitable for the locations and seasons should be transplanted at the optimum time of planting; for each variety there is own range of planting period and it is within that critical period of planting alone that the variety gives full manifestation to its yield attributes, which results in high production of the crop. This principle applies equally to both short duration and long duration crops.

In general, it may be stated that for the first crop short duration rice grown in South Madras, transplanting done within the first week of July preferably in the month of June itself, give satisfactory yields, while for the 2nd crop of rice, the middle or 2nd week of October can be considered as the optimum date of planting for getting best results. However, late plantings extending up to November-December with right choice of varieties to fit in with the seasonal conditions, could be resorted to without reduction in yield of the crops.

In the Circars, for the first crop the earlier the planting i.e. in June, the higher is the yield. Contrary to the above stated axiom for the first crop, the later the planting for the second crop, the bigger is the yield, as the early planted second crop usually succumbs to the incidence of stem borer attack and the harmful effect of the western wind during that period. The first week of February is the optimum time for planting second crop to get best results.

Transplanting period for Eastern Rice Zone. In the Eastern Rice Zone comprising Orissa, Bengal, Assam and Bihar, the best period for transplanting that gives maximum output of the main crop is middle of July to end of July, the early part in the first week of August being as good as July in certain favourable years. There was a distinct fall in yield as the planting gets delayed. Plantings at the end of August generally prove to be very poor, the yield being one-third to half of its normal yield. For ‘Boro’ paddy in Assam the last week of December (i.e., 28th-31st) has proved to be an ideal period for transplantation.

In the Northern Zone comprising Uttar Pradesh, Punjab (I) and Kashmir, very early transplanting alone in the first week of June has proved to be the best.

In the Western Rice Zone of Bombay and northern parts of Malabar (Madras) for the first crop, the planting in June is the ideal period for bumper production.

The profound influence of the time of planting on the yield of the crop is thus well recognised. Primus facies this is the most vital factor that decides the productive capacity of a variety. Every effort should therefore be made to transplant the crop at right time, ignoring slightly other factors like the ideal preparation of the land, age of seedlings etc. If, however the ideal planting period is missed due to causes beyond the control of man, the adjustment of other cultural practices as fertilising the crop, planting the seedlings closer, using greater number of seedlings per hole and double transplantation, etc., should be resorted to. The evolution of
a hybrid strain in which is synthesised the high yielding capacity of one strain of proved merit of the tract and, the ability to respond well under late planted conditions of another strain would, no doubt, prove to be very useful to the cultivators who may be obliged to transplant the crop rather late in the season. A time lag in the optimum time of planting for a high yielding strain of the tract could thus be obtained.

G. SOME ASPECTS OF TRANSPLANTING PRACTICES

The most important factors that are intimately connected with the yield of transplanted rice crop have been already dealt with and it is now proposed to discuss below some aspects of transplanting practices that are taken with a view to getting over certain practical difficulties experienced by the cultivators in adopting the method of transplantation extensively.

(i) The duration of rest to the uprooted seedlings

Pulling out seedlings on one day and planting them the next day is almost the universal practice. But it is not always possible to adopt the above practice due to reasons beyond the control of the cultivator namely heavy rains interfering with planting, time-lag required for transporting seedlings to a long distance and scarcity of labour.

It has been observed that the seedlings held over for a few days after pulling appear to fare badly. How far, and to what extent the yield is affected due to planting such seedlings and up to what safe limit the uprooted seedlings could be kept and planted without prejudice to yield have been determined by conducting simple experiments at a few Research Stations especially in Madras and the results of the trial are briefly given below:

Adururai Station. At the Adururai Station in a simple experiment, seedlings were pulled out and planted on the same day, second day, etc., up to six days in a long duration variety ADT 2 and observation made. The results revealed that the transplanted seedlings did not establish themselves satisfactorily if planted later than the third or the fourth day but that the tillering capacity and yield of the established plants did not vary up to fifth day. But in the sixth day- planted crop, the establishment was very poor, nearly 50 per cent of the seedlings dying off and the tillering capacity of the plants was also poor.

As would be seen from the yield data presented in Table XII below there is absolutely no harm in delaying the planting up to three to five days after the seedlings are pulled out. This period is likely to be much less for short duration varieties.

Sooner planting for short duration varieties. In the case of short rices, experience has, however shown that seedlings uprooted and planted on the very same day itself establish much more quickly than those given different periods of rest. The sooner the planting is done, the better for short duration varieties.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grain yield in lb. per acre</th>
<th>Percentage of increase over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same day</td>
<td>1284</td>
<td>100</td>
</tr>
<tr>
<td>Second day</td>
<td>1285</td>
<td>100</td>
</tr>
<tr>
<td>Third day</td>
<td>1294</td>
<td>101</td>
</tr>
<tr>
<td>Fourth day</td>
<td>1310</td>
<td>102</td>
</tr>
<tr>
<td>Fifth day</td>
<td>1317</td>
<td>102</td>
</tr>
</tbody>
</table>
Experiments at Maruturu with *Garikasamavari*, a four months crop, have also shown that it is not advisable to postpone planting beyond four or five days after the seedlings are pulled out. It has also been observed at the same station with regard to the varieties *Basangi* and *GB.24* that the seedlings given long rest of 5 or 10 days when planted suffered high mortality and besides the flowering was also slightly delayed.

A similar experiment was conducted in Assam State with a 'Boro' variety for 4 years. In this experiment the uprooted seedlings before plantings were rested in mud and water for 0, 3, 6 and 9 days. The average yield of the different treatments for 4 years is given in Table XIII below:

<table>
<thead>
<tr>
<th>Duration of rest (days)</th>
<th>Acre yield in lb. (average of four years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1721</td>
</tr>
<tr>
<td>3</td>
<td>1642</td>
</tr>
<tr>
<td>6</td>
<td>1551</td>
</tr>
<tr>
<td>9</td>
<td>1203</td>
</tr>
</tbody>
</table>

Yield diminished with increase in duration of rest. It would be seen from the data that the yield diminished progressively with every increase in the duration of the rest and this decrease in the yield was much more pronounced, in the case of nine days-rest seedlings. It would appear that rest given to the seedlings more than 3 days would tell upon the yield of the crop adversely.

(ii) Topping the foliage of the seedlings

It is a common practice that the top foliage of the seedlings is removed by mazdoors before planting if the seedlings are a bit overgrown. This is done with a view to prevent the seedlings being blown over by the wind as tall seedlings are liable to be affected by wind unless they are planted quite deep in the mud. Probably it is also done to minimise transpiration of the plant which has to establish new roots and shoots. Whether or not it is a sound practice to prune the seedlings at planting time has been tested at Aduthurai Station (Madras) with 2 short and one long duration varieties. The experiment conducted with 2 short duration varieties i.e., ADT.3 and ADT.4 (3/4 months duration) where the seedlings without any pruning were compared with pruning them to 3 inches and six inches height from top, showed that in the case of ADT.4 the cutting off made no difference in the final yield whereas in the case of ADT.3 the yield was definitely reduced by pruning from the six inches of the height.

Pruning of long duration variety. This experiment carried out with a long duration variety ADT.4 (6 months) indicated that the pruning did not affect the final yield. Evidently, the cutting has no effect in the late varieties. At the Coimbatore Paddy Breeding Station, the practice of pruning the seedlings at the top while planting is invariably adopted as a convenience and there has been no ill effect produced on the yield.

In other rice growing States also where transplanting is practised, the pruning of the top of the seedling, if it is over grown, is done to facilitate planting. The pruning might also prove useful in that there is a chance of getting rid of some insects, particularly thrips if present are usually to be found at the top of the leaves which remain rolled.

Pruning of seedling in low lying area not advisable. It should, however, be emphasised here that the pruning of the seedlings should not be done for the plantings in low-lying places which are subject to temporary flooding; for it is absolutely necessary that at least a portion or the top of the leaves to a height of one-two inches may not get completely submerged. However, there are a few varieties that withstand complete submergence for a few days without much harm to the plant. It would thus be seen that pruning is not a harmful practice except for short duration rice.
(iii) Ripening the seedlings before planting

South Malabar. There obtains a practice, in South Malabar (Madras), of purposely delaying planting and making the seedlings undergo a sort of ripening process off the ground before the second crop planted in September-October. The seedlings bundled together are arranged in a circular heap with the roots exposed and foliage towards the centre hidden. The heap is left undisturbed for three or four days. The seedlings lose their green colour and look pale on the fifth day. The seedlings thus treated are removed on the fifth day and placed in water overnight in a corner of the field to be planted the next day.

The main idea of giving this ripening process is to induce a sort of fermentation that might produce such heat within the heap that would kill young insects and destroy egg masses that the second crop is usually subjected to in this tract. If the heap is found dry, water is sprinkled to facilitate fermentation. The seedlings treated in this manner resume their green colour soon after planting much faster than untreated seedlings and are on the whole better grown and free from insect pests.

Maruteru Station. A similar experiment was conducted at Maruteru Station with different periods of ripening 4, 6, 8 and 10 days. It was observed that there was no difference in yield between the treated seedlings and normal seedlings. However, the mortality of seedlings of 10 days ripening treatment was rather high. The above experiments showed that this period of ripening the seedlings for a few days before planting in any case for not more than a week, has something to be recommended as a sort of control measure against mealy bug attack in rice.

(iv) Root pruning of seedlings

When seedlings are uprooted from the seed bed, a certain amount of pruning of the roots does occur naturally under normal conditions. But under unfavourable conditions when injudicious irrigation has been given to the dry or wet nursery, the uprooting of the seedlings is found to be difficult because of the deeper developed root system and the undue force required to pull them. This often results in the snapping of the seedling at its collar and in a most severe pruning of the root system. Whether or not this pruning of the roots of the seedlings is harmful or beneficial has been tested at a few stations in Madras and Mysore, that is, Coimbatore and Pallambi.

Experiments were conducted at Coimbatore and Pattambi with pruning away all the roots at the time of planting and such pruned plants gave yield as good as that obtained with seedlings that were not pruned. It was also observed that the quick establishment of transplanted crop depends upon the rapid formation of the fresh set of new roots which develop immediately after transplanting. The roots remaining with the seedling at the time of transplanting do not seem to function at all.

Aduthurai Farm. Experiments were conducted at Aduthurai Farm on the effect of severe root pruning of seedlings at transplanting for three years with short and long duration varieties. In the year 1933, severely root pruned seedlings of ADT 11, a six months' variety were compared with normal seedlings pulled out from the seed-bed, in strips in ABBA fashion repeated eight times. The results of this trial showed that the non-pruned seedlings gave a significant increase in the yield to the extent of 38 per cent over pruned seedlings. But in the subsequent years 1934 and 1935, the pruned seedlings gave an increased yield of about 6 and 12 per cent respectively. Of this, the increased yield of 12 per cent in 1935 was quite significant.

Pruned seedlings give higher yield in long duration variety. In the case of another long duration variety, ADT 2 it was found that the pruned seedlings gave higher yield over normal seedlings by 11 and 4 per cent in 1934 and 1935 respectively. But this increase in the percentage was not remarkable.

However with regard to short duration varieties ADT 3 and ADT 4 of 100 days, the results of the experiment, in general, indicated that pruning the roots was harmful.
In the year 1934, in the case of the strain ADT-3, the non-pruned seedlings gave a significant increase in yield of about 19 per cent over pruned seedlings, while an increase in yield of about 10 per cent was recorded in the case of the strain ADT-4. This increase was not statistically significant. Contrary to the results obtained in 1934, the results of the year 1935 showed that pruned seedlings gave increased yield over non-pruned ones by about 4 per cent.

Pruning lessens yield in short duration varieties. It would thus be seen that pruning the roots of the seedlings may not affect the yield of long duration crop varieties adversely but it does tell upon the yield of the short duration varieties to some extent. In this connection, it may be stated that if the seedlings are grown under hardy conditions, say, raised in a dry-bed without much water, the root development is poor and such seedlings are seen to establish quicker than seedlings grown under more favourable conditions with plenty of manure and water.

(v) Double transplantation

The practice of double transplantation prevails in a few rice growing tracts in view of special conditions of such tracts. In this method seed is first thickly sown in the nursery and then planted close together in bunches. Subsequently these bunches are uprooted and planted in the main field. This practice is adopted and found to be of some benefit for special tracts: (1) where either facilities for early planting are not available or early planting is not feasible, (2) where early planting results in too rank a vegetative growth due to over-dertility of the soil (3) where it is desired to hasten the flowering of the crop for early harvesting (4) where dearth of seedling is apprehended due to damage to the seedlings on account of natural or unforeseen causes (5) where sowing all the seed material is necessary and (6) where more efficient weed control is necessary to minimise the cost of expenditure in this item.

This practice of double transplantation is being adopted in some special tracts of Madras Bombay, Uttar Pradesh and Assam and the results of the trials are briefly summarised below.

Godavari delta in Madras State.

In the Central delta of Godavari in Madras State, the conditions obtainable are such that facilities exist for early sowings but not for early plantings. To prevent the early sown seedlings from becoming too rank in growth, they are planted in a second nursery after a month, about three inches apart, and the same replanted a month later in the main fields with wider spacings.

Samalkot Station.

At Samalkot Station, double transplanting was compared with single planting for five seasons. For double transplanting, seedlings from the primary nursery were uprooted after a fortnight and planted in another seed-bed from whence they were finally lifted for planting in the main field after a month whereas in 'single transplantation' the seedlings were allowed to remain in the nursery for one and a half months and then uprooted for planting straightaway in the main field. The results of the five years trial indicated that 'double transplanting' was distinctly superior to 'single planting'. Where water difficulty is felt for planting straightaway in the field in time, this method has been found to be quite useful to tide over critical and anxious periods of deficient water supply. Though this may entail extra expenditure by way of planting in the secondary nursery, yet it helps in saving of seed, timely planting of healthy and strong seedlings, reducing the chances of the crop lodging prematurely and increasing the yield. At this Station, it was found in an experiment that three pounds of seed sown in one cent of nursery produced enough seedlings to plant three cents in the first instance and 34 cents finally; while in single transplantation the same quantity sown in one cent was enough to plant 12 cents only. For transplanting one acre of land 10 lb. of seed would be sufficient to cultivate under the method of double transplantation, while 25 lb. of seed would be required for single transplanting. Where there is dearth of seedlings due to unforeseen causes, the cultivators resort to double transplantation in order to cover comparatively larger area of land. This contingency often arises in parts of Madras State especially in the Southern districts.
Maruteru Station. At the Maruteru Station where experiments were conducted to prevent the premature lodging of the crop which is common with rich soils, double transplanting was experimented upon as a useful agronomic practice. Early and late sowings and thick and thin sowings were also included in the experiment. The general results of the experiment indicated that the yield difference in favour of double planting was very little. In the case of thin sowing only significant effect on the yield was noticed.

Buchiredipalayam Station. A similar experiment conducted at Buchiredipalayam Station representing Nellore tract in Madras State showed the beneficial effect of adopting double transplanting. This tract often experiences water difficulty as it has to depend upon the monsoon rains which are erratic with the result that the period of transplanting fluctuates very widely. Since time of planting is an important factor, seed-beds are sown in time with the hope of monsoon breaking in time. If, however, the rains are late and water scarcity is apprehended, the method of double transplanting with the limited supply of water seems to be the only devise to prevent the seedlings forming nodes. Under such conditions double transplanting has proved to be distinctly superior to single transplanting with aged and noded seedlings. Following results were obtained from experiment conducted for 3 years on double planting at the Buchiredipalayam station.

1) Double transplanting may be adopted as an alternative to single planting in places with uncertainty of water supply for planting.

2) In two out of 3 years in mid season sowings (15th August) corresponding to the project area of Nellore tract, 30 days in the primary nursery and 15 or 30 days in the secondary nursery appear to be more suitable for double transplanting.

3) The fields planted with double transplanting come to flower earlier than those planted with single planting for the same age of seedling and this early flowering is more marked even up to 10 days under the late planted conditions with longer ages of seedling.

Double transplanting better than single transplanting. At Aduthurai Station double transplanting was tried with a Kar variety ADT 9, a four months' variety, in the year 1943 and the result showed that double transplanting was better than single planting even under late planted conditions in the 1st August.

The practice of double transplanting prevails in Thana district of Bombay and is adopted with a view to reduce production of straw and increase the yield of grain. The conditions obtainable here are similar to that in West Godavari, where the practices of double transplanting and topping the crop in early stages are resorted to.

In Assam State, double transplanting is in vogue in the 'Boro' tracts where late planting is occasionally unavoidable due to the late recedence of water. It happens often that the late planted crop besides giving low yield than the early planted one, is damaged by the occurrence of floods.

Habibganj Farm. To get over the difficulty of flood, experiments were conducted for four years at Habibganj Farm with double transplanting. One month old seedlings were first transplanted in a st of land with 3-4 seedlings per ho' or a distance of 6 inches apart either way. One month after the seedlings were uprooted and retransplanted in the experimental plots along with two months old seedlings unrooted from the original nursery. The yield data of the two years results are presented in Table (a) of Appendix V.

It will be seen from the results that 'double transplanting' in the low level lands gave an average increase of 39.8 per cent over single planting. This additional yield counterbalances the extra expenditure incurred in double transplanting. It has also been observed that double transplanting had induced early flowering definitely by about 9 days, a very desirable feature for early harvesting of the crop in the 'boro' land where the crop is often damaged by early floods especially at the harvesting period and where there are facilities for early sowing but not for early planting.
Experiments on 'Boro' and 'Tupa'. Similar experiments were carried out for three years in high level lands with two factors having two varieties 'boro' and 'tupa' and three different kinds of transplanting namely, early single planting with 40 days old seedling; late single planting and double planting with 70 days old seedlings. In the table i(b) of Appendix V the averages of three years' results are given. It will be seen from the yield data that in the case of the 'boro' strain, 'double transplanting' undoubtedly proved to be better than either early or late single planting by about 16 per cent, besides being earlier by about a week over single planting only.

In the case of the variety 'Tupa' early single planting gave an increased yield of about 10 per cent over double planting, the converse of the findings obtained for the 'boro' variety. However, double transplanting was distinctly superior to late single planting by about 60 per cent besides being earlier by about a week. These results would thus indicate that 'Tupa' should invariably be selected for early planting while 'Boro' for late planting; the differential response and reaction of the varieties to the time of planting are clearly manifested in these trials. Under Assam conditions double transplantation either in low or high level lands has been found to be superior to late planting in both yield and earliness.

Double transplanting in Uttar Pradesh. At Naginu Station (Uttar Pradesh) double transplantation experiments were conducted for four years with early and late varieties to test its efficiency over single transplanting. The yield data of the experiments are given in Table ii of Appendix V. It will be seen from the yield figures that in the case of the early variety T.21, double transplanting gave an average an increased yield of 189 lb. per acre over single planting on a control yield of 391 lb. per acre. Besides, the double transplanted plots came to flowering earlier by about 8-10 days which facilitated early harvesting so that the land could be prepared in time for the rabi crop.

In the case of late varieties, however, double transplantation did not yield better results than single transplanting except in one year when it gave an increased yield of about 9 per cent over single transplanting. The early flowering of the crop in favour of double transplantation did not occur as was observed in the early variety T.21. Where late planting is inevitable, double transplantation under Nagina conditions would decidedly prove to be advantageous. If double transplantation were to induce early flowering of the crop by a week in the strain T.22 which is recommended for growing as a mid duration first crop wherever irrigation facilities exist, it would go a long way in economising the cost of expenditure on irrigation. Instead of adopting broadcasting in the middle of April, the method of double transplantation could be used with advantage both in point of cost of cultivation and yield. It has also been observed that a great amount of saving in seed is effected by the method of double transplantation, as the number of seedlings required in single transplanting is about two and a half times more than in double transplanting.

Double transplanting experiments in Central Rice Research Institute. At the Central Rice Research Institute, in 1948 a trial was conducted with variety FR. 43 B to test the advantage or otherwise of double transplanting of the rice under three planting conditions, (1) seedlings transplanted in the field after 30 days in nursery bed, (2) seedlings transplanted to another nursery bed after 30 days and then retransplanted in the field after another 30 days, (3) seedlings transplanted in the field after 60 days in the nursery bed.

The yield data of the experiment is given in Table iii of Appendix V. The results indicated that double transplanting was superior to late single planting by about 9 per cent but inferior to early single planting by about 20 per cent. Probably this increase might be attributed to the time of planting which happened to be a month earlier in the case of the single transplanting as compared to the time of double planting.
Double transplanting superior to single transplanting. This experiment was carried out with 3 and 2 strains, with slight modifications in the date of planting in 1949 and 1950 respectively. It would be seen from the results of the two years trial set out in Table iv of Appendix V that under late transplanted conditions, double transplanting was definitely superior to single planting by about 9 and 31 per cent respectively over the seedlings of 30 and 60 days of age used in the single transplanting. However, double transplanting gave 10 per cent less yield as compared to single planting done a month ahead of it, and evidently the factor ‘time of planting’ might have been responsible for it. A study of the yield attributes of the different treatments revealed the following facts:

(i) the length of ear-head in the early single planting and late double transplanting was greater than that of late single planting and
(ii) the height of the plants was greater. These two factors contributed to the bigger yield of the crop obtained in those treatments.

It would thus appear that double transplanting is a good practice and can be recommended for tracts where late transplanting is inevitable due to various reasons. It also helps in advancing the maturing of the crop by about a week in certain varieties. The beneficial effects of double transplanting within the ‘optimum’ planting period have not yet been critically examined. There is every possibility that this practice might enhance the yield of the crops under heavy manured conditions combined with other suitable intercultural operations.
AFTER CULTIVATION

FOLLOWING practices of after cultivation are dealt with in this chapter:

(i) Irrigation practices

(ii) Inter-culturing operations

(iii) Manuring practices

(1) Irrigation practices

The first and foremost operation that has to be taken care of after planting is the irrigation of the crop. As a rule, transplanting is carried out with about half to one inch of water in the field. The low level of water is maintained for about a fortnight till the new transplants are firmly established. Thereafter, the level of water is increased to 2 to 3 inches till the grains pass the dough stage. The water is then drained away completely 5 or 10 days before the harvesting of the crop. The time as to when this draining should be done depends upon the property of the soil. In the porous and light soils with less capacity to retain moisture, irrigation should be continued till one or two grains at the base of the ear-head are found green. Irrigation may, however, be cut off in the heavy soils a week to 10 days before harvesting because of its high moisture retaining capacity.

Draining of irrigation water. It should be emphasised here that the irrigation water should be frequently changed letting in fresh water. The most ideal method to do so would be to allow the impounded water to drain away slowly both by surface and underground drainage. This would also promote better aeration of the roots as evidenced by the well developed root system, extending up to a depth of a foot or 14 inches in a well drained land. Against this in an ill-drained or alkaline land it has been found that the roots are confined to a few inches from the surface. In almost all the major rice growing tracts in India, where paddy is grown under canal irrigation, the above practice is adopted except in canal irrigated areas of Bihar where the practice of completely dewatering the field a month to one and a half month after transplanting i.e., in the middle of September is in vogue. This is done with a view to make the land crack for a few days and then flood it copiously. This practice is supposed to make the plants grow more vigorously. For a similar reason in other countries like Italy and Spain, there is often a practice to drain off the water completely from the fields now and then. This draining of water should on no account be done after the formation of the ear-heads. In fact, when once the plants enter this phase, water must be given in plenty as this is the period when the transpiration activity is at its peak.

Higher water level gives more yield. Experiments carried out in other countries like Philippines and America indicated that the practice of maintaining a level of water at about 6 inches or even slightly more in the field about 30 days after the emergence of the plant from the sowings until the crop is ready to drain for harvest, gave the highest yield both in grain and straw. A supply of about one inch of water gave the lowest yield and it was also observed that a continuous flowing of water slowly in the field was found to be the best practice of irrigation resulting in higher production of the crop.

Water depth checks weed growth. The depth of water in the field while suppressing weed growth promotes better tillering of the rice crop. In India, however, it will be seen from the results of the irrigation experiments conducted at the Research Stations that too much and continuous flooding of the field is not at all necessary for the higher production of the crop and, it is also apparent from the fact, that in some parts of Krishna in Madras State crops that are
Irrigated by water lifts give yields better than crops receiving copious flow irrigation. Flooding, however, keeps the weeds under check effectively and curtails the cost of weeding operation. Experiments were conducted in most of the rice tracts to determine the optimum water requirements of rice crop and the results of their trials are briefly reviewed below:

**Optimum water requirement of the rice.** In Madras, irrigation experiments have been carried out first to ascertain the quantity of water required by crops and then to find out the details of time and quantity of water needed, to secure the maximum yields. Earlier trials conducted at Samalkot Farm to find out whether rice could be grown as a garden land crop giving irrigation as and when necessary proved to be a failure because the rice crop was smothered by weeds. But at Maruteru Station when one of the ‘Basangi’ strains of the station was transplanted first in a well-prepared puddled soil and later treated as a garden crop, except flooding it copiously once for the purpose of weeding the crop, came up well and yielded nearly 4,000 lb. of grain, as if it were a swamp paddy.

**Irrigation trials with right treatments.** At Maruteru Station, irrigation trials involving eight treatments were conducted for 3 years (1938 to 1940) with a view to find out what quantity of water at what suitable intervals would give the highest yield of the crop. The results were not significant for the first crop in any year but the general trend of the results indicated that the normal treatment i.e., standing water (about 2 inches) always gave the highest yield followed closely by the treatments i.e., 2 inches of water in either 3 or 6 days intervals. The treatment that received water at longer intervals of 12 to 18 days even with higher dose i.e., 4 inches did not seem to be as beneficial as short interval irrigations with less quantity of water to the crop.

In the second crop season it was noted that the yields were in proportion to the quantity and frequency of water supplied. The control plots which received the largest quantity of water nearly always gave the highest yields. It was found advantageous to give irrigation at shorter intervals i.e., 2 inches in 3 days or 6 days.

The general trend of the results of the later trials also conducted at Maruteru Farm in the years 1943 to 1946 with suitable modifications in the treatments revealed that the control i.e., 3 inches depth of water kept standing at all times gave the highest yields in two first crop seasons and was on a par with the treatments receiving water at 3½ days intervals. All the treatments where water was supplied at 7 days intervals recorded lower yields. For the second crop, normal irrigation gave significantly higher yields over all other treatments followed by 3 inches in 7 days and 2 inches in 3½ days. There was an indication that it was not enough if water was supplied in sufficient quantity till the crop established and then reduced considerably since this practice resulted in lowering the yield by about 14 per cent over the normal. The 50 duty-water for the second crop till planting and thereafter 50 duty-water would seem to be essential as otherwise the newly transplanted young crop may succumb to the injurious effects of alkaline salts that would rise up to the top surface due to the drying of the soil and inadequate irrigation.

**Coimbatore.** In a similar experiment conducted at Coimbatore where water supply for rice crop was obtained from tank-fed channels and supplemented by ‘well’ irrigation, the differences were not significant in three out of five years, i.e., when the rainfall was normal or above normal. The general trend of the results indicated that in years of deficient rainfall, the plots receiving the treatment i.e., 2’ irrigation given at 3 days intervals gave the best yield and equalled the yield of the plots that were given the normal treatment i.e., 2 inches of standing water throughout. Other treatments, receiving water either 2 inches or 4 inches at wider intervals recorded lower yields.

An examination of the yield data would roughly indicate that where economy of water is the main consideration, the practice of adopting 4” in 6 days or normal irrigation for four weeks followed by 4 inches at 12 days intervals would seem to be better than other treatments namely 2 inches or 4 inches at wider intervals right from the beginning. This would thus suggest that
for the plants to establish themselves well, the plants should not be starved of water at the initial stages. The yield data of the Maruteru and Coimatore irrigation experiments are given in Tables 1 and 2 of Appendix VI.

Pattukottai Farm. A similar experiment conducted at Pattukottai Farm in the sandy loams of the Cauvery Mettur project area indicated the same results as obtained at Maruteru Station i.e., the yields were in proportion to the quantity and frequency of water supplied. At Athururai Farm, where the soil is of alluvial origin, irrigation experiments were conducted for a few years but no reliable conclusion could be drawn from the yield data because the different treatments could not be given proper conditions as water let in one plot percolated into the other and this vitiated the results.

Effect of drying out paddy fields. Another set of experiments was carried out for 2 seasons (1946 and 1949), to find out how far drying out of paddy fields would affect the ultimate yields as compared to ryots' practice of keeping a film of water, standing throughout the season. The results indicated that the yields were highest in plots where water was always kept standing.

In the 1949 season, keeping the fields 'dry' for 2 days appeared actually to improve the grain and straw yields; keeping the field dry for 3 days before letting in water, had no adverse effect on yields but drying for 4 days was slightly harmful, while drying for 5 days was definitely so, lowering the yields by nearly 20 per cent from controls. A similar trend was noticed in the straw yields also. This experiment would thus indicate that paddy fields should not be kept without standing water for more than 3 days at a stretch. This intermittent drying-out irrigation experiment was conducted as an anti-malarial measure also in order to destroy mosquito larvae usually found in standing water in rice fields.

Timely irrigations increase yield. At Pattambi Station an experiment was conducted in 1948 to find out how far occasional irrigation to the pure rain-fed crop at critical periods in the absence of adequate showers would help to increase the yield. The results showed that the yield of the broadcast paddy was increased by 28 per cent by a few timely irrigations.

Irrigation experiments were conducted in Mysore State both for summer and Hain crop for three years. The treatments involved in this experiment were as follows:

(i) watered whenever required
(ii) watered once in 3 days
(iii) watered once in 5 days

The results in the case of summer crop showed that the treatment i.e., watered whenever required, gave the highest yield, the amount of increase in yield being 14 and 10 per cent over the treatments (ii) and (iii) respectively, whereas in the case of Hain crop, there was practically no difference in yield between the treatments (ii) and (iii) but the treatment (iii) i.e., watered once in 5 days was lower in yield compared to the other two by about 5 per cent.

Another experiment was conducted at Nagenhailli Farm, where the treatments were (i) continuous irrigation, (ii) irrigation one day (iii) irrigation 2 days and (iv) irrigation 4 days. Results showed that continuous irrigation was distinctly superior to the treatment (iv) i.e., irrigation 4 days by about 7 per cent, while there was little difference between treatments (ii) and (iii) which gave, however, an increased yield of about 4 per cent over treatment (iv).

Standard irrigation experiment. At Nagar, a standard irrigation experiment recommended by L. G. A. R. was conducted for three years. It included a split plot design with 6 treatments i.e., 3 doses of water (rain only, rain plus 20 inches, rain plus 40 inches) applied at 2 intervals, (3 and 6 days). In 1939 and 1941, the treatment differences were insignificant. In 1940 the irrigation could not be given on account of too frequent down-pours, and this resulted in the abandoning of the experiment. It was restarted in 1946 and continued till 1950. The
result of the year 1948 was vitiated due to heavy rains, while the absence of water in the canal in 1949 resulted in the abandoning of the trial. The treatments in the experiment consisted of 4 doses of water of 3", 6" and 9" supplied at 14, 21 and 28 days intervals. In the year 1946 the treatment differences were insignificant but there was the indication that the treatment that received 9", 6" and 3" of water at 14, 21 or 28 days intervals gave higher yield than the treatment receiving 9", the difference in yield on an average being about 210 lb. per acre. The results of the year 1947 also showed that the treatment differences were insignificant. The experiment was tried under ideal conditions, because the distribution of rain in that year remained fairly even. The results indicated that small doses of water frequently given, result in good production of the rice crop. The fact that there was no significant difference in yield between the different treatments pointed out that if there was nice and even distribution of rain, even 14.76 inches of water was as good at 45.61 inches which was the maximum received by any plot. The results of the experiment in the year 1950 indicated significant differences in interval of irrigation, the one with 4 days intervals gave significantly higher yield, than 8 or 12 days intervals. It would thus be seen that under Nagina conditions, small doses of water say 3" given at short intervals of 4 days seem to be desirable for obtaining normal yields. The yield data of the experiment for 1947 and 1950 are given in table 3 Appendix VI.

Nigar practice of Bihar. In Bihar State, there obtains an irrigation practice known as 'Nigar' which means completely dewatering the paddy field in 'Uttara Nakhtra' (14th to 28th September) and filling up again in 'Hathia' (28th September to 12th October). The consensus of the ryots' opinion is that the above practice results in higher production of crop. To test this opinion an experiment was conducted for 3 years at Sabour and Bikramganj Farms during the period 1934 to 1936 and 1936 to 1938 respectively. It included four treatments namely,

(i) water constantly standing
(ii) water supplied whenever crop needs it (control)
(iii) change of water every fortnight with 2 days interval between each filling for the purpose of aeration
(iv) completely draining off water in 'Uttara' and filling up in 'Hathia'.

The treatment differences were not significant except in one year 1935.

Results of Nigar Experiment. The general trend of the results at Sabour indicated that there was no special advantage in practising 'Nigar'. Three years' average yield of the 'Nigar' treatment was same as that of keeping water constantly standing. The treatment (ii) i.e., supplying water whenever the crop needed, gave an increased yield of about 5 per cent over that of 'Nigar'. The results of the Bikramganj Farm showed that the treatments 2 and 3 gave an increased yield of about 7 per cent over the treatment of 'Nigar'. Since the above increase was not statistically significant, it may be concluded that if at all there is any special merit in the treatment of 'Nigar' it is only in economising with water during periods of water scarcity when the fields could be kept dry for about a fortnight during the growth period say 45 days after planting, without prejudice to the yield. The practice of 'Nigar' is, however, not warranted as a course of agricultural routine, as this may cause undue pressure on irrigation resources at the particular period of 'Hathia' when the demand and also the quantity of water required will be more and pressing from all corners.

Irrigation experiments in Dorsa (clay-loam). Irrigation experiments were conducted at Labhandi Rice Research Station for 5 years (1933 to 1938) in 'dorsa' (clay-loam) soil with 2 varieties i.e., one medium and another long duration variety with 3 treatments namely,

(1) standing water
(2) watered when necessary
(3) no irrigation.
The results of the five years indicated that in 'dorsa' soil the treatment i.e., standing water gave significantly higher yield than the treatment i.e., no irrigation, by about 9 per cent in the case of medium ripening variety and 44 per cent in the case of long duration variety. There was an insignificant difference of 3 to 6 per cent in yield between the treatments 2 and 3. It may be mentioned here that during the course of 5 years' trial, it was in the year 1935 only, that the necessity was felt to give 2 acre inches of water to the treatment No. 2 i.e., watered when necessary. It would appear from the result that the practice of irrigating the late maturing variety and keeping standing water especially at the later stages after the flowering and during the ripening phase, seems to be decidedly beneficial, as this would give an additional yield of about 450 lb. over a control yield of 980 lb. per acre.

Relative effects of different doses of irrigation and different dates of planting. At the Rice Research Station, Chinsura, an irrigation experiment was conducted for 5 years with a view to study the relative effects of different doses of irrigation and different dates of planting singly and in combination on 2 varieties of rice. There were 2 levels of irrigation i.e., irrigation and no irrigation except in the first year 1937 which had 3 levels i.e., irrigation at 7 days interval (1/2 dose) (2) Irrigation at 15 days interval (full dose) (3) No irrigation. Two varieties i.e., Bhasamuk and Patna 23 (Gosha) were used with 2 dates of planting (the date of planting for the 'No irrigation' treatment depending upon the rainfall.)

The results of the experiment in general indicated that in years when the rainfall was slightly above normal and the distribution was quite favourable as in the year 1937, there was no difference in yield between the irrigation treatments. The plots that did not receive any irrigation gave as good an yield as the plots that received irrigation once in 7 or 15 days. But, in the years when the rainfall was moderate or below normal or normal with uneven distribution, the 'Irrigation' treatment gave the highest yield over 'No irrigation' the amount of such increase in yield varied from 9 per cent to 27 per cent, depending on the amount and nature of the distribution of rainfall. In the three seasons out of five, the 'Irrigation' and 'No irrigation' treatments gave practically identical yields, while in the remaining two seasons 'Irrigation' treatment gave definitely higher yield than 'No irrigation' treatment. In this connection it may be stated here that this irrigation experiment could not be carried out under quite ideal conditions owing to the practical difficulty experienced in preventing the seepage of water from one plot into another. In light of this limitation, the result obtained in the above experiments should be assessed with caution.

Optimum water-level for sail crop in Assam. To determine the optimum water-level for sail crop, as many as fifteen types were tried at Karimganj Farm in different water-levels ranging from 3" to 12". A water-level of 3" to 4" during the growing period of the crop has been found to be the best. To secure this water-level, it will be sufficient to keep the soil of the plots in order, so that it can arrest the rain water which is plenty in Assam. The maintenance of proper water-level in the sail field serves two purposes, namely, the effective control of weeds and the water requirement of the crop.

General results of irrigation experiments. From the discussion of the results of the irrigation experiments conducted in different States under diversified soil and climatic conditions, the following facts emerge out:

1. Rice crop adapts itself admirably under different environs and yields equally well both under irrigated and non-irrigated conditions, provided in the latter case adequate and timely rainfall supplies optimum quantity of moisture to the crop.

2. Under irrigated conditions, constantly maintaining 2" of standing water in the field with frequent change letting in fresh water, results in the highest production of the crop. The practice of giving small quantity of water at frequent intervals—2" irrigation at 3 days intervals—seems to be more beneficial than giving more quantity of water at longer intervals. Under conditions obtainable in Coimbatore the drying of the field continuously for 5 days is definitely harmful but it is not so under Bihar conditions.
Weeding beneficial for soil. At the Titabar Farm (Assam) the results of a weeding trial in a "sail" crop indicated clearly the beneficial effect of this cultural operation on the yield of the crop. The yield data of the experiment is given below:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield in lb. per acre</th>
<th>Percentage of increase in favour of weeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeded</td>
<td>3955</td>
<td>31.79</td>
</tr>
<tr>
<td>Non-weeded</td>
<td>3001</td>
<td></td>
</tr>
</tbody>
</table>

(iii) Manure application and green manuring practices

A rice crop producing 3,000 lb. of grain and an equal quantity of straw from an acre removes from the soil roughly 58 lb. of Nitrogen, 23 lb. of Phosphoric acid and 41 lb. of potash. Unless and until the soil is replenished with the plant food utilized by the crop in the shape of manure either as organic or inorganic form, the fertility of the soil cannot be maintained at the high level. It is, therefore, necessary that the field should be invariably manured for getting bigger yield of the crop every year.

Bulky organic manures best for rice. Bulky organic manures like cattle manure and compost are the best for rice crop both from the point of supplying important plant nutrients to the crop as also for maintaining the physical texture of the field. Since cattle manure or compost has slow action it is desirable to apply about 5 tons of it as a basal dressing. The fields can be manured either under dry or wet conditions as the case may be, depending upon the practice adopted in the tract.

Green leaf or green manure is the next best alternative to cattle manure. Any type of green leaves obtained from the chopping of trees, shrubs, or wild plants can be utilised for green leaf manuring. This manure should be applied about a fortnight before transplanting in order to let the leaves rot completely. Where green manure crop is grown in situ, it should be ploughed under the soil ten days before transplanting, for it has been observed in some places that a certain amount of toxicity is produced in the very early stages of the rotting of the green manure which seems to affect the transplanted crop adversely.

A basal dose of 5 to 6 thousand pounds of green matter may be quite sufficient to an acre. The excess quantity of green stuff available from the field after meeting its requirement can be utilized for other fields or composting.

Bone-meal in conjunction with green manure yields better results. Experimental work on green manuring in most of the rice zones has indicated that the application of 10—12 thousand pounds of green manure has not resulted in giving any appreciable increased yield over the optimum economic dose of 5-6 thousand pounds of green matter. In conjunction with green manure, compost, or green leaf, a basal dressing of 100 lb. of bone-meal or super-phosphate may be applied at the time of last ploughing. The application of phosphatic manure at this time has been observed to be beneficial to the crop. The application of super phosphate has not given strikingly positive yield response in most of the rice soils of India. None the less, the use of this fertilizer in small doses in conjunction with organic manure is essential with a view to maintain nitrogen and phosphoric acid equilibrium in the soil. The repeated application of nitrogen alone will aggravate the phosphorus deficiency and ultimately reduce the fertility of the soils.
Use of ammonium sulphate fertilizer. In tracts where green manuring is not feasible, it is recommended that the fertilizer ammonium sulphate at the rate of 100 lb. to an acre should be mixed in the sub-soil a few days before the final preparation of the land for sowing or planting. This method of sub-soil fertilizer application can be practically effected by putting the fertilizer just behind the plough furrows.

It may be pointed out here that the experimental work done in Japan has proved that the sub-soil application of the fertilizer was more efficient than surface application as evidenced by the higher yield responses of the crop in the former method. This finding has also been corroborated by experiments conducted at Central Rice Research Institute, Cuttack, in the cultivators fields in a number of places near about Central Rice Research Institute and also in the Rice Research Station at Nagina (U. P.). This practice of initial sub-surface application is worthy of adoption in tracts where the conditions for fertilizing the crop at the later stage of the crop growth are not feasible due to incessant rains and absence of facilities for drainage etc.

Optimum dose of fertilizer. With regard to the best time and dose of the fertilizer to be applied to the crop, experiments have been conducted in almost all the Rice Research Stations and the general trend of the trials has revealed in most cases that the optimum dose is about 100 lb. of ammonium sulphate per acre to be applied 3 to 4 weeks after transplanting in the case of short rices of 105 to 115 days duration, and 6 to 8 weeks in the case of long duration varieties 150 to 160 days.

The best method of applying fertilizer is to mix this quantity with 6 to 10 times its volume of earth and make it into small pellets which could be thrust into the soil 2 to 3 inches by hand at the time of weeding or after harrowing. This sub-surface placement of the fertilizer increases its manurial value and it has been observed at the Central Rice Research Institute, Cuttack, that 20 lb. of nitrogen applied in this manner is equivalent to 40 lb. of nitrogen applied in the surface in the customary manner.

It may, however, be pointed out here, that the application of ammonium sulphate to rice crop should be done judiciously. Where rank growth is obtained and premature lodging is apprehended, fertilizing the rice crop should be withheld. At the time of applying ammonium sulphate, if it is done by surface method it should be ascertained that there is not too much of water in the field. Further, the water in the field should not be drained for at least 48 hours. As a precautionary measure the crab or rat holes in the field bunds should be plugged with earth and made impervious before applying the chemical manure.

Since the overall production of cattle manure or composts in the country is inadequate and its demand for cash crops grown in garden or wet lands is very great, sufficient quantity of this manure is not available for the rice crop. To tide over this manural problem prevalent almost in all the rice tracts, green leaf manuring or green manuring has been resorted to with great success.

Varieties of green manure crops. There are many kinds of green manure crops, the most popular amongst them being Sesamum, Daunca, Sesbania speciosa, Kolinti, pilipesura etc. These can be grown in situ in the rice field either in single or double cropped lands soon after the removal of rice crop. Wherever facilities exist the growing of suitable green manure crop in situ should be adopted, as this is the easiest and cheapest method of manuring rice crop. It has been noted invariably in all the places that this green manuring of rice crop has given positive yield responses, comparable to that of chemical fertilizers. Besides this, growing of green manure crop in situ and mixing them up in the soil, have the additional merit of correcting the physical texture of stiff clayey or sandy light soils as also in facilitating other cultural operations. There is a short or long intervening period between the two crops of rice and this of course varies from tract to tract.
Best time for sowing manure. The best time for sowing of the green manure crops like sunnhemp or daincha would be just two months before starting the preparation of the land for sowing or transplanting. Where facilities exist for very early sowing, a heavy seed rate of say 40 to 60 lb. of daincha to an acre should be used, lest the manure crop becomes woody and renders diffusion in the soil difficult and costly. In such cases, other suitable slow-growing green manure crops like kollaj or jollipuana may be grown with advantage. In the rice zones where planting is done in the month of July, the green manure crop should be sown in the premonsoonish showers of May. It is essential that before this manure crop is sown the fields should be opened and kept ready to facilitate the proper sowing operations.

Green manuring of rice. The following manurial regimen may be adopted with advantage for the rice crop. If cattle manure or compost is available, it may be applied as a basal dose and worked into the soil at the rate of 5 tons per acre. The next best alternative to cattle manure is the application of green leaf or green manuring in situ the rice crop. Five to six thousand pounds of green matter per acre is found to be the optimum and economic dose in most places. The application of green leaf or green manuring in situ should be done a fortnight before the sowing or transplanting of the rice.

Super-phosphate or bone meal at the rate of 75–100 lb. per acre should be applied along with the above organic manures for maintaining the fertility of the land. Besides the basal dose of manure, ammonium sulphate at the rate of 100–150 lb. per acre depending upon the fertility of the soil may be applied as follows:

Half of the above dose should be worked into the soil 2–3 inches deep either before sowing or transplanting seedlings as the case may be. The next half dose of the fertilizer should be applied 2–3 inches deep inside the soil in the form of pellets (i.e., the fertilizer mixed with soil and made into small balls), 3 to 4 weeks after transplanting in the case of short rices and 6 to 8 weeks in the case of long duration crops. It has been observed that this dose of manure gets a good response if it is applied properly after planting. The quantity of fertilizer should be reduced or avoided wherever there is rank growth.

Manure application and green manuring practices, Madras State. In the Southern districts of Madras State the practice of growing a green manure crop for the first crop of rice is being largely adopted by the cultivators with good success. It is possible to raise green manure crop for the first rice crop since there is an intervening period of about three months between the second crop of rice and the succeeding first rice crop while for the second crop of rice there is hardly any interval for growing green manure. It has however, been observed that the yield response of the second crop of rice to green leaf manuring is equally good.

With a view to provide cheap leaf manure to the second crop, trials were made at Adhuthurai station by planting Sesbania aculeata or Sesbania speciosa seedlings, separately raised from a dry seed-bed, just at the fringe of the field bunds very closely at 3 inches apart at the time of planting the first crop of rice. It has been found that these plants grow nicely and give about three to four thousand pounds of green matter, a fairly satisfactory quantity for the second crop of rice. The same station reported that green leaf manuring supplemented with a small dose of chemical fertilizer increased the yield of the second crop two to three fold. In other tracts having similar conditions, this practice can be adopted to a great advantage.

Green manuring where crop is sown broadcasting. Where the rice crop is sown by broadcasting the best method of green manuring is to sow paddy (80 lb.) mixed with 15 lb. of daincha seed. At the time of bushing or blasting, which is usually done 5 to 6 weeks after sowing, the plants of the green manure crop which by then grown to a sufficient height, providing about 5 to 6 thousand pounds of green matter to an acre, are generally uprooted and buried under the soil by the coolies during the operation of weeding and filling up the gaps. Instead of broadcasting, daincha seed can also be drilled in between the two rows of drilled paddy through another hopper provided near the handle of the country drill. The daincha plants
are then uprooted six weeks after sowing and buried in the soil during the weeding operation. This new method of green manuring rice crop adopted in Tirurkuppam station in Madras State has given excellent results in increasing the yield of the crop by about 35 per cent as compared with that of the control, i.e., no green manuring. There are a number of leguminous green manure crops which require experimentation regarding their suitability or otherwise for the different soils and climatic conditions. Further experiment on green manure crop has started in many States very recently.

Green leaf: As has already been stated above, leaf manuring is as good as green manuring from the point of view of increasing the yield of the rice crop and keeping the texture of the soil in good condition. Green leaf manuring is possible and economical only in tracts which are nearer to the forests, jungles or waste lands which could provide sufficient green leaf from trees or shrubs. However, it may be possible to augment the resources of green leaf by growing suitable quick growing plants like *Glyricidia maculata* or *Tephrosia candida* all along the big field bunds and irrigation channels in the rice tract. These plants do give fairly good quantity of leaf, as much as 30 to 40 lbs. of green matter from a plant.

Application of green leaf manure. Green leaf manure is usually applied to the soil a fortnight before the planting. But, in some parts of the southern districts of Madras, tender leaves of leguminous or non-leguminous plants are trampled into the soil just after the transplanted crop has established, say, three to four weeks after planting. This practice also has been found to give good results. As evidenced from experiments in Ceylon, ammonia may be made available to the soil at all stages of the decomposition process which may coincide perhaps with the active period of rice growth.

In this connection it is worth while to mention here that the practice of growing a green manure *in situ* and incorporating it into the soil for the rice crop has a steadying influence on the yield of the crop, irrespective of the vagaries of the season. Apart from the quantity of rain and its distribution, factors like humidity, temperature, sunshine etc., prevailing in the growth period of the rice crop have profound effect in determining its yield. In some years in spite of adequate supply of water throughout the life period of the crop, the yield has been found to be below normal.

Effect of season on the yield. Low yield is generally attributed to the bad season but even in bad seasons, it had been observed that the fields in which green manure crop had been grown and buried every year as a matter of routine gave normal yield, thereby indicating that green manuring counteracts the ill-effects of bad season to a considerable extent. For instance, the yield of the Kar first crop round Ambasamudram Farm (Madras) in 1943 was about fifty per cent of its normal yield due to bad season but a plot of 43 cents in which green manure crop was grown continuously for a period of 6 years had shown reduction in yield to a tune of 17 per cent only as compared to its normal yield. It is, therefore, obvious that green manuring has great potentialities in not only increasing the yield of the rice crop in normal years but it also acts as a buffer against the bad effects of unfavourable season.
CHAPTER V

HARVESTING AND THRESHING

THE harvesting of rice crop is invariably done with hand sickles. There is a considerable variation in harvest practices in the different rice tracts. In some places the crop is cut when a few green grains at the base of the panicle are still found ripening, whereas in other places the crop is not cut, until it is dead ripe and the grains start shedding. The time at which the crop is harvested has an important bearing not only on the ultimate yield of the crop but also on the milling quality. Apart from the inherent quality of the grain, it is known that any delay in harvest gives rise to high percentage of breakage in milling. At the same time premature harvesting would result in lower outturn of grain of the crop besides affecting the milling quality.

Harvesting in Circars of Madras State.—In the Circars of Madras State the rice crop is harvested at a stage when the ear-heads are just ripe and the straw is still green. The sheaves are dried in the field for three or four days and then put into stacks and allowed to remain for about four months. Probably, this is done with a view to make the grain undergo a sort of curing. It is possible, apart from other factors like dearth of labour at the busy harvesting season, absence of wind at the period of winnowing the grain and waiting for the harvesting of the leguminous crop from the rice field for stacking in alternative layers with paddy straw etc., compel the cultivators to resort to this practice. For somewhat similar reasons, specially dearth of labour and lack of transport facilities from the field to the threshing floor, the cultivators of Orissa State cut ear-heads from the harvested sheaves which had been allowed to dry in the field for about 4 days. The ear-heads are then stacked and threshed at a convenient time in March or so.

In the southern parts of Madras State, the above practice of stacking the sheaves or ear-heads does not obtain due to various reasons. Insecurity in leaving the stacks in the field trespass by men and cattle and the tenure system of sharing the produce in definite proportions play an important role. The harvested sheaves immediately after allowing a certain amount of drying in the field are bundled together, brought to the threshing floor and threshed so that the owner of the land gets his quota of produce from his tenant on the spot.

In tracts where fodder scarcity is realised, the rice crop is cut very close to the ground, while in places where fodder is available in plenty as in Circars in Madras State longer stubbles are left from the second crop in the double crop lands. This when ploughed under, serves the purpose of manure. In some places as in parts of Malabar in Madras State and in some parts of Orissa, the ear-heads are cut and the straw left over is either cut again or allowed to be grazed down. A certain amount of shedding of the grain, while harvesting, does happen depending of course on the variety involved, the maturity of the crop and also the time of harvesting. Harvesting the crop in the early hours of the day, before the day is hot minimises the shedding of the grain.

Time of harvesting.—The results of a few trials conducted in Uttar Pradesh and Bihar States with regard to the time of harvesting the crop are briefly given below.

At Nagina (Uttar Pradesh) station, a study was made to examine the relation between the hauling quality of the rice and the age of paddy at harvest. Samples were taken from a particular field (i.e., from 20 to 40 days for early paddy and 30—50 days for the late paddy) after flowering. Six samples were harvested at intervals of four days. The results of the hulling trial after proper drying of the grain revealed that for early types like T.1 and T.21 the harvesting of the crop 32 days after flowering but within 36 days, give highest outturn of whole grain of rice, while for the late types like T.17 and T.23 the harvesting of the crop 46 to 50 days after flowering seemed to give the best results.
At Kanke Farm (Bihar), an experiment regarding the best time for the cutting of a medium duration Dahia paddy was carried out for four years with the following result. The harvesting of the crop was done on five different dates representing early, normal and late periods of harvest, commencing from 5th November to 7th November. The results of four years' trial showed consistently that the yield from early harvested crop was as good as the yield from the crop which was allowed to get dead ripe in the field. This indicated that 'Dahia' paddy could be cut at least a week earlier than is the normal practice without in any way affecting the yield or value of the grain as seed.

Experiments were conducted at Karimganj and Titabar Farms (Assam) with four and five sail varieties respectively with a view to determine the best period for harvesting the rice crop. The crop was harvested at a regular interval of 8 days the first harvest being done 30 days after flowering and the last after 54 days. The table below gives the yield figures of different periods of harvest.

**Table XIV**

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Periods from flowering</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Lat Sail</td>
<td>2967</td>
<td>3030</td>
</tr>
<tr>
<td>Kerr Sail</td>
<td>2690</td>
<td>3065</td>
</tr>
<tr>
<td>Nagra Sail</td>
<td>2469</td>
<td>2579</td>
</tr>
<tr>
<td>Badshahlog</td>
<td>1685</td>
<td>1922</td>
</tr>
<tr>
<td>Mean</td>
<td>2498</td>
<td>2633</td>
</tr>
</tbody>
</table>

**Karimganj Farm**

Yield in lb. per acre (average of 3 years)

**Titabar Farm**

Yield in lb. per acre (average of 3 years)

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Differential response of different varieties at Karimganj Farm.—The results at both the Stations show that the sail crop should not be harvested before the expiry of at least five weeks from flowering. There is, however, a differential response in the yield of the varieties and the time of harvesting at the Karimganj Station. It is evident from the above data that Late sail did not suffer from early harvesting while Kerr Sail did best at 38 days, Badshahbog at 46 days and Nagwa sail at 54 days. In the case of Badshahbog specially the early harvesting of the crop i.e., 98 days after flowering was definitely harmful, the decrease in yield being 25 per cent as compared to the harvesting done 46 days after flowering. At the Titabar Farm, the above differential response of the varieties was not noticed.

threshing paddy

Threshing in most places is done immediately or within two to three days of cutting of the crop. As was mentioned earlier, the harvested sheaves are dried in the field in certain rice tracts with a view to stacking them but if this drying is not done, heating in the stack would take place which would damage the grains. Even in tracts where threshing is done immediately, allowing the sheaves to dry for a few days in the field after they are cut, makes threshing easier as the grains drop off completely by beating. While early cutting of the crop is expected to contribute to the better quality of the grain, it makes the threshing slightly more difficult.

In some places, a portion of the field is prepared as a temporary threshing floor and threshing is done immediately after harvest in the afternoon, allowing a few hours drying in the field. This is done with a view to avoid the shedding of the grain from the bundles while carrying them from the field to the place of threshing.

threshing in Southern districts of Madras.—In the Southern districts of Madras the threshing is done in two stages. The bulk of the grain is threshed by beating the sheaves on the well prepared hard ground, and what is left over that, is subsequently trodden out by a team of cattle. In some places as in Circars (Madras) where the sheaves are stacked, they are simply spread out and threshed by the treading of cattle. In Orissa State the ear-heads are threshed by the treading of cattle.

The ease with which the grains come off the ears, at the time of threshing, varies with different varieties. There are varieties which shed their grains easily with light beating, while others require hard beating against a hard surface. The easily shedding character of a variety is certainly a disadvantage for obvious reasons and equally so the non-shedding character which entails more labour in threshing the grains. In tracts where loss due to shedding of the grains on account of strong winds that shake the plants violently is feared non-shedding character is considered most desirable. The growing of a high yielding variety combined with the quality of normal shedding is most ideal for the normal tracts, as this would ensure loss against shedding and minimise the cost of threshing.

Besides the usual methods of threshing mentioned above, there are a few machines, both power driven and manually operated, which are used for the purpose. Special mention may be made here of the Japanese pedal thresher which is very simple in construction and can easily be operated by woman or even a juvenile. A thresher of similar type is also now manufactured in India and the cost of it is about Rs 120. Apart from the efficacy of this thresher, the only great advantage of this threshing machine is the ease with which the threshing of non-shedding types could be effected even by woman labourer. The relative efficacy of the different methods of threshing is given in Appendix VII.

paddy cleaning, drying and storing

(i) cleaning

After threshing the produce should be cleaned, and dried before storing. Otherwise the grain is liable to be damaged. The cleaning of the produce is usually done after drying it once and this facilitates the separation of the chaff from the grain at the time of winnowing.

Whereas in other countries winnowing machine is common for cleaning the produce, here
in India, the winnowing is all done by throwing up the threshed produce in a stream against the direction of the wind. The chaff and ill filled grains are blown off to a distance and the heavier and sound grains fall nearer. The separation of the chaff thus mainly depends on the strength and continuity of wind blowing at that time. Since threshing is done on mud threshing floor, particles of soil and stone are generally found with the produce. The proportion of this foreign matter present also depends on the condition of the crop at harvest. Since a fair amount of mud sticks to the ears, it remains there if the crop is lodged and the harvesting is done under moist condition of the field.

(ii) Drying

The grain is usually dried by spreading it one to two inches thick on a clean mud floor for a day or two. It has been found that there is usually 15 per cent of moisture at the time of harvest. This goes down to about 10 to 12 per cent by the above drying and the produce is stored in ordinary gunnies. For consumption this method may be considered alright, but for seed purposes, the paddy should be dried very well so that the moisture content is brought to the level of 10 to 11 per cent.

Storage of seeds.—It may be pointed out here that the seeds should be kept in air tight receptacles especially in tracts where the humid conditions prevail during the period of storage. The grain is liable to absorb moisture from the air which if it become high would reduce the viability of the grain. Experiments conducted in Aduthurai (Madras) with regard to the amount of drying necessary for storing have revealed that good drying of the cleaned produce once is quite sufficient.

For purposes of preserving the produce for seed, it is essential to give the produce two good dryings on clear sunny days. It is established that germination increases with the increase in the number of dryings. It may be mentioned here that too much drying is unnecessary as excessive drying results in high percentage of broken rice when the grain is pounded or milled. Further, rapid drying of the harvested produce in hot sun should not be done as this brings what is known as sun crack; i.e., cross fracture in the kernel, making it unfit for milling purposes.

(iii) Storing

The storing of the grain is done in different ways in the different rice tracts. The receptacles used vary both in kind and size. In Cercars (Madras) large quantities of paddy 300 to 1000 bags (1 bag containing 160 lb.) are stored in specially built granaries called gathis which are nothing but elevated structures built on pillars and provided with walls of bamboo mats on all sides thickly plastered and a pucca roof with projecting eave.

Storage methods in Madras: In some parts as in Tanjore (Madras) large quantity of paddy about 200 bags is stored in circular Paris with walls made of straw twist temporarily erected on elevated piece of ground. Then there are shallow underground pits used for storing grains for short periods. This practice obtains in parts of Madras and Orissa State.

It is said that the grains stored in pits for a short period of 2-3 months are found to be very good for hulling and the quality of rice obtained therefrom is comparable to that got from a stock of one year old. There are also other receptacles like the common sun-dried mud bin with bottom holes for drawing the paddy as and when required. Granary made of wooden planks are seen in Malabar (Madras). Small quantity of paddy is kept in straw bundles by ordinary cultivators. The common jute gunny is usually used for keeping well dried paddy for short periods and this is certainly a convenient receptacle for handling the produce especially for the transporting of the produce from one place to another.
CHAPTER VI

ROTATIONS

The importance of crop rotations as a factor in increasing production as well as in maintaining soil fertility is well known. Specially, in dry and garden farming rotational cropping is invariably adopted; whereas in the case of most of the wet land, grown with rice, there is practically no rotation practiced. Rice follows rice, year after year. But, of course in the loamy soils where facilities for irrigation and drainage exist, important crops like sugarcane, betel-vine, plantain, turmeric and tobacco are grown in actual rotation. The area under the above rotational cropping is, however, comparatively very small.

Rice crop usually occupies the ground for about 9-10 months in the case of double crop rice lands, while it holds the field for about 6 months in the case of single cropped areas. It may be possible to take a catch crop during the period intervening the two crops of rice. The kind and nature of the catch crops coming in rotation will depend upon the season in which rice is grown. Experimental work done on the rotation of crops in rice land is very little. A short account of the catch crop rotations practiced in the rice lands is given below.

Madras.—In the Southern Districts of Madras a catch crop of pulses like green gram and black gram is sown while rice crop is still standing both in the case of single and double crop lands. In single crop lands, senna and gingelly are usually taken after a rice crop. Where rice is grown as a garden crop, a crop of ragi or gingelly is usually grown in the hot weather. The crops like cotton, chilam, cumbu, tobacco, onion, etc., are also rotated with rice. Green manure crops like daincha, Sesbania speciosa and sannhemp are grown for green manure purposes in February-June for the following rice crop.

Eastern Delta of Godavari.—In the Eastern Delta of Godavari sugarcane forms one of the rotation crops. As a catch rotation crop, either sannhemp or pillipesara is grown in between the two crops of rice in December-February for green manuring the second crop of rice. In the single crop area, a gingelly crop is taken between January and April. In the dry lands in the first year, the dry rice is sown as a pure crop or mixed with red-gram, cotton or sannhemp. In the following year, gingelly alone is grown between June and September and crops like Bengal gram, horse gram are grown between October and February.

Krishna Delta.—In the Krishna Delta either sannhemp is grown for fodder purposes or pulses like green and black grams are grown for grains after the removal of the rice crop in December. Pillipesara is, of late, grown both for fodder and green manuring the second crop of rice.

Vizagapatnam District.—In the Vizagapatnam District one of the common rotations is ragi rice and gingelly. The other crops like cumbu, gingelly, maize, jute and onions are also grown in the early season March to June, and this is followed by rice in the season July to December.

Eastern Rice Zone.—In the Eastern rice zone comprising of Orissa, Bengal, Assam and Bihar there prevails the extensive practice of taking a catch crop of legumes like Mung, Biri, Gram, Peas etc. In the standing crop of the late variety of rice, especially in heavy soils, the seeds are sown broadcast a week before the harvest of the crop. Where the soil is of a light type, the land is ploughed twice and the seeds are sown.
Effect of growing pulses on succeeding rice crops.—Systematic trials on the effect of growing different pulses on the succeeding rice crop has not been carried out except at Sabour and Nagina. At Sabour Station, investigation on the most suitable leguminous catch crop and its bearing on the growth and yield of paddy, was conducted for three years and it would appear from the yield data that the continuous growing of the various catch crops like, Gram, Peas, Khesar either on the high or low lands, has no deleterious effect. The yield data are presented below.

### Treatment in the previous Rabi season

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Gram</th>
<th>Pea</th>
<th>Khesar</th>
<th>Fallow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean yield of paddy in lb. per acre, (High land) average of 3 years yield</td>
<td>2013</td>
<td>2087</td>
<td>2046</td>
<td>2017</td>
</tr>
<tr>
<td>Expressed as % of yield over &quot;the treatment fallow&quot;</td>
<td>99·9</td>
<td>103·0</td>
<td>101·4</td>
<td>100·0</td>
</tr>
<tr>
<td>Mean yield of paddy in lb. per acre (Low land) average of 2 years yield</td>
<td>2127</td>
<td>2197</td>
<td>2184</td>
<td>2224</td>
</tr>
<tr>
<td>Expressed as % over control (Fallow)</td>
<td>95·6</td>
<td>99·0</td>
<td>98·2</td>
<td>100·0</td>
</tr>
</tbody>
</table>

At Nagina Station (Uttar Pradesh) rotation trial (1936 to 1941) was conducted. Paddy was taken in Kharif 1936, and fallow, gram, wheat and linseed taken in the same rabi. In the subsequent year paddy was taken in Kharif and the above catch crop rotation was adopted. This rotation was practised for 4 years. In 1940 rabi, fallow was given in all the plots and in Kharif 1941, paddy was taken again. The average yields in pounds per acre of paddy for four years after the different rotations were paddy-fallow 1709, paddy-gram 1421, paddy-linseed 1276, and paddy-wheat 1148.

Paddy-fallow was statistically significant over all other treatments in the combined analysis of the data. The above rotation was followed by paddy-gram, paddy-wheat and paddy-linseed. It was also found from the yield figures of the paddy crop raised in Kharif 1941, that there was no residual effect of rotation on the yield of paddy.

It has been observed at Nagina station that late paddy-berseem rotation appears to be very promising under farm practices, though no regular experiments have been carried out on this rotation. “Berseem” grows very well in the standing late paddy crop and brings a good return as a fodder crop from fields which would otherwise lie fallow.

Gorakhpur farm.—Rotational experiments conducted at Gorakhpur farm showed that pea was the best rotation for early paddy during rabi, while Berseem proved to be easily the best after late paddy.

Kashmir.—The work done in Kashmir State farm for 5 years (1943-47) has revealed that the catch crop rotation of paddy-lentil was easily the best followed by paddy-fallow (cultivated in autumn), paddy-fallow (cultivated during winter) and paddy-rape. The yield data are given below.

<table>
<thead>
<tr>
<th>Yield in Pounds per Acre (Treatments)</th>
<th>Paddy rape</th>
<th>Paddy-fallow (cultivated in autumn)</th>
<th>Paddy-fallow (cultivated in winter)</th>
<th>Paddy lentil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield of paddy (Five years average)</td>
<td>1907</td>
<td>2266</td>
<td>2153</td>
<td>3082</td>
</tr>
</tbody>
</table>
It was also found from the average yield of paddy obtained for two years (1948 and 1949) that the rotation i.e., paddy-lentil left a residual effect of about 14 per cent as compared to the rotation of "paddy-rape".

In the year 1950 and 1951, the economic aspect of growing paddy after paddy and "paddy-rape" rotation was studied and it would appear from the results obtained that the growing of the oil seed crop after paddy gave an economic return as good as that got from paddy after paddy, though the yield of paddy was lowered in the former case.

Effect of growing leguminous crops.—Experiments on the effect of growing a leguminous crop with and without phosphate on the succeeding rice crop have been conducted in the Research Stations of Bombay State. The results of the trial have indicated that the average yield of paddy after "wal" (Dolichos lablab) is higher by about 8 per cent than the control plots and the additional benefit accrued due to the manuring with P2O5 increased with the increasing dose of P2O5, the increase in yield due to manuring with P2O5 being about 12 per cent.

A similar trial conducted at the Central Rice Research Institute, Cuttack, for a year with catch green manure crop of daincha has shown that the application of P2O5 to the leguminous crop increased the green matter of the crop three to four fold, but the yield of the succeeding rice crop taken from the green manure strip plots, was only equal to that obtained from plots which received a similar dose of green matter got from outside. Further investigation in this matter is still underway. It has been observed at the Central Rice Research Institute that groundnut crop grown after harvest of paddy has been found to give a good yield. The yield of rice crop following the groundnut crop is also considerably increased.

It is a well known fact that many legumes improve soil fertility especially when grown with the help of phosphatic fertilizers. It need not be emphasised here that especially for newly reclaimed lands a suitable leguminous green manure crop should precede or succeed after paddy for building up the fertility status of the soil. For the rice lands, green manuring provides the most important food constituent of Nitrogen at a cheap rate. Wherever possible, green manuring of rice crop in situ should be practised.

The relative efficiency of different green and leguminous manure crops on the vegetative and reproductive phase of the rice crop as also their suitability for the different types of soil needs detailed investigation. Suitable rotation of crops may not give immediate results but it is of greatest importance in building up the soil fertility.

The sequence of growing first and second crop of rice varieties in double crop wet lands.—Though it may not be quite proper to discuss in this section as to which is the best sequence of growing the first and second crop varieties in the double cropped lands, yet it has some bearing on this subject matter. The rotation of crops aims not only in building up of the fertility of the soil but also in maintaining it at a particular level so that bigger yields are obtained from the crops regularly. Systematic trials on this aspect have not been carried out in many farms but it would appear from the observations recorded in a few stations that there exists a sort of inter-relationship between the growing of a particular first crop variety followed by another suitable second crop variety. For instance, in the Tambaramparani tract of Madras State, if a deep rooted paddy strain like Co.12 was used as a second crop instead of other varieties like Anai-konika etc., the yield obtained from the field was reported to be higher than that obtained from other varieties under unmanured conditions. The increase in the yield of the strain Co.12 is most probably due to the capacity and ability of the strain to utilize the plant nutrients from the deeper layers of the soil by virtue of its deep root system. Notwithstanding the high yield obtained in the second crop season with the strain Co.12, the yield of the succeeding first
crop with a moderate root system is not affected under normal manuring. It is therefore, obvious that this sequence of raising first and second crop would maintain the fertility of the soil at a fairly high mark of production. A similar observation was made in the deltaic tracts of Godavari too.

The judicious sequence of rice culturing with varieties having different agronomical and physiological characteristics would thus prove to be helpful in maintaining the fertility of the soil. It would be worth the attempt if this aspect of the problem is given a critical examination at the research station, located in the double crop areas.
CHAPTER VII
PESTS AND DISEASES OF RICE

Insect pests of rice

IT is recorded that about thirty different species of insects attack rice. Fortunately, there are only a few that really cause appreciable damage to the rice crop at various phases of its growth. A short account of the important pests that do great damage to the rice crop together with the curative and preventive measures is given here.

1. The Army Worm of rice (*Spodoptera mauritia*, Boisd.)

This is one of the most serious pests of rice and causes extensive damage to the nursery and sometimes to the young broadcast crop. The caterpillar of the insect which is nocturnal in habit defoliates seedlings and young plants during nights. Its damage is usually noticed by the cultivator only after it has practically damaged the crop. Whole seed-beds are sometimes wiped out in a single day. The caterpillars in large swarms march from one field to another after doing the damage.

Control measures.—Where water is available this can be controlled by flooding the infested fields or nurseries. Sometimes digging a deep trench round the nurseries prevents the caterpillars migrating to the next field. Clearing of the grass on the bunds where eggs are usually laid in the off-season, scraping the bunds and exposing the pupae may be done to keep the pest under check. Dusting with 5% B. H. C. (Gammexane D. 025 at the rate of 20 lb. per acre has proved to be very successful in controlling the pest. Approximate cost of treating the fields thus comes to about Rs. 6 per acre.

2. Rice Stem borer (*Schonobius incertellus*, W.)

This is another major pest of rice found in most of the rice tracts. The caterpillar bores into the stem and virtually kills the shoot and causes the characteristic white ear-head. It also attacks seedlings in the nurseries and sometimes kills them. If the incidence of this pest occurs in the young transplanted seedlings, tillering is very much affected and the plant is not able to make any headway. There seems to be a strong relationship between the date of planting rice crop and the incidence of this pest. If the planting of a particular variety is done in its normal season, then the outbreak of this pest is not markedly manifested. For instance, in Orissa State if the popular paddy strain T. 1242 is planted rather late in August or September, the crop is badly attacked by stem-borer, while the crop planted in its normal season, that is by the last week of July or 1st week of August, is least affected by the pest. This phenomenon has also been noticed in West Bengal, Bihar etc.

Late second crop escapes damage in Godavari Delta.—It may be pointed out here that if the second crop of rice is planted early in the Dalua season, i.e., December—April in the Godavari Delta (Madras), the crop is usually wiped out by the severe attack of stem-borer. But if it is planted late by the end of January or the 1st week of February, the crop escapes from its attack. Probably the conditions obtained late in January favour its natural enemies to be more active and the pest is parasitised and kept under control or the broods of the pest do not emerge late in January or thereafter.

Control measures.—The best method is to dodge the pest by suitable cultural practice of planting the crop in the right time when the activity of the pest is at its lowest ebb. It can also be reduced by planting varieties resistant to the attack of this pest. Systematic elimination of egg masses from the nursery by collecting them from leaves, close cutting of the crop at harvest and burying of the stubbles may be useful. Use of light traps may reduce further spread as the adults are attracted by light and killed. Flooding the field and allowing the
to stand and rise in temperature slightly to $35^\circ$ C as adopted in countries like Japan
kills the larvae. It has been observed in Mysore State that trap nurseries i.e., nurseries that
are purposely grown very early, nearly a fortnight or so ahead of the date of raising normal
nurseries in the season, seems to minimise the attack of this pest in the transplanted field. Ex-
periments under way at the Central Rice Research Institute seem to indicate that dusting
the crop with 5 per cent BHC at the time of the emergence of the brood is very useful in con-
trolling this pest and minimising the loss in the yield of the grain. Seed-bed attack is con-
trolled by spraying 0.2 per cent BHC or D.D.T.

3. Rice Gall Fly [Pachydiplosis oryzae, (W-M.), Mani]

This insect (maggot) causes the formation of a hollow tube-like outgrowth from the cen-
tre of the shoot in place of the normally developed internode and leaves. The outgrowth
called “silver shoot” is caused by the maggot of the small gall fly which bores into the stem at-
tacking the shoot bud. If the attack is light, in spite of the appearance of “silver shoot” in the
main stem, tillers are produced which bear normal ear-head, but in the case of severe infestation
all the successive side shoots are also attacked by the pest.

Control measures.—Application of quick acting manure like Ammonium sulphate which
stimulates the growth of the crop and induces production of tillers seems to mitigate the evil
effects of this pest. A continuous setting of light trap attracts thousands of flies, thereby re-
ducing their impact. Dipping the seedlings in 0.2 per cent BHC at the time of transplanting
and dusting the crop with 5 per cent BHC at the time of brood emergence seem to reduce
the damage to some extent.

4. Rice Bug (Leptocoris acaulis, T.) and (L. Variornis, Fabr.)

These are present in almost all rice tracts and are characterised by their bad odour. The
bug sucks the juice from the tender ears with the result that the grains are ill-filled and dis-
coloured. The pest usually appears when the early varieties start flowering.

Control measures.—Hand netting in the early hours of the day has been found to be very
efficacious. Removal of the grasses from the bunds, where the bugs breed may reduce their
multiplication. The dusting of 5% BHC (Gammexane D. 025) at 20 lb. per acre costing
about Rs. 6 controls this pest very effectively.

5. Rice Grasshopper (Hieroglyphus banian, F.)

Usually this is not a serious pest, but, in some parts, it takes a heavy toll on the broad-
cast crop. The grass-hopper does damage by feeding on the foliage and by cutting the
ear-heads. The remedial and preventive measures suggested for the rice bug mentioned above
do control the pest too effectively. The sides and tops of field bunds should be scraped tho-
roughly to a depth of 2 to 3” soon after harvest to destroy the eggs of the pest.

6. Rice Hispa (Hispa armigera, Ol.)

This is a small bluish insect that appears in certain rice tracts and damages the rice crop.
Here, both the grub and the beetle damage the crop, the former by mining into the leaf
and the latter by scraping the green foliage. Badly damaged fields present a whitish, dried up
foliage.

Control measures.—If the attack is in the nursery, the pest can be controlled by flooding the
field, forming a thin film of kerosene emulsion on the top and passing a rope across the field.
Hand netting to catch the beetles is found very effective and practicable. Dusting with
BHC (D. 025) at 20 lb. per acre controls the pest effectively. The grubs are usually found to
feed from the top portion of the leaves. Therefore if the attack is on a fairly grown up crop,
the top of the leaves to an extent of 4 to 6 inches could be cut, removed and burnt with a view to
killing the grub. A stimulating dose of ammonium sulphate helps to recover the crop from the
setback received due to the insect damage.
7. **Paddy Mealy Bug** (*Riparia oryzae*, Gr.).

This pest affects the crop in patches. Colonies of the minute insects infest the inside of rice-sheath and suck up the plant sap with the result that the affected plants do not make any headway in their growth and remain stunted without producing ear-heads. In severe attack the whole plants present a scorched up appearance. It is said that the incidence of this pest is severe in years of deficient rainfall. It is suggested that the source of infection in the field are the seedlings.

No effective remedy is known against the pest. Destruction of the affected plants is the only remedy known and this prevents further spread of the pest. To control mealy bugs, the bunds of the paddy nurseries are burnt and a trap nursery one foot wide close to the bund on all sides is raised to ward off infection.


This pest usually appears in the seed-beds. When in large numbers they suck up the plant juice, and the tender leaf blades get rolled up and present a withered appearance. Due to this attack, the seedlings do not grow well and are not sturdy.

**Control measures.**—The pest is easily controlled by flooding the seed-beds with a thin film of kerosene emulsion on the top. Spraying with a dilute infusion of tobacco is also found to be very effective and economical. Spraying with BHC at 0.05 per cent concentration has proved to be very effective in controlling this pest. A small dose of ammonium sulphate applied to the seed-bed makes the seedlings grow vigorous and get over the trouble.


It is a small, active, wedge-shaped insect about 5 mm in length, green in colour and damages the rice crop occasionally. A systematic hand netting and destruction of bugs would give considerable relief. The adults are commonly attracted to light in large numbers. Setting up of light traps controls the pest to some extent, but effective control is obtained by dusting with 3% BHC.

The following are some of the other minor insect pests on rice:

1. Climbing cut-worm (*Girphis albistigma*, M)
2. The rice case worm (*Nymphula depunctalis*, Gr.)
3. The rice skipper (*Parnara maidius*, F.)
4. The rice leaf fold (*Chaphalaceus mediinalis*, G.)
5. The horned caterpillar of rice (*Melanitis imene*, G) and
6. A few species of leaf eating beetles. These pests could be easily controlled by the application of BHC (D. 0.05)

Among the non-insect pests, the following do great harm to the rice crop: Rats, Crabs, Sparrows and Parrots.

**Damages due to Rats.**—The rat is a serious pest on rice. At times it takes a heavy toll on the crop. It attacks both the growing crop and the harvested and stored rice. The damage is done especially when the plants are just in bloom or when the grains are in milk stage by cutting the stem at the bottom. They also collect the ripened ear-heads and store them in the burrows. The rats are very clever and their elimination is beset with lots of difficulties. The tortuous course of tunnelling in the burrows with a sort of trap doors inside it, makes the use of cyanogas, ineffective.

**Control measures.**—Professional rat catchers do excellently the job of digging out the burrows tracing the course of rat holes and killing them. It is very rarely that a rat once located escapes their hands. The cyanogas foot pump is also used with some success.
The bow which is commonly used in Tanjore (Madras) delta is found to be effective. A simple device of trapping the rats in the fields with two small mud pots as is practised in Ambasamudram Station (Madras) has also been found to be quite successful. With the recent use of zinc phosphide as a poison bait, the control measures have become definitely more effective. The chemical is mixed untouched with hand with 50 parts of any rat food, preferably cooked rice with fried onions, and the bait is exposed in important corners of the field. For an acre of land the chemical used does not cost more than 6 annas. One pound of chemical would be sufficient for 10 acres.

Crab.—Crabs damage the rice crop both directly and indirectly. Direct damage is caused when the crabs nibble the sprouting seedlings in the nurseries or cut the freshly transplanted seedlings. When once the seedlings are well established and begin to produce tillers, there is no risk of damage by crabs.

Control measures.—Keeping the fields well drained and destroying the crabs either by direct catch or trapping them help in keeping down the incidence of loss. When water is let into the fields young boys and girls can be employed to catch them. This method certainly helps in keeping down the crab population.

Trapping crabs has been found successful at Aduthurai farm (Madras). The trap consists of an ordinary wide mouthed pot buried in the corner of the field with its mouth in flush with the level of the field. The pot is baited with two handfuls of rice bran. The crabs attracted by the smell of the bran get into the pot where they are trapped. The sloping convex neck of the pot prevents all means of escape. The trapped crabs are removed and destroyed. Usually 5 to 6 traps may be sufficient for an acre.

In addition to the two methods given above, calcium cyanide poison was dropped into the crab holes and their mouth closed. This proved to be successful in killing the crabs but it was found to be more expensive. In Bombay State where crabs assume the role of a serious pest in some places trials are underway with new chemicals DDT & Gammaexane. To get over this difficulty, seedlings in bunches of 8 to 10 are purposely planted in Bombay State so that the survival of the few may come up well and give a uniform and good stand of the crop.

**Pests of stored grain**

*Rice Weevil (Calandra oryzae).*—This attacks both milled rice and unshelled grain. The larvae easily make their way through the husk. As the eggs are laid inside the grain the grub feeds on the kernal and after attaining maturity comes out of the grain. The damage due to this insect is serious specially with milled rice. Occasional drying of the grain is the only remedy. Dusting the bags with 4% BHC reduces the pest infestation in the godowns.

*The Rice Moth (Sitotoga cerealella).*—This is a small shining insect found flying in numbers inside the infested godowns and causes damage to stored rice in husk. It is the caterpillar of the moth that bores into the grain and turns it into chaff.

Control measure.—The most effective measure for controlling this insect is the cleanliness and proper drying and cleaning of the material, before storage. Dusting the receptacles and the walls of the store houses with D.D.T. kills the minute eggs and larvae. As a preventive measure against rice moth, a thin layer of dry sand may be kept on the top of the bin or receptacle. The moths that emerge out from the grain burrow through the sand and come out, but cannot get inside to lay eggs in the grain. Further multiplication is, thus, controlled.

Experiments still under way at the Central Rice Research Institute, Cuttack, have indicated that mixing one pound of sweet flag powder in 100 pounds of rice has been found to be effective in controlling the store pests. It has also been found that raw rice is more susceptible to pests than par-boiled rice. With regard to keeping paddy in condition, the mixing of 8 ounce of sweet flag in 100 pounds of paddy has proved to be effective in controlling the insect damage.
The most important diseases of rice in India are:

(i) Blast
(ii) Foot rot
(iii) Helminthosporiose
(iv) Stem Rot
(v) Blast disease

It is caused by the fungus *Piricularia oryzae*. When the disease breaks out, characteristic brown spots with ashy grey centres appear on the leaves. When the spots enlarge, they sometime merge into one another. In severe attack the whole leaf turns brown and shrivels up. The attack is manifested also at the nodes and in particular the neck i.e., the node at which the axis of the ear-head may be said to begin. In such cases the grains in the ear-head become ill-filled or chaffy and the ear-head breaks off at the neck. A field badly infested by this disease presents a blisted appearance and the loss caused is indeed great, even amounting to 50 per cent of its normal yield.

The fungus is propagated through its spores and it is spread from plant to plant through the agency of wind and rain.

**Control measures.**—This disease occurs in a virulent form in certain years only when weather conditions for the sporulation of the fungus and its spread are favourable. The sporadic nature of the outbreak and the rapidity of spread do not admit any preventive or curative measures. Spraying fungicides periodically may control the disease in the nursery but it is impractical on a large scale, in the transplanted crop. At the Central Rice Research Institute, Cuttuck, spraying with bordeaux mixture has helped to control neck infection and prevent the loss caused by the disease in very susceptible varieties.

**Damage.**—The loss caused by the disease has been greatly reduced by the growing of disease resistant strains. In Madras State, two blast resistant hybrid paddy strains isolated at Coimbatore have been made available to the cultivators and they are getting exceedingly popular. It may also be pointed out here that very intensive and heavy dose of nitrogenous manuring seems to be the pre-disposing cause for the occurrence of this disease. Therefore, the practice of very heavy manuring beyond the level of 40-60 lb. of nitrogen should be avoided. Besides, the late planting of the varieties out of their normal season seems to be one of the factors contributing to the outbreak of this disease. For the present the substitution of resistant varieties alone offers the only means of sure control.

(ii) Foot rot of rice (*Fusarium monilze um* var *majes*)

The disease is seed-borne and primarily affects the seedlings, causing paling of the leaves, elongation of the stalk and resulting in the death of the seedlings. In the transplanted crop, the diseased plants are tall and lanky, standing up prominently above the general level of the crop. Another secondary symptom associated with the disease is the development of adventitious roots from the node above the ground level. No ear-heads are formed, and if they are, they may be chaffy.

The disease is seed-borne and is controlled effectively by treating the seed with fungicides like ceresan, or agrosan. One gram of the fungicide is used to treat one pound of seed (1 in 450 parts by weight).

(iii) *Helminthosporiose* (*Helminthosporium oryzae*)

This is found to occur in all rice areas. In certain years this causes serious damage to the crop in Bengal and parts of Madras.
The disease is characterised by the formation of dark brown and reddish spots on the leaves, irregularly oval or circular in shape. It infects the nodes and in severe cases the 'neck' as in 'blast'. The grains are also infected with spots similar to the ones appearing on the leaves. The pathogen is present on the surface of seed as well as inside the glumes. Only Hot water treatment of seeds (8 hours pre-soaking in cold water, followed by 20 minutes immersion in water kept at 52° C) satisfactorily controls the internally borne mycelium. Spraying with one per cent Bordeaux mixture is beneficial in keeping the disease in check in the nursery.

Control measures.—The practical control measures for the disease are (1) the destruction of infected stubbles (2) using seed from non-infected crop (3) growing of resistant varieties and (4) seed treatment to control surface borne infection by fungicides.

(iv) Stem rot

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

Control.—(i) The diseased stubbles should be uprooted and burnt (2) Grow only resistant varieties in fields where disease appears regularly.

Fungus Diseases.—The fungus diseases of minor importance are:

(i) the false smut
(ii) udhatta
(iii) Bunt and
(iv) root rot complex due to pathogen and non-pathogenic causes.

False smut of rice (Ustilaginoidea virens). This is reported to occur throughout the rice areas. The ovary is replaced by a mass of yellowish green spores of the fungus. It is widely believed that the appearance of the disease is associated with bumper yields.

Udhatta.—The ear is transformed into a dark coloured rod.
CHAPTER VIII

IMPLEMENTS

Plough

THE ordinary wooden plough is the universal implement used all over the country. The country plough used for wet cultivation is of course lighter and smaller than the one used for dry cultivation. As is well known, the country plough makes "V" shaped furrows, going to a depth of 2 to 3 inches without any inversion of the soil. By repeated ploughings only, say, 6 to 8 times, an ideal puddle is obtained for transplanting rice seedlings.

In addition to the actual ploughing, the trampling of the animals also contributes to the puddling of the soil. The country ploughs are very light especially in deltaic tracts, the reasons being (1) the heavy soils offer greater resistance to ploughing than light soils, (2) the animals sink deep more than in light soils and hence it would be difficult for them to pull big sized ploughs and (3) the animals are generally not very big. Ploughs of bigger size commonly used for dry land cultivation are used for the opening of the wet lands under dry conditions in many rice tracts. This facilitates subsequent ploughing operations easy.

Mention may be made here of a peculiar type of country plough in Orissa State, the body of which, unlike other ploughs, has a duck-foot shape. Because of this design it is able to cover a larger area with ease both under dry and wet conditions of ploughing. It may be said that for puddling operations, country ploughs seem to be better than iron ploughs. Ploughs differ in size and construction are found in different parts of India.

A number of small mould board ploughs useful for wet land ploughing is also now available. Though the initial cost will be a little more than that of country plough, due to their durability, they would prove cheaper in the long run. For the initial opening of the land even under wet condition, the iron mould board plough works admirably well, burying the weeds and stubbles of the previous crop due to the inversion of the soil. Besides, the turnover of the work is more and the execution is thorough and perfect. It may be said that two iron ploughings may be equivalent to that of four country ploughings in respect of the production of the tilth or the stirring of the soil. After the weeds have rotted sufficiently, the puddling operation starts and for the subsequent puddling, iron plough is not very useful especially for heavy soils, as the plough simply gathers the slushy mud and the mould board does not function at all.

However, for light soils the working of iron plough is as good as country plough. It may be mentioned here that plough of Cooper No. 11 or 25 pattern are found to be quite suitable for the first course of ploughing the wet land with a few inches of water. These ploughs can be drawn by medium sized bullocks or buffaloes generally used for country ploughs in some tracts. The depth of the puddle is important and the deeper the puddle, heavier is the crop. It is, therefore, recommended that iron ploughs for suitable size and strength of the animals should as far as possible be used for producing better tilth or puddle of the wet land.

Wet land puddler

The wet land puddler is very useful, economical and labour saving implement for producing a fine puddle in wet land, after ploughing the field twice or thrice with a plough. It consists of 3 angular bladed cast iron hubs rigidly fixed to a hollow horizontal pipe and rotates when hauled by a pair of animals. The blades work into the soil, break up lumps, pulverize them and leave the field in a fine condition. By using this implement the final ploughing may be dispensed with and the field planted after levelling. For satisfactory working, the puddler has to be operated with about 2 to 3 inches of standing water in the field, otherwise the wet soil clogs the blades and forms a lumpy mass, which prevents the rotation of the bladed hubs. At
times, it is found necessary for the workman to stand on the wooden framework of the puddler, while working. He should place one leg on the front frame and another at the back frame of it so that this implement can work efficiently.

It may, however, be pointed out here that this wet land puddler does not work efficiently in all types of soils, especially in heavy soils. But with suitable modification in the sizes of the blades riveted to the hubs, this implement can be used even in heavy soils. In a normal 8 hours working of a day, this implement can cover an area of about 3 acres. This implement can also be used for incorporating young crop of green manure like *dauncha* or *sannhemp* but difficulty is experienced; while working this the clogging is caused by the stems of the plants getting intertwined between the hubs. Those stems should be removed now and then while working. This implement can also be worked as an efficient clod crusher in dry or garden lands. The approximate weight of the implement is 60 lb. and it requires a pair of well built good animals.

**Burmeese Settun**

This implement introduced from Burma in Madras State is reported to be very efficient for burying in green leaf manure. It consists of a rotating axle to which are fixed 8 horizontal iron blades. The whole thing is fitted in a wooden frame. A pair of medium sized animals can easily work this implement. As the implement works, the rotating blades help to press the green leaf into the puddle. About 1½ — 3 acres can be covered per day by this settun. A large number of women used to be engaged for trampling leaf with their feet into the soil. This implement is simple in construction and can be made by any local carpenter. Its size can be varied according to the needs of the tract and the capacity of the animals harnessed. The cost of the implement ranges from Rs. 35 to 60 depending on the size.†

**Green manure trampler**

It is a light implement for effectively burying into puddle green manure spread on the field. It consists of four 10" diameter steel discs with cast iron hubs, rigidly mounted on a horizontal pipe shaft rotating in wooden block bearings. It can be worked by a pair of animals. In a day of 8 hours, an area approximately 2½ to 3 acres can be effectively trampled. The cost of working this implement per day would be Rs. 3½ where as for the same operation for the same area i.e., 2½ acres, 16 women would be required at a cost of Rs. 19. The approximate weight of the implement is 70 lb.*

**Levelling board**

Levelling Board is a very useful implement which serves an important purpose of levelling the field after puddling. It also compacts the mud to a certain extent. There are three kinds of levelling boards: (1) a flat heavy plank with a handle attached to it in the centre and secured to the yoke by 2 ropes passing through 2 eyes or rings provided at either ends of the board, (2) a beam with a 'V' shaped groove cut deep into it without a handle and secured to the yoke in a similar manner as the first type through the rings fixed on the top side of the board at either end, (3) the third, two sized planks of dimension 7" — 0"×0—4"×0—3" joined together with three wooden pieces with a hollow space of about four inches between the two planks.

Where the mud has to be moved from one portion of the field to another, the second pattern serves the purpose better as the hollow portion when dragged against the mud moves it more effectively. Even the first type can be made to move the earth by holding the handle up

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*It costs approximately Rs. 75 and manufactured by M/s P. S. G. & Sons, Coimbatore, Madras State.
†(The Superintendent Agricultural Research Station, Aduthurai (Madras) may be in a position to give particulars about the local manufacturers from whom this could be obtained.)
*This implement is manufactured by M/s P. S. G. & Sons, Coimbatore (Madras).
and keeping the plank in a slanting position, but this gives an additional strain to the driver. If the soils are not too heavy the driver stands upon the levelling board as it moves, so that the compacting and levelling is done more satisfactorily. Under dry conditions the second and the third types of levelling board could also be used for breaking the clods. The levelling board is weighted by the ploughman standing on it while working. Good levelling of the field is necessary as it facilitates easy drainage and irrigation in times of need.

**Bidha**

It is a sort of cultivator which is used for intercultivating the dry sown crop of rice in Orissa State. A number of wooden or iron tynes is fixed on a wooden body and this implement is worked a few days after sowing the broadcast crop of rice with the object of uprooting the grass and other weeds that appear after sowing the paddy. In the process of working this implement not only grass but paddy seedlings are also disturbed and uprooted. To meet this contingency, a heavy seed rate is usually adopted for broadcasting.

**Cultivator**

This implement is very useful for tracts where summer ploughing is done as a sort of preparatory cultivation for the rice crop, which is to be sown either broadcast in the wake of the monsoon or transplanted later. The cultivator has five tynes adjustable to various widths and can cover 2 acres a day of eight hours. This implement can be advantageously used for tilling the soil, after the field has received three or four ploughings. This can also be used for covering the broadcast sown seed instead of working a country plough for the above purpose, as the cultivator can cover a large area.

**Guntaka**

This implement is generally used for intercultivation in the dry lands. It consists of a heavy beam and an iron blade. This implement could also be used for operations like creating tilth for the preparation of seed-bed, covering sown seeds and breaking clods. For the broadcast sown lands, this implement may prove to be useful for getting good tilth of the land, but this could be used after the fields have been ploughed twice or thrice.

**Drill**

For dry rice which are drilled in parts of Madras and Bombay, the ordinary seed drill known as 'gorru' in Madras is used. The seed is fed by hand through a circular wooden feed cup connected to the tynes by bamboo or tin tubes. This indigenous implement is certainly very useful for drill sowing rice as line sowing would facilitate interculturing operation and also minimise the seed rate. Mechanical seed drills are also now available in the market. A Dania seed Drill with 9 tynes worked by a pair of bullocks has been found to be quite successful at the Central Rice Research Institute, Cuttack. But it must be pointed out here that for the successful working of it, the tilth of the field must be very fine as otherwise the sowing will be imperfect. Further, the size of the field should also be fairly big, not less than an acre.

**Paddy-field weeder**

The weeding and interculturing of the rice crop in Japan is done by special type of paddy weeders. They are made of boat-type iron frames with two couple toothed rollers set one behind the other. There are two kinds of paddy weeder i.e., single weeder and 2 row-weeder. The single weeder could be operated by one man assisted by a boy, while a 2 row-weeder needs two men. It should be pointed out here that for working this weeder, the rice should be planted in lines—a practice which is in vogue throughout Japan. The working of this paddy weeder in an ideally prepared land at the Central Rice Research Institute has been found to be quite satisfactory. Till such time as the practice of line planting is adopted as a matter of routine,
the scope for introducing this implement is not bright in India. Under the existing conditions, line planting would entail greater expenditure as compared to bulk planting. But it may be possible to make the madoola plant the crop in fairly straight lines without the help of marking ropes and this is specially feasible where a wider spacing of, say 9' to 12' is adopted for long duration varieties in soils of very high fertility.

Under the above conditions, single weeder can be worked by a man assisted by a boy in the irregular lines by negotiating the implement in a suitable manner without damaging the plants. This implement can also be used for weeding and interculturing the crop in a field which is either drilled or dibbled behind the country plough at a later stage when the crop is treated as a swamp paddy. This paddy weeder functions not only as the weeder but also as a cultivator in raking up the soil and slightly earthing up the plants. The turn over of work from a single weeder may be about 40 cents in a day of 8 hours work.

Tractors

Maximum yields can be obtained only if the sowing or transplanting of the rice crop is done at the appropriate time and this aspect has been fully dealt with earlier. Delayed sowing or transplanting of the crop do affect the yield to a tune of about 25 per cent of its normal yield. Due to unfavourable seasonal conditions and other factors like lack of human or bullock power to cope up with sowing of a large area in a limited time, the sowing or transplanting of the crop is often delayed and specially so in a vast rice tract with the result that the average acre yield of the zone is lowered. It is in regard to the gain in time, and efficiency, that ploughing of the rice field with tractor is to be thought of and resorted to.

Rice cultivation is mechanised in U.S.A., Australia, Malaya, etc., and tractors of various designs are put to use for opening up the fields. In India, trials conducted with different types of tractors at the Central Rice Research Institute, Cuttack, and other States have shown the efficiency of ploughing operation, timeliness and quick turn-over by them in the wet lands only under optimum moisture conditions. But with regard to puddling rice lands with 2-3 inches of standing water, the working of a special implement 'Gem' Rotavator hitched to suitable tractors has alone been found to be quite successful and satisfactory at Madras and Bombay States. The quality and the turn-over of the work done by the Rotavator as reported in Madras and Bombay States are as under:

At Malhakul in Bombay State.—The Rotavator covered on an average 3/4 of an acre per hour and the quality of the job done was excellent resulting in perfect mixture of soil. The soil was worked to a depth of 7" burying all weeds and the consistency of the puddle was uniform throughout. "The Rotavator tractor attachment also has entered the wet-paddy fields of Madras State. Equipped with the special swept back iron blades, it was successfully demonstrated in 1951 in Madras, where it did the work of puddling, green manuring and levelling without any of the wheel slip experienced with other types of cultivator."

It is, therefore, obvious that the best method by which our vast uncultivated land and the fields that are badly infested with weeds could be brought into production expeditiously and economically is by the use of this revolutionary implement. A great lee-way is to be made in the direction of mechanising rice cultivation. Whether large scale mechanisation without jeopardising the labour economy of the cultivator class of the country could be introduced in India is a vital point that deserves serious consideration. But the mechanisation is no doubt essential and necessary for reclaiming new areas as this would prove to be economical and expeditious and further it would also be useful for rice tracts where it is not possible to bring the land to sowing in the right time.
CHAPTER IX

GENERAL CONCLUSIONS

The important conclusions obtained from the results of the cultural experiments in different States are summarised in this section State-wise.

Madras

The rice area in Madras may be broadly grouped under six tracts and each is served by one or two research stations to meet the needs of the various soil and climatic conditions of the tract. The results obtained in those stations may, therefore, be applicable for the tracts represented by them.

Preparatory cultivation.—With regard to the preparatory cultivation of rice fields, it is recommended to plough the land soon after the harvest of the rice crop and allow it fallow or it may be sown with suitable green manure crops or pulses. Where the practice of growing a pulse crop like Mung or Blackgram exists already, it is recommended to grow a green manure crop of dathua or Sesbania speciosa along the field bund to a width of 1-2 feet for green manure purposes to the succeeding rice crop.

The effect of summer ploughing of light paddy soils is not harmful to the succeeding rice crop, while it is injurious to the heavy clay soils of Tanjore, Krishna and Godavari deltas.

Age of seedlings best for adoption.—The results of the experiments on the age of seedlings show, in general, that for the short duration varieties of 100-115 days, 3 to 4 weeks old seedling give best results, while for the long duration varieties of 5-6 months, seedling of 35 to 42 days are considered optimum age for planting. However, seedling with ages ranging from 30 days up to 70 days can be planted without much prejudice to the yield. Providing the sowing of the seedling is prevented by arresting irrigation to the seed-bed and that the planting is carried out within the optimum planting period of the variety concerned. It may be pointed out here that since the time of planting has profound influence on the yield, the seedlings of late grown nurseries should be stimulated by dose of manures so that seedlings of even two-three weeks of age can be uprooted and planted in the right time.

Optimum spacing for different varieties.—The general trend of the results of the spacing experiments done in the research stations reveals that the optimum spacing for the short rice of 100 to 115 days duration is 5 in. X 4 in. with 2 seedlings per hole, and for the 5-6 months duration variety grown as main ‘samba’ or ‘chaladi’ (second crop) the spacing of 6 in. X 6 in. singles or doubles: or 6 in. X 12 in. with 3 seedlings per hole may be considered optimum. But, in the case of the very rich soils of Godavari Delta, a wider spacing of 7 in. X 7 in. is absolutely essential for the first crop like MTU 1. For the strain MTU 30 the spacing of 6 in. X 12 in. or 12 in. X 12 in. with 2 to 4 seedlings per hole has given very good yields, while for the second crop MTU 15 and 6 in. X 6 in. spacing with 3 seedlings is the best.

Time of planting.—With regard to the time of planting, it may be stated in general, that for the first crop short duration rice grown in South Madras as represented by Ambasamudram, Aduthurai, Thirukkottai, Thirurkuppam and Pattambi stations, etc., transplantations done within the first week of July preferably in the month of June itself give satisfactory yields, while for the long duration second crop of rice, the middle or third week of October can be considered as the optimum date of planting for getting best results.

For late plantings extending upto November—December as obtained in Tambaraparni Valley, the right choice of varieties like ASD-5, GEB-24 and FB 2 should be selected as they alone would give satisfactory yields. For the tracts in Circars represented by Samalkot and Maruteru stations, the early planting in June definitely gives the highest yield, while for the second crop, however, late planting in the first week of February gives the best result.
Planting in Nellore tract.—In the case of Nellore tract represented by Buchireddipalayam station, early planting of the variety Molagatulu in 10th August gave nearly 40 per cent more yield over medium planting i.e., 7th October. However, the planting of this variety with seedlings of 90 to 75 days old in the middle of October gave fairly satisfactory yield provided ‘blast’ disease does not occur. It is especially for such tracts, that double transplanting is recommended. For the tract represented by Coimbatore Station, July—August planting gave the best result.

Green manure crops and the seed rate.—The growing of suitable green manure crops like S. anegeta, S. spectrusa, Sunnhemp, P. philippinum with a heavy seed rate of 30–40 lb. per acre for double crop lands and Tephrosia purpurea for the single crop lands is recommended. In the Tanjore Delta for providing green manure to the second crop, the planting of S. spectrusa along the field bunds is advocated. For the purpose of seed production, the green manure plants can be planted along the bunds in the second crop season. The growing of a cotton variety like P. 216F. as a catch crop between the second crop of rice and the succeeding first crop is recommended in Tanjore Delta, wherever facilities exist for irrigation to the crop in summer.

Mysore

It would appear from the results of the trials conducted at the Research Stations that from practical considerations for rainy season varieties, planted in August, seedlings of 45 days old with a spacing of 6’ × 6’ doubles per hole and for summer varieties planted in the middle of March seedlings of 25 to 30 days of age planted with a spacing of 6’ × 6’ doubles per hole may be deemed to be the best for getting maximum out-turn of the crop.

Orissa

Summer ploughing advantageous.—Summer ploughing of rice fields is recommended as there is no deleterious effect on the succeeding rice crop. The growing of suitable mid-duration varieties which yield usually better than Belai types is recommended for the uplands, having facilities for occasional irrigation to the rice crop during its last phase of maturity. Drilling or dibbling the Aman paddy, is advocated instead of broadcasting as this would effect a very great saving of valuable seed by about 50 per cent.

Optimum seed rate.—For broadcast sowings, a seed rate of 60-80 lb. per acre is quite sufficient for getting a good crop. The practice of broadcast sowing paddy seed, mixed with 15 lb. of daincha seed per acre is to be extended to all tracts. For the transplanted crop of medium duration variety like T. 1145 seedlings of 40 days of age with a spacing of 6 inches apart either way can be planted up to third week of August without prejudice to grain yield.

Spacing of seedling and optimum time for transplanting.—In the case of long duration variety like T. 90, seedlings of 35 days old with a spacing of 6’ to 9’ with 2–3 seedlings per hole are found to give best results, the optimum time of planting ranging from 25th July to 9th August. Fairly satisfactory yields have been obtained from plantings done upto 28th August also but plantings done beyond August have given poor yields.

Under Berhampur Station conditions in a five months variety like Bapakwanda no difference in yield between 30 to 50 days old seedlings was observed but the yield dropped with seedlings over 50 days of age.

The optimum spacing for the above variety was found to be 6’ × 6’.

Manure crop and its seed rate.—The growing of a green manure crop like daincha or sunnhemp specially for uplands only, in the month of May–June i.e., in the wake of the pre-monsoonish showers with a heavy seed rate of 40 lb. per acre, incorporating the same in situ a week before planting and transplanting paddy in the month of July upto the first week of August, is recommended for canal irrigated areas.
The growing of *Jullupesara* sown in March as a green manure for rice crop is also recommended. The growing of *Sesbania aculeata or speciosa* along the field bunds distanced at one foot apart for seed purposes is advocated. Where the practice of growing a pulse crop after *Aman* rice is in vogue, it is recommended to grow *daunca* or *Sesbania speciosa* along the field bunds to a width of one foot for getting green leaf for the succeeding rice crop. In canal irrigated areas, the growing of suitable short or medium duration second rice crop planted in January is advocated.

**West Bengal**

At Bankura station which represents the undulating land with comparatively poorer and lighter soil of laterite origin of West Bengal, the practice of dibbling or broadcasting early maturing varieties at the right sowing time has given usually better yield than transplanting the crop late with over-aged seedlings under the erratic monsoon conditions.

*Optimum time for raising seed-bed.*—Under Bankura farm conditions for planting late varieties raising the seed-bed on the 6th June and planting on 16th July with 42 days seedlings distanced at 6 to 9 inches apart either way with single seedling per hole would give highest yield. However, from practical considerations, it is recommended to raise seed-beds on 19th June or 20th June and effect the plantings done in the middle of July with young seedlings of 4 or 3 weeks of age respectively.

Planting from the above seed-beds can also be done till the end of July with 6 and 5 weeks old seedlings. For late plantings beyond 30th July it seems advantageous to use seedlings of young age of 4 weeks from late sown (1st week of July) seed beds.

*Planting period under Chinsurah condition.*—Under the condition obtained in Chinsurah Station which represents the deltaic region of Bengal with very fertile soil of alluvial origin, the planting period 29th July—August 1st seems to be ideal for getting maximum out-turn of crop. From practical agricultural point of view, it is recommended to raise thin dry seed bed on 10th June and carry out the planting from the middle of July up to the middle of August with seedlings of the ages ranging from 5 to 9 weeks.

*Spacing of seedlings.*—In years of normal rainfall, a wider spacing of 9" or 12" between plant to plant with single or double seedlings should be adopted, but in years of low rainfall during the planting period the spacing of 6"×6" with one or two seedlings should be resorted to for obtaining satisfactory yields. The practice of green manuring *in situ* the rice crop as advocated in the case of rice fields of Orissa State is recommended for enhancing the yield of the crop.

**Assam**

Winter ploughing of the rice fields is as good as summer ploughing both in the case of Autumn and especially *Aman* rices. Eight ploughings with country plough to a depth of 3" seem to give satisfactory yield but deep ploughing to a depth of 6 to 9 inches once in three years is recommended.

*Optimum time for sowing 'Aus and Sali'.*—For broadcast *Aus* the best time of sowing is March—April, the seed rate being one maund per acre, while for the transplanted *Aus* the best time of planting is in May with 3-4 weeks (early types) and 4-5 weeks (late types) old seedlings distanced at 3 inches (early types) and 4 inches (late types) with 2 to 3 seedlings per hole.

*Sali or Sali* crop should be planted in the month of July with seedlings of 5 to 6 weeks of age distanced at 6-9 inches either way with 4 seedlings per hole.
Seed rate.—For lands grown with typical deep water rices, April sowings with a seed rate (dry sown) of 105 lb. per acre have given better results over May sowings. While for wet sown, the optimum seed rate is 75 lb. per acre. Dry sowing are generally found to be superior to wet sowings. Transplanting for ‘Aman’ crop is definitely inferior to broadcasting in point of grain yield.

Best time for planting ‘Boro’.—With regard to ‘Boro’ paddy, the best time for planting is late December to early January. For early planting on or before 4th January, seedlings of 4 weeks of age are found better; whereas for late plantings done after 4th January, older seedlings are to be preferred. The optimum spacing to be adopted is 6 inches either way with 4 seedlings per hole.

Bihar

Transplanting under Kanke and Sabour condition.—Under conditions obtainable at Kanke and Sabour farms, the broadcast sowing of paddy is as good as that of transplanting in point of yield. However, transplanting is recommended for other obvious reasons. In the case of transplanting under Sabour farm conditions, the raising of seed-bed may be done in two batches, i.e., 20th and 27th June for practical reasons of planting either on the 25th July or 8th August as the case may be, with seedlings of 4, 5 or 6 weeks of age. The planting on 25th July with 4 weeks old seedlings gives best result. The spacing of 6–9 inches with 3 seedlings per hole may be considered as optimum.

Under Gaya farm condition, the optimum time for raising seed-bed seems to be 15 to 20th June for the plantings of July 15th to August 3rd. The optimum spacing under normal planting is 6–9’ apart either way with 2 seedlings per hole. However, for late plantings done beyond 3rd August, 6’×6’ spacing with 3 seedlings per hole should be adopted.

The green manuring of rice crop as suggested for Orissa State is also applicable for this State for increasing the yield of the crop.

Uttar Pradesh

Under Nagina farm conditions, winter ploughing with pre-monsoon sowing in the first week of June with the high yielding strain T. 21 is recommended as this practice not only enables the crop to mature earlier but also gives enough margin for allowing rabi crop to be put into the field in time, and also gives an increased yield of 15 per cent over late sowings with short duration rices. A seed rate of 50 lb. per acre is considered optimum under Nagina conditions.

June Transplanting more suitable.—With regard to transplanted crop, planting in the middle of June is advocated, as the July plantings yield 20 per cent less as compared to the earlier ones. Seedlings 30 days old for transplanting early varieties and up to 40 days old for late varieties are recommended.

Double cropping.—The double cropping of rice where late varieties are predominantly grown is recommended for getting more production of rice. An early variety like T-22 sown broadcast on 12th April could be harvested on 21st July and again a late variety like T-100 could be planted on 3rd August. The yield of the two crops would give about 46 maunds per acre as against 26 maunds obtained from a single crop grown with a late variety both under manured conditions.

The double transplantation of early varieties is advocated as it helps the crop to mature earlier by a week as also for increasing the yield.
Gorakhpur Farm.—Under Gorakhpur farm conditions 10th June sowing gave the best result. Sowing later, i.e., beyond 20th June gave poor out-turn as compared to the earlier sowing. A seed rate of 80 lb. per acre is considered as optimum. With regard to transplanting under Gorakhpur, Panchperwa and Tissushi farm conditions, the period 10th to 20th July seems to be best for obtaining good yield. For early varieties June planting has been found to be the best.

Green manuring.—S abundhemp as green manure grown in situ appears to be the best method of manuring under Nagina farm conditions. In the rotational experiment at Nagina, paddy-fallow treatment has proved to be the best and most economical and this has been followed by paddy-grain. The rotation of paddy-wheat and paddy-linseed has been found to be unremunerative. Under Gorakhpur farm conditions, pea has been observed to be the best rotation for early paddy during rabi, while for late paddy, berseem has proved to be easily the best for rabi. This late paddy-berseem rotation has also given very promising results under Nagina conditions. Berseem seems to grow very well in the standing late paddy crop and brings a good economic return from the fields which would otherwise be fallow.

Punjab

Gurdaspur farm conditions.—The spacing of 6" × 6" with two seedlings per hole is recommended, as the wider spacing of 9" × 9" or 12" × 12" has been found to be poor in yield, the yield being half as much as that obtained in the treatment 6" × 6" spacing. After the division of Punjab the improvement work on rice for Punjab has been very recently started and work is just in progress.

Kashmir

Under broadcast sowing condition, the earlier the sowing, preferably in May the better is the yield. There is a progressive decline in yield with the delay in sowing. Similar trend has been noticed in the case of transplanting as well. The optimum time for transplanting is the last week of May to first week of June.

Spacing and seed rate.—A spacing of 3" × 3" to 6" × 6" with two to three seedlings per hole is recommended. It is also suggested here to reduce the existing heavy seed rate of 24 lb. sown in one cent of seed-bed to 6 to 8 lb. as this would naturally give sturdy and healthy seedlings.

Precautionary steps should be taken for obtaining good germination of the seeds against the cold wave that might occur during that period. 'Lemnil' as a green manure is recommended to be grown after rice as this appears to be the best form of manuring.

Bombay

The existing practice of 'rabbing' seed-bed should be discouraged, as this wasteful method can be substituted by manuring the seed-bed with farm yard manure or compost at 40 cart load and application of cake and ammonium sulphate or manure mixture at 40-60 lb. of nitrogen per acre. The useful organic material used for 'rabbing' can be better utilised for manuring the transplanted field.

Spacing and number of seedlings.—It is recommended to adopt the following spacing and the number of seedlings advocated per hole for the conditions obtained at the farms noted hereunder:

Karjat and Igatpuri farm conditions 8" × 8" with 8 seedlings per hole.

Bulbar farm conditions 6" × 6" with 8 seedlings per hole.
Ratnagiri farm conditions: 10" × 10" with 8 seedlings per hole.

Vadgaon farm conditions: 6" × 6" with 2 seedlings per hole.

Navagam farm conditions: 6" × 6" with 1 seedling per hole.

A spacing of 15" between rows and a seed rate of 60 lb. per acre appears to be the optimum treatment in the drilled rice of Karnataka. For the broadcast sowing of sprouted seed in standing water, the seed rate of 60 lb. seems to be optimum.

**Madhya Pradesh**

At Labhandi, Adhartal and Richa Farms, a seed rate of 80 lb. per acre under dry broadcast sowing has been found to be optimum. For early paddies a seed rate of 100 lb. per acre is recommended to insure against adverse conditions. Drilling with 6" spacing for early and medium varieties has given the best result under Adhartal farm conditions. Under 'Matasi' (sandy loam) and Doris (clay loam) soil conditions 'biasing' the early, medium and late varieties of crops 3 weeks after sowing is recommended as this practice has given the best result over 'no biasing' or 'late biasing'. The practice of transplanting is advocated wherever facilities exist, as this gives higher yield with better economic return.
PART II
SHORT NOTES FOR EXTENSION WORKERS

In order to make the practical conclusions obtained in various rice research institutes available to the Extension Workers, in a concise form, efforts have been made to prepare short notes giving a background information of the rice zones in each State together with season, rainfall, crop system, varieties grown and the specific cultural recommendations for each rice zone.

Madras State

The following four rice growing zones, distinguished by the nature of the rainfall, climatic conditions, seasons and the cropping systems are found in the State:

1. The West Coast districts of Malabar and South Kanara.
2. The Southern districts, comprising of Tirunelveli, Ramanathapuram and Madurai.
3. The Cauvery Delta including Tanjore, parts of South Arcot and Tiruchirapalli.

Zone No. 1

In this zone, rice is cultivated over 1.7 million acres of land as a successful rainfed crop because of the plentiful rainfall during the South-West monsoon and irrigation from springs developed during the rainy season. The distribution and the amount of average rainfall during the year is given below:

<table>
<thead>
<tr>
<th>District</th>
<th>Hot weather February-May</th>
<th>S. W. mon-soon June-September</th>
<th>N. E. mon-soon October-January</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malabar</td>
<td>12 in.</td>
<td>80 in.</td>
<td>17 in.</td>
<td>North-East monsoon rains are mostly received in October and middle of November</td>
</tr>
<tr>
<td>South Kanara</td>
<td>7 in.</td>
<td>125 in.</td>
<td>12 in.</td>
<td></td>
</tr>
</tbody>
</table>

The different crop seasons are given below:

<table>
<thead>
<tr>
<th>District</th>
<th>First crop</th>
<th>Second crop</th>
<th>Third crop</th>
</tr>
</thead>
</table>
Soil. The soils of this tract are of laterite origin. The dry land or upland is of red gravelly nature, while that of the single and double crop lands varies from sandy loam to loam. The topography of the land is undulating with low hills and shallow porous soils. The soils in general are deficient in organic matter and lime.

Cropping system. In the Malabar districts on the higher slopes (Modan land), rice is grown as a rainfed crop once in two years and lower down (Palliyal) a single crop of rice is grown every year in terraced fields either as a transplanted or broadcast crop. Further down in the valleys, two crops of rice, one following the other are raised. In the district of South Kanara, the first crop is transplanted and the second crop is often sown broadcast.

Malabar Tract

The following are the recommendations for the Malabar tract:

I. Modan or dry land. In good tilth (8-10 ploughings) sow broadcast improved strains at the rate of 80 lb. per acre. Dibbling seed (60 lb. per acre) behind plough furrows (9" apart) at about 4 inches in the furrow, is recommended. The levelling board should be worked when the moisture conditions are below optimum. Either sow Crotalaria striata—a green manure, as mixture with the dry paddy, or sow samthemp after the harvest of paddy for using it as green manure for the second crop of the double crop wet area.

Gingel or horse gram can be sown as catch crop after paddy.

Adopt the following two-year rotation in the modan land:

1. Pine apple. Kew or Mauritius varieties planted in trenches of 9" deep with a spacing of 3’ X 2’1/2’ under well manured conditions of 20 tons of farmyard manure per acre.
2. Groundnut. AH.25 (TMV. 1) variety dibbled behind the country plough in April-May at the rate of 100 lb. per acre.
3. Cotton. Cambodia (Co. 2).
4. Ragi. Ec. 917 (Co. 9).
5. Paddy. Following varieties of paddy are recommended:

II. Palliyal or single crop land. Sow Kolingi at the rate of 25 lb. per acre after the harvest of paddy for the next rice crop. Sow paddy broadcast or dibbled during April-May (1st week); the earlier the sowing, the better is the yield. If, however, conditions for sowing within first week of May are not obtainable, transplanting alone should invariably be adopted for getting good yields.

Dibbling is strongly recommended for facilitating weeding and interculturing with Japanese weeder or country plough.

Transplant seedlings of 25-35 days old with 2-3 seedlings per hole at 4 inches distance either way within June.

The varieties recommended are PTB 7, PTB 2 and PTB 10.

III. Second Crop land

(a) First crop. Adopt the same practice as suggested for palliyal land.

(b) Second crop. Transplant the crop within 10th to 20th October with (wet or dry nursery) seedlings of 50-60 days old. For late planting i.e., after 20th October, it is recommended to use 30 days old seedlings. The optimum spacing is 6’ X 4’ with two seedlings per hole.
The following varieties are recommended:

**First Crop.** Early duration: PTB 8, PTB 22, PTB 23, PTB 24, PTB 25, PTB 31 and PTB 32.

Medium duration: PTB 9 and PTB 2.

Late duration: PTB 1 and PTB 5.

**Second Crop. Early duration:** PTB 18, PTB 21, PTB 12 and PTB 20.

**Late duration:** PTB 4, PTB 15 and PTB 16.

**Third crop land**—It is confined to very small areas near the wells in the double crop lands. PTB 10, a short duration variety of 100 days is recommended to be grown under very heavy manured conditions.

**Manuring.**—Manure the seed-bed with 6 tons of farmyard manure and 2 tons of wood-ash per acre.

With regard to field manuring, apply 4000 lb. of green manure grown in situ or brought from manured land or outside in combination with 150 lb. of bone-meal or super-phosphate as a basal dose. Top-dress the crop a month after planting with 150 lb. of ammonium sulphate. Apply wood-ash to the field once in three years a month before planting.

**South Kanara District**

Adopt the cultural recommendations suggested for Malabar tract.

The following varieties are advocated:

**First Crop.** PTB 7, PTB 10, PTB 11, PTB 14, PTB 17, PTB 20, MGL 1 and MGL 2.

**Second Crop.** PTB 4, PTB 16, PTB 19, Co. 3 and Co. 14.

**Third Crop.** PTB 10.

**Zone No. 2**

(Tirunelveli, Ramanathapuram and Madurai Districts). An average annual rainfall of about 31 inches is received in this zone. The rainfall distribution in the different seasons with its range is given below:

<table>
<thead>
<tr>
<th>Season</th>
<th>S.W. Monsoon</th>
<th>N. E. Monsoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>5°—6°</td>
<td>4°—9°</td>
<td>16°—21°</td>
</tr>
</tbody>
</table>

The perennial rivers Tambaraparani and Vaigai, rising from the Western Ghats, with their reservoirs and anicuts enable the double cropping of rice over a large area in this zone. Besides, the numerous rain-fed tanks scattered in the tract facilitate the cultivation of rice during the North-East monsoon season.

The main cropping seasons in the river-fed areas are as follows:

- **June—September** First crop
- **October—March** Second crop

The cropping season in the rain-fed tank areas is not clear-cut but varies according to the sowing of the crop which depends entirely upon the time of receipt of rainfall and the intensity of the rain. However, the cropping is done in the normal years of rainfall in the Karthigai i.e., November—March or Manavari i.e., December—March seasons according to the availability of water.
Cropping system. Transplanting is invariably done in river-fed areas, while in the rain-fed tank areas, broadcast sowing is mostly adopted in certain parts of Ramnad and Tirunelveli districts. Transplanting is also done in the ayacut of big tanks which get filled up with North-East monsoon rains.

The following are the recommended cultural practices:

Direct Sowing. Dibble the seed behind the country plough furrows (about 10" between furrows) with a spacing of 4" in the furrow, instead of broadcast sowing. Adopt a seed rate of 60-80 lb. per acre, depending on the moisture content and texture of the soil. Interculture the crop with hand hoe in the case of broadcast sowing and with light country plough with bullock power after 3-4 weeks under optimum moisture condition in the dibbled crop. Treat the crop as a swamp paddy, only after 6-8 weeks. Then thin the crop wherever necessary and fill up the gaps.

Manuring. Work into the soil 10 tons of compost or farmyard manure per acre before sowing or sheepon the field at the rate of 3000 sheep per acre. About 6-8 weeks after sowing, top-dress the crop with 75-100 lb. of ammonium sulphate in conjunction with 50 lb. of super-phosphate or bone meal or incorporate 2-3000 lb. of tender parts of green manure plants like Kolangi, Avarai or any kind of green leaf. In the case of drifting, sow alternate lines with Sannhemp or daincha and bury the green manure plants after 6-8 weeks at the time of weeding. Where the crop is dilled, sow the green manure seed before dilling. In the case of broadcast sowing, mix 20 lb. of daincha with paddy seed and sow the mixture broadcast.

I. Single Crop land. (Aug.-Jan.) Sowing should be done within the month of September; the earlier, the better. This, of course, depends upon the weather conditions.

II. Double Crop land

(i) First crop. (a) Direct sown—Dibble the first crop Kar in May-June (1st week). Where sowing in puddle is feasible, the sowing should be done within first week of June.

(b) Transplanted—(June—Sept.) Raise dry or semi-wet seed-bed in the last week of May.

Plant the Kar crop with 3-4 weeks old seedlings before the end of June. Adopt a spacing of 4" × 4" with 2 seedlings per hole. Plant S. speciosa seedlings at 2 inches apart along the fringe of field bunds.

In the case of big holdings, raise daincha or S. speciosa in February-March in one half and (black or green gram in the other half for grain), where the holding is small and scattered, grow (green or black gram with) a belt of daincha crop all around the field bunds to a width of 4 feet for manuring the Kar crop.

Manuring. Apply compost or farm yard manure at the rate of 10 tons per acre in conjunction with 150 lb. of super-phosphate or bone meal. In the place of compost, grow a green mature crop in situ and incorporate it. Top-dress the crop four weeks after planting with ammonium-sulphate at the rate of 100-150 lb. per acre.
(ii) **Second crop.** Raise dry or wet nursery as is feasible.

The optimum time for planting varieties like ASD.6 is between 5th to 20th October with 46 to 55 days old seedlings. Seedlings, 26 days old, however, could be planted without the yield being affected, provided the planting is done within 20th October. The optimum spacing is 6'×6' with 2 seedlings per hole.

For varieties like ASD.5 and Co. 2, the optimum time of planting is the second week of November with 30 days old seedlings. The optimum spacing is 12'×6' with 2 seedlings per hole.

**Manuring.** Uproot the green manure plants planted along the fringe of the field bunds and bury them while preparing the field for second crop.

Top-dress the crop with ammonium sulphate at the rate of 100-200 lb. per acre or apply green leaf of any kind from outside at 5000 lb. per acre or 400-600 lb. of groundnut or castor cake per acre.

**Harvesting.** Harvest the crop of ASD.5 or Co. 2 in the early hours of the day about 3 to 4 days ahead of its normal maturity with a view to preventing the shedding of the grains.

**Varieties recommended for Tirunelvelli District**

The following varieties are recommended for Tirunelveli district:

- **First Crop:** — ASD. 1, ASD. 7, ASD. 2, ASD. 3, ASD. 8* and ASD. 9*
- **Second crop:** — (Sept.—Feb.) : ASD. 6, Co. 12, ADT. 11, Co. 25 and Co. 16  
  (Early)
- (Late) : (Oct.—March) : ASD. 5, Co. 2 and GEB. 24
- **Single Crop land:** ASD. 6, Co. 12, ADT. 11, Co. 25, Co. 16, ASD. 5, ASD. 4, GEB. 24,  
  PTB. 2, ASD. 8† and ASD. 9†

**Varieties recommended for Ramanathapuram District**

The following varieties are recommended for Ramanathapuram district:

- Autumn (Kar)(June—Sept.): ASD. 1 and ASD. 2
- **Second crop (late)** (Oct.—March) : ASD. 5 and Co. 2
- **Winter single crop** (June—March) : GEB. 24, Co. 16, ASD. 5 as planted crop and ASD. 4 and Co. 17 as broadcast rain-fed crop

**Manasari season:** (Jan.—May.) : ASD. 1 and ASD. 2

**Varieties recommended for Madurai District**

The following varieties are recommended for Madurai district:

- **First Crop:** Co. 13
- **Second crop:** (Oct.—March)—Co. 2, ASD. 5 and GEB. 24

**Zone No. 3.**

Tanjore, parts of South Arcot and Thiruchinapalli districts.

This is one of the most fertile zones in South India, formed of the alluvium of the river Cauvery. The soil varies from loam to clayey loam, tending to alkalinity at the tail end reaches of the delta. This zone records four to six inches of rain in hot weather, ten to twelve
inches in S.W. monsoon months of June—September and twenty eight inches in the N.E. monsoon months with occasional gales striking the coastal regions. The Mettur Reservoir of the Cauvery river, coupled with the rainfall ensures an assured supply of water in normal years for the rice cultivation at the scheduled periods. There are two cropping seasons namely, *Kuruvai* (June—September) followed by *Thaladi* (October—February) as in Tanjore district or *Samba* (July—January) followed by *Nawari* (February—June) as in the two taluks of Kulithalai and Musiri of Tiruchirapalli district.

*Cultural and manurial recommendations:*

Do not summer plough the heavy soils as this ploughing is deleterious to the succeeding rice crop.

In the case of big holdings sow green manure *diantha* or *S. speciosa* after the harvest of the *Thaladi* or *Samba* crop in one half and *green or black gram* in the other half.

I. *First crop.* Adopt semi-wet seed-bed for the first crop. Plant 3 weeks old seedlings within the month of June with a close spacing of $4\times4'$ with two seedlings per hole. Plant all along the fringe of the field bunds *S. speciosa* seedlings closely at 2 inches apart. Incorporate the green manure *in situ* at the rate of 4-5 thousand pounds per acre in conjunction with 150 lb. of super-phosphate. 3-4 weeks after planting, top-dress the crop with 100 to 150 lb. of ammonium sulphate.

II. *Thaladi* or *second crop.* Uproot the green manure plants grown along the fringe of field bunds, spread and bury them in the field in the course of preparing the puddle and work into the puddle 150 lb. of super-phosphate at the time of last ploughing. Plant the crop within the month of October with about 6 week old seedlings, distanced at 6-inches apart either way with 2 seedlings per hole. Top-dress the crop with 100-150 lb. of ammonium sulphate about 6 weeks after planting.

III. *Single crop of Samba* (August—January). Plant the crop within the middle of September spaced at 6 inches apart either way with one or two seedlings per hill. The optimum age of seedlings for strains like Adt. 11 is 32 to 45 days and, for strains like Adt. 1, 31 to 39 days. Green manure the crop with *Kolinsi* or *Pillipesara* *in situ* in conjunction with 150 lb. of super-phosphate or bone-meal. Top-dress the crop about 8 weeks after planting with 100-150 lb. of ammonium sulphate. If blast is prevalent, ammonium sulphate application should be withheld.

*Rotations.* Sow P216F cotton seed in lines 2' apart with 6—9 inches within the lines in the paddy stubbles soon after the harvest of the rice crop in January—February. Interculture the crop later with *Mammoti.*

The installation of Filter point pumps is recommended wherever feasible for raising cotton during summer-fallow of the rice lands and for raising seed-beds early in the season for the first crop.

For Tanjore and southern taluks of South Arcot the varieties recommended are the following:

*First crop.*—(June—September).—Adt. 3, Adt. 4, Adt. 9, Adt. 16 and Adt. 20.
Second crop (Thaladi).—(October—February)—Adt. 1, Adt. 2, Adt. 8, Adt. 25, Adt. 11, Adt. 21
Samba Single crop.—(July—August to December)—Co. 25, Co. 19, PTB 16, Adt. 6* and Adt. 7*
Varieties recommended for Thiruchirapalli district:
First crop.—Adt. 20, Adt. 3, Adt. 15, Adt. 19 and Adt. 18
Second crop and Samba single crop.—Adt. 11, GEB. 24, ASD. 5, Co. 2, Co. 3, Co. 15, Co. 19 and PTB 16
Navarai season.—(February—June).—Adt. 9, Adt. 12, Co. 13, Co. 20, MTU. 9, MTU 15 and PLR. 7

Zone No. 4

The Central part, comprising of Chingleput, North Arcot, parts of Chittor, Salem, South Arcot and Coimbatore districts.

The system of cropping in this zone is peculiar. Some crops like paddy, short-term garden crops like ragi, cholam, cumbu, groundnut, gingelly, etc., are grown in the wet lands under irrigation in one part or the other of this tract. The cropping scheme is dependent mainly on the vagaries of the monsoons. The chief source of irrigation, in addition to the monsoon rains, is from rain-fed tanks, spring channels, rivers and wells with high water table. The coastal district of the zone receives 15—16 inches of rain during the S. W. and 25—30 inches of rain during the N. E. monsoons while in the Central districts the precipitation of the N. E. monsoon is about 15—20 inches only. The hot weather rains are scanty, rarely exceeding 3 inches. Depending upon the intensity of the seasonal rainfall and the consequent availability of water in the tanks, the mode of paddy cropping is decided by the farmers. The following are the cropping seasons for paddy.

Surmavari season : May—June to September.—A short term crop of paddy of 110 days duration is raised with the help of S. W. monsoon rains supplemented with well water.

Samba season : July—January.—The paddy is sown with the S.W. monsoon rains in July—September and the crop matures with N. E. monsoon rains in January supplemented with well water.

Navarai season : January—May.—A short term paddy crop is taken only in the ayacut of such tanks which have sufficient water to support a short rice crop and also with the help of the lift irrigation wherever facilities exist.

The second crop of rice is also grown as Thaladi soon after the harvest of the Surmavari crop in the season October—March if sufficient water is available in the tanks to mature a second crop.

The following varieties are recommended

1. Chingleput and Northern parts of South Arcot :

(i) Surmavari season (May—June to September) TKM.5, TKM.6 and Co. 13
(ii) Samba season (July—January)
   (a) Rainfed : TKM.1, and TKM.4
   (b) Semi-wet : Adt.22 and BAM.3
   (c) Wet : Early planting . GEB. 24
      Normal planting . Co. 19, Co. 5 and Co. 25
      Late planting. . Co. 2 and ASD. 5

  *Udu cropped.

16—13 I. C. A. R./57
Navarai season: (January to May)—TKM.5, TKM.6 and Co. 13

2. Chittoor district:
(i) Swarnavari season: TKM.5, TKM.6 and Co.13
(ii) Samba season (single crop): GEB.24, Co.2, ASD.5, Co.19, Co.15, Co.25 and Adi.22 (*for semi-dry sowings)
(iii) Thaladi (November—March)—Co.2, ASD.5 and Co.5
(iv) Navarai season: Co.13, Co.18 and Co.20

3. North Arcot district:
(i) Swarnavari season: Co.13, Adt.14, PLR.2, PLR.7, TKM.5 and TKM.6
(ii) Early Samba season: Adt.22 (*for semi-dry cultivation)
(iii) Thaladi season: Co.2, ASD.5 and Co.5
(iv) Navarai season: Co.13, Co.18, Co.21, Co.22, Adt.14, Adt.18, PLR.7, TKM.5 and TKM.6

4. Salem district:
(i) Swarnavari season: Co.13, Co.21 and Adt.3
(ii) Early Samba season: GEB.24, Co.1 and T.672
(iii) Samba season: Co.3, Co.2, ASD.5, Co.14 and Co.19
(iv) Navarai season: Co.10, Co.13, Co.21 and Co.22

5. Coimbatore district:
(i) Swarnavari season: Co.13, Co.10 and Co.23
(ii) Early Samba season: GEB.24, Co.1 and T.672
(iii) Samba season: Co.2, ASD.5, Co.3, Co.4, Co.7, Co.11, Co.15, Co.19 and Co.25
(iv) Navarai season: Co.10, Co.13, Co.18 and Co.22

Cultural and manurial recommendations

I. (a) Swarnavari season crop (May—June to September). Instead of broadcast sowing drill or 'dibble paddy seed behind plough furrows at the rate of 60 lb. per acre. In alternate lines, sow sunnhemp and after about 6 weeks bury the green manure crop after letting in water at the time of weeding. In the case of transplanting for Swarnavari crop, plant the seedlings as early as possible in the season preferably within June at 4 inches apart either way with 2 seedlings per hole. The optimum age for variety Co. 13 is 3 weeks and for variety Adt.4, 5 weeks. Manure the field with either farmyard manure or compost at the rate of 10 cart-loads per acre and fertilize it with ammonium sulphate at the rate of 100 lb. per acre, a month after planting.

II. Thaladi crop (October—November to March). The optimum time for planting is the second week of November with seedlings of about 5 weeks of age with a spacing of 6'×6' with 2 seedlings per hole.

III. Samba crop (July—January). (a) Plant the seedlings 6' apart either way with two seedlings per hole. Manure the field with 6,000 lb. of green leaf of Croton sparsiflorus or pungham, sunnhemp or daincha per acre about 2 weeks before planting. Fertilize the crop with ammonium sulphate at the rate of 100—150 lb. per acre about 6 weeks after planting.
(b) **Navasai season (January—May)**: The optimum age of the seedlings is about 3-4 weeks and the spacing should be 4 inches apart either way with 2 seedlings per hole.

### Implements:

- **Kattamaram**, a small log of hard wood of about 7 feet length with 6" width for breaking clods and levelling and **kurnaram**, a tooth spiked implement for collecting weeds, are recommended.

### Andhra State

There are two distinct rice zones in this State:

1. The districts on the east coast mainly Nellore, parts of Chittoor, Anantapur and Cuddapah.
2. The Northern Circars covering the districts of Vizagapatnam, Godavari, Krishna and Guntur and parts of Kurnool and Bellary.

#### Zone No. 1.

In this zone specially Nellore district fifty per cent of the rice area is irrigated by reservoirs fed by Pennar river and fifty per cent is irrigated by wells and tanks that depend for their supply on the North-east monsoon rains. An average annual rainfall of about 38 inches is spread over as follows:

- **South-West monsoon (June—September)**: 8.0"  
- **North-East monsoon (October—January)**: 27.0"  
- **Hot weather (February—May)**: 3.0"

There is one main rice crop season which starts with the onset of the South-West monsoon. But, in the Chittoor district, rice is grown in three seasons with the available well water and with short duration rice strains.

#### Cropping system:

One long duration crop of rice namely **molakolakula** is grown in this tract on most of the area. The planting period for paddy depends upon the break of monsoon and the amount of precipitation during the different months in the season. Generally in the project area, the planting commences from the month of July. In the rainfed area, the main planting period extends as late as November according to the availability of water. If the main crop fails, **kesari** a short duration crop variety is sown and harvested in February. In a small area, a second crop of rice in the spring or **dalwa** season (January—April) is taken if sufficient supply of water is available.

The following varieties are recommended for the tract:

- **Winter sarva single crop (July to January)**: GEB.24, BCP.3, BCP 2, BCP 1 (2552), BCP 1 (2555) B. C.P. 4, BCP.3 and Adt. 22* (*suitable for semi dry areas).
- **Spring or dalwa season**: Adt. 3, MTU.9, MTU 15 and Co. 20

The following are the recommended practices:

1. In the case of dry sown crop, the lands are ploughed and kept in good tilth for sowing at the break of rains in August.
2. Drilling or dibbling seed at the rate of 60 lb. per acre behind the plough is better than broadcast sowing.
3. Initial interculturing of the dry sown crop of rice with Pallamanu, a tyned heavy beam may be done with a view to stir the soil and uproot the weeds. Passing country plough in between the rows of the dibbled plot is suggested to stimulate the growth of the crop when it is treated as a swamp paddy.

4. In the project area, dibbling sprouted seed under puddled conditions is as good as transplanting. The earlier the sowing, the better is the yield.

5. Transplanting, invariably gives good yield. Therefore, wherever possible transplanting is recommended. The optimum time of planting for obtaining satisfactory and good yield ranges from the middle of August to middle of September. The later plantings of October or November give only half the yield of the earlier plantings. They are often subjected to severe attack of paddy 'blast' which reduce the yield considerably.

6. The seedlings of 30 to 60 days old can be used for planting without the yield being affected. Where late planting is inevitable, young seedlings of 30 days old seem to be preferable to much older seedlings.

7. The optimum spacing is $6 \times 6$ with one or two seedlings per hole.

8. Double planting can be adopted only as an alternative to single planting in places where water supply is uncertain for planting. In the mid-season sowings i.e., 15th August, it is advisable to keep the seedlings in the primary and secondary seed-beds for 30 and 15-30 days respectively.

**Manurial**

Grow the green manure crop of daincha, or sannhemp after the harvest of the rice crop. Besides, apply bone-meal and groundnut cake each at the rate of 100 lb. per acre as a basal dose. A month after planting, apply 100 lb. of groundnut cake to the crop.

**Zone No. 2.**

This is the most important and fertile rice zone with an elaborate and efficient irrigation system from the great rivers Godavari and Krishna, supplemented by rainfall from both the monsoons. The top soils here are mostly black and stiff clays and go to a depth of about one foot, followed by layers of loam or sandy loam down to the water table which is fairly high.

The average annual rainfall in this zone is about 39 inches and its distribution in the 3 seasons is as shown below:

<table>
<thead>
<tr>
<th>Season</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>South-West monsoon (June—September)</td>
<td>35.6&quot;</td>
</tr>
<tr>
<td>North-East monsoon (October—January)</td>
<td>10.6&quot;</td>
</tr>
<tr>
<td>Hot weather season (February—May)</td>
<td>4.0&quot;</td>
</tr>
</tbody>
</table>

There are two seasons for paddy, namely Sarva i.e., June—November and dalwa, January—May.

**Cropping system**

In the first season, the long duration varieties are invariably grown, but medium and short duration crops of paddy are grown in some areas for early harvest. In the second or dalwa season, only medium or short duration varieties are grown. The second crop planting is started only at the end of January, though water is available in the canal for early planting. This is done because the early planted crop succumbs to the severe attack of stem-borer.
### Varieties recommended for Zone No. 2

**Strains recommended for the Northern Circars covering the districts of Vizagapatnam, Godavari, Krishna, Guntur and parts of Kurnool and Bellary:**

<table>
<thead>
<tr>
<th>Variety</th>
<th><strong>Autumn (kar) (June—October)</strong></th>
<th><strong>Winter (Saroa) single crop (June—December)</strong></th>
<th><strong>Spring (deul) (January—April)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vizagapatnam</strong></td>
<td>AKP.1</td>
<td>AKP strain Nos. 4, 5, 11, 3, 8 and 2.</td>
<td>SLO. 16, ADT. 3.</td>
</tr>
<tr>
<td><strong>Srikakulam</strong></td>
<td></td>
<td>BAM strain Nos. 1, 3, 6, SLO.12, GEB.24 and MTU.1, MTU.19.</td>
<td>MTU.9 and MTU.15.</td>
</tr>
<tr>
<td><strong>East Godavari</strong></td>
<td>MTU.3, MTU.17*, MTU.18*, MTU.20</td>
<td>MTU strain Nos. 1, 5, 10 and 16. SLO.1 and SLO.5</td>
<td>SLO.15, SLO.16.</td>
</tr>
<tr>
<td><strong>West Godavari</strong></td>
<td>MTU.3, MTU.17* and MTU.18*</td>
<td>MTU strain Nos. 1, 5, 10, 11, 14 and 16.</td>
<td>MTU.9 and MTU.15.</td>
</tr>
<tr>
<td><strong>Krishna</strong></td>
<td>MTU.3, MTU.17* and MTU.18*</td>
<td>MTU strain Nos. 1, 5, 7, 8, 11, 12, 13, 19 and 16* SR.2682 and GEB.24.</td>
<td>MTU.9, MTU.15.</td>
</tr>
<tr>
<td><strong>Guntur</strong></td>
<td>MTU.17* and MTU.18*</td>
<td>MTU strain Nos. 7, 8, 12, 13, 19 and 22 SR.2682 and GEB.24.</td>
<td>SLO.19.</td>
</tr>
<tr>
<td><strong>Kurnool</strong></td>
<td>Adt. 3</td>
<td>GEB.24</td>
<td></td>
</tr>
<tr>
<td><strong>Bellary</strong></td>
<td>Adt. 3</td>
<td>GEB.24</td>
<td></td>
</tr>
</tbody>
</table>

**Cultural and manurial practices recommended for the Central and West Godavari and Krishna and Guntur are as follows:**

1. **The single crop lands** are wetted once in March and again in April and this is done with a view to obtain favourable conditions of the land for easy movement of cattle in puddling. The sowing of green manure crop should be done, in the first wetting in March.

2. The plantings done within June give the best yield. The yield reduces progressively with the delayed plantings.

3. Seedlings of the ages varying from 5 to 7 weeks can be planted without the yield being affected, provided the planting is done within the middle of July.

4. The optimum spacing for the strains like MTU.3 is 8" × 8" with two seedlings per hole while for the strain MTU.10, a spacing of 6" × 12" with 2 seedlings or 12" × 12" with four seedlings seems to be ideal and economical too. However, for poor soils, close planting should always be adopted.

5. Judicious topping to check the rank growth, so common in the rich soils should be done carefully by cutting at or above the topmost leaf juncture line and not later than the end of August.

*Varieties for rainfed areas.
†Varieties for stagnant water conditions.
*Varieties suitable for coastal saline areas.
6. Green manuring at the rate of 4,000 lb. per acre, is economical. Super-phosphate at the rate of 100 lb. is also applied as a basal dose and worked into the soil in order to maintain the fertility of the soil.

Top-dressing the crop, about 6 weeks after planting with ammonium sulphate is recommended for the fields where the crop growth is moderate and lodging is not apprehended.

The ideal period for planting the second crop is from the last week of January to first week of February; the later the planting, the better is the yield. However, to obviate the water difficulty experienced for the second crop, the areas not cropped in the first cropping season due to submersion are planted in early January with seedlings raised in November, while in other areas planting can be done in the later half of January with seedlings sown in December under semi-dry seed-beds. Where late planting is done in the first week of February, it is recommended to use the seedlings from a nursery raised under a special method (vide page 145). The optimum spacing for the second crop MTU.15 is $6'\times3'$ with 3 seedlings per hole. In rich soils, the spacing of $6'\times6'$ may also be adopted without the yield being affected.

The application of even 2,000 lb. green leaf gives yield response. Green manuring up to 15,000 lb. per acre can be advantageously applied for higher yield returns. In the case of small application of 2,—4,000 lb. of leaf, fertilizing the crop with ammonium sulphate a month after planting at the rate of 200—300 lb. per acre is worthwhile for getting higher yields.

**Cropping in very rich soils**

In very rich areas in single cropped lands, an early variety of 100 days duration like Adt.3 followed by late ones like GEB.24 or Co. 3 has given 50% more grain than a single late crop. This practice has proved to be useful where facilities exist for planting the early variety by the 15th June.

**Green manuring programme for the deltas**

<table>
<thead>
<tr>
<th>Green manure crop</th>
<th>Sowing time</th>
<th>Paddy crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Piliipeaure either pure or mixed with samanea</td>
<td>In standing main crop before harvest</td>
<td>For the succeeding second crop harvest</td>
</tr>
<tr>
<td>2. (a) Piliipeaure and daincha</td>
<td>Sown in the para crops in last watering (about 10th March) or ploughed field (March 1st week)</td>
<td>For the succeeding main crop harvests are early and others if they are late</td>
</tr>
<tr>
<td>(b) Piliipeaure and Sesbania species</td>
<td>In the standing crop daincha if</td>
<td></td>
</tr>
</tbody>
</table>

**N.B.** Sesbania species sow as early as February does not become woody even by the end of June. It withstands alkalinity and comes better even where daincha fails.

**Recommendations for the eastern delta of Godavari as represented by the conditions obtained at Samalkota Agricultural Research Station:**

1. For the transplanted crop, winter ploughing is deleterious. Dry ploughing in thinakari is, however, less deleterious. Wherever possible, puddling the land in June for planting seems to be a good practice. For dry sown paddies, summer ploughings are quite essential for sowing at the right time. Further, this practice has proved to be distinctly better than that of ploughing the land at the break of the South-West monsoon and sowing the seed.
2. The optimum time of planting lies between the middle of June to middle of July; the yield is reduced with the delayed plantings considerably. (The earlier the planting, the better is the yield).

3. The best spacing seems to be 6" apart either way. The optimum age of the seedling for planting for variety like Konamani is 30 days.

4. Double transplanting is useful to overcome initial difficulties of water supply.

5. Green manuring at the rate of 4,000 lb. per acre in conjunction with 2 cwt. of super-phosphate as a basal dose is advisable. For the fields which are not green manured, application of ammonium sulphate at the rate of 100 lb. per acre at the time of planting is advocated.

Second crop

1. Broadcast sowing of the crop in puddle is preferable in the month of December and January, while transplanting is desirable after January.

2. Dry seed-bed seedlings are preferable to that of wet seedlings.

3. Green manuring at the rate of about 8,000 lb. per acre is easily the best method of manuring for getting high yields. As an alternative, application of castor cake at the rate of 800 lb. per acre in conjunction with 2 cwt. of super-phosphate may be adopted.

For green manuring same practices which have been recommended for the Central and Western Godavari delta can be safely adopted.

For areas covered by Vizagapatam district and upland taluks of Godavari, Krishna and Guntur districts which depend mainly upon the monsoon rains and the water supply available from rain-fed tanks, the following are the recommendations:

1. Sowings in the nurseries have to be done only at the end of June or early in July. The earlier the seedlings are raised under dry nursery with the help of wells or doruvu, the better it would be for planting early in the season, should the season be favourable. The seedlings of 1 to 2 months old of the dry seed-bed could be used even for late planting without the yield being affected, if the seasonal rains are received late for facilitating the planting operations in August—September.

2. Two to three seedlings, instead of the bunches spaced at 6" apart either way are to be planted.

3. The application of about 8,000 lb. of green leaf or green manuring in situ in conjunction with 100 lb. of super-phosphate per acre is recommended.

4. Sow daicha and saangemp at the rate of 40 lb. per acre with the first rains in June—July. For the uplands entirely depending on South-West monsoon rains, the paddy sowing should be done with the first rains of the monsoon, even if the preparation of the land is not up to the mark. The delay in sowing adversely affects the yield to a considerable extent. Drilling or dibbling the seed behind the country plough is better than broadcast sowing. Sowing green manure crop of daicha mixed with paddy is suggested, the crop of daicha being buried under as green manure 6-8 weeks after sowing at the time of interculturing the crop with country plough or hand-weeding.

Orissa State

Rice is grown on 80 per cent of the total cultivated area. The soil and climatic condition under which rice is grown vary considerably. The following are the distinct rice areas in the State:

(i) The Mahanadi and Rishikulya basins with an adequate rainfall and a good system of irrigation.
(i) The low lying submerged areas with a precarious crop in the main season followed by a spring-rice called *dalua*.

(ii) The coastal belt liable to inundation in the summer season by sea water.

(iii) The uneven and hilly zone comprising the Jeypore and Sambalpur districts.

**Soils**

There is a great diversity in the physical and chemical composition of the rice soils according to their derivations and locations. Rich and friable loams characterise the Mahanadi and Rishiкуlya areas; the submerged tracts have darker coloured stiff clay; the coastal tract is mostly saline; and poor laterite soils are found in the higher regions.

**Cropping seasons**

There is only one main season for rice crop. The majority of the areas is cropped from June—July with the advent of the South-West monsoon rains. There is also another season *dalua* (December—March) in which a short duration rice crop is taken. This *dalua* cropping is confined only to the areas subjected to periodical inundations, where a main crop is difficult or cannot be grown. The *dalua* sowing or planting is done immediately after the floods recede in December.

Since the rice crop has to grow and mature with the rains of the S. W. and N. E. monsoon seasons, varieties, varying in duration and suitable for the different locations of the rice lands and for the particular type of soils, have to be raised for successful cropping. The rice of the State can be divided into three classes:

(i) The *aus* or autumn rice, consisting of the *beali* and *laghu* groups

(ii) The *sadar*, *aman* or winter rice with differing durations

(iii) The *dalua*, *bora* or spring rice.

The *aus* rice is sown in the uplands, which are not capable of retaining much moisture. The varieties under *beali* group are of short duration (90 to 105 days), while those of *laghu* group are of medium duration (120—130 days). In the porous type of soils and in very high lands the *beali* varieties are raised, while in the medium high lands with loamy soils, the *laghu* types are grown. The *beali* and *laghu* types are invariably sown broadcast.

The *sadar*, *aman* or winter rice comprise of long duration varieties. Depending upon the moisture retentive capacity of the rice lands, varieties varying in duration from 135 to 160 days are grown.

The *dalua* varieties are of about 120 days and are raised from the month of December.

**Varieties recommended for the different categories of land**

*Cuttack, Puri, Balasore and Sambalpur district areas*:

*Beali* types: B.76, B.76-i, PTB.10 and Type N.196

*Laghu* types: T.380, T.635, T.608

Early winter: T.56, T.442, T.1145, SIO.6, SLO.9 and PTB.13

Mid-winter: T.141, T.812, T.412, T.895

Late winter: T.90, T.1242, BAM.6, BAM.9, OBS.7A and Jhelly No. 192.

**Berhampur area**

High Land paddy for rainfed area: BAM.12 and BAM.13

Mid-winter types: BAM.1, BAM.11 and T.812

Late winter types: BAM.3, BAM.6, BAM.8, BAM.9, T.1242 and T.90.
The following cultural methods are recommended:

1. The rice fields should be opened soon after the harvest of the mid and late winter rice crops and sown with mung at the rate of 20 lb. per acre. Summer ploughing of the land after the removal of the pulse crop is recommended.

2. For sarad crop, dibbling of the seed behind the country plough in the furrows should be done instead of broadcast sowing. About 6 seeds should be dibbled in the furrow at a spacing of 4 inches apart. The plough furrows can be formed with plough at a distance of 10 to 12 inches. This cultural practice effects a considerable saving in the seed rate. About 40 lb. of seed are sufficient to sow an acre. This method facilitates frequent interculturing operations with bullock power. Before dibbling paddy, danicha seed, at the rate of 20 lb. per acre should be sown broadcast.

3. Where broadcasting is adopted, a seed rate of 60—80 lb. of paddy seed mixed with 20 lb. of danicha seed per acre, depending on physical texture and the moisture content of the soil at the time of sowing is recommended instead of adopting the prevailing seed rate of 90 to 100 lb. per acre.

4. The bushening operation should be done 6—8 weeks after sowing. In the case of sarad varieties, drastic thinning of the paddy plants in the operation of bushening should be avoided. It would be desirable to have normal stand of the crop, as if the field is planted at about 9 inches apart either way.

5. Where dibbling the seeds is practised, the dibbled crop is intercultured thrice with country plough. The first interculturing of the crop is done, about 6 weeks after sowing and the second about 3 weeks after the first operation. The third interculturing is done with Japanese Weeder about 3 weeks after the second operation.

6. The preparation of the land for transplanting consists in giving a course of two ploughings with iron plough like Cooper No. 11 or 25. The green manure crop is effectively buried by working the 'Green manure trampler' or 'Burmese Satoon'. After a week's interval, two ploughings with iron or country plough are given and levelled perfectly with a levelling board. In the loamy soil, the final puddling operations are done economically by working the 'Wet land puddler' or 'Burmese Satoon'.

7. The optimum time for transplanting sarad varieties ranges from the middle of July to the first week of August. The yield decreases progressively with the delay in the plantings. In the medium lands, T.112.5 or T.141 can be planted up to the third week of August with seedlings of 40 days of age without the grain yield being much affected. The optimum age of seedlings for the mid-aman and aman varieties is about 7 weeks. The aman varieties are planted 9 inches apart either way in the fields of average fertility with 2 to 3 seedlings per hole. A close spacing of 6 inches apart either way is recommended for poor soils.
The planting of *daichna* (*Sesbania aculeata*) or *Sesbania speciosa* in the month of July—August along the field bunds, spaced at one foot apart, for seed purposes is advocated as it would be possible to obtain about 60 lb. of seed from the field bunds raised on an acre of land.

8. Green manuring in situ the rice crop, both for the broadcast and transplanted, is the best and economical method of manuring. In the case of dibbled or broadcast crop, the *daichna* is buried under at the time of bushsetting. If the growth of the rice crop is not up to the mark, 75—100 lb. of ammonium sulphate in combination with 75 lb. of bone-meal or superphosphate is applied at the time of filling up the gaps and weeding the crop a few days after bushsetting. Where planting is adopted, the fields are sown with *daichna* at the rate of 20—25 lb. per acre at the receipt of the first pre-monsoon showers which are usually received in the last week of May or within the middle of June. The green manure crop of *daichna* in the growing period of 6—8 weeks, gives about 5,000 lb. of green matter and it is buried in situ.

Before the final ploughing and levelling, 75 lb. of bone-meal or superphosphate is applied to an acre. Ammonium sulphate at the rate of 75 to 100 lb. per acre is also given 6 weeks after planting. Sub-surface application in the form of pellets is advisable.

9. In the canal irrigated areas, the growing of suitable short duration rices like PTB.10 and *daichna* varieties like MTU.15, DI.3 and DI.4 as second crop in January to March-April should be undertaken.

**West Bengal**

Rice is the chief crop, occupying more than 80 per cent of the total cultivated area. It is grown mainly with the help of the monsoon rains as in Orissa State. The rice tract of Bengal may be broadly classified into three zones

(i) North Bengal, mostly hilly consisting of sandy or laterite soil and traversed by a number of small rivers.

(ii) The tract lying extreme west of the State where the soils are of lateritic origin, but thrown into different levels.

(iii) The delta portion in central and lower Bengal with rich alluvial deposits of rivers but generally deficient in water supply; the lower reaches of this portion are marshy with salt incrustations in summer.

There is only one main season for rice crop namely, June—December. An average rainfall of 72" is recorded during the period May—October. The amount of rainfall of about 35 inches during the period June—August facilitates the transplanting operation of the main *aman* crop. The transplanted crop matures with the receding rains of the North-East monsoon. Transplanting is invariably adopted in all rice lands except in the high lands, which are porous in nature, and in very low lands.

**Different variety groups.** Depending upon the situations of the land as also the type of the soil, varieties varying in duration are grown. These varieties can be classified into five broad agricultural groups. Though some of these rices are morphologically very similar, they are distinct so far as their adaptability to distinct regions and seasons is concerned. These groups are as follows

(i) **High land aus**—Sown in April—May and harvested in August—September. It is purely dependent on rains and is broadcast at the earliest opportunity. It is generally a precarious crop and is followed in some areas by a cold weather crop of mustard or pulse.

(ii) **Low land aus**—Sown broadcast in low lands in February—March and harvested in August—September.

(iii) **Transplanted *aman***—The largest area is put under this class of rice which is transplanted in the month of July-August in semi—low lands and harvested in November—December.
(iv) **Low land aman**—Very long duration varieties are planted in July—August and harvested in December—January.

(v) **Bara**—Sown in seed-bed in the month of October and transplanted in December on the low land areas, which do not dry up in the cold weather. The crop is ready for harvest in March.

The following are the varieties recommended for the alluvial and laterite tracts:

**Alluvial Tract (Sweet)**

<table>
<thead>
<tr>
<th>Districts</th>
<th>Aman paddy</th>
<th>Aku paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Districts</td>
<td>High to medium high land</td>
<td>Medium-high land</td>
</tr>
<tr>
<td>Nadia</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>Howrah</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>Hooghly</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>West Dinajpur</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>Murshidabad</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>Bankura</td>
<td>Bhutnuri - 36, Kele, Jhanji -34</td>
<td>do.</td>
</tr>
<tr>
<td>Birbhum</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>Midnapore</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>Darjeeling (plains)</td>
<td>Marichbatti, Dhusral, Charnock, Dular, Satarika and Resenba (under recommendation for hilly regions)</td>
<td>do.</td>
</tr>
</tbody>
</table>

**Alluvial Tract (Saline)**

<table>
<thead>
<tr>
<th>Districts</th>
<th>Aman Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium high land</td>
<td>Medium land</td>
</tr>
<tr>
<td>24-Paraganas</td>
<td>Rupsail</td>
</tr>
<tr>
<td>Midnapore</td>
<td>Patnai-23, Patnai-28, Rupsail, Sitasail</td>
</tr>
<tr>
<td>Kumargore, Ara 108/1 Patnai-23</td>
<td>Do.</td>
</tr>
</tbody>
</table>
The following are the recommendations that could be put into practice in the alluvial tract of the State for obtaining bigger crop yields.

1. **Ass crop**. For the transplanted ass, it is suggested to raise the seed-beds in two flushes, from the middle of June at an interval of about a week, so that it would be possible to plant at the end of July or so with seedlings of optimum age, i.e., 4 weeks. A spacing of 6 inches either way with two seedlings per hole should be adopted.

2. **Aman crop**. The plantings, carried out within the month of July, have recorded the highest yields. The yield decreased progressively as the transplantings became late. From the practical agricultural point of view, it is, therefore, recommended to raise thin dry seed-bed

### Recommendations for alluvial tract

#### Laterite Tract (Sweet)

<table>
<thead>
<tr>
<th>District</th>
<th>High to medium high land</th>
<th>Situation I Medium high land</th>
<th>Situation II Medium land</th>
<th>Situation III Low land</th>
<th>Situation IV very low land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part of Marshidabad</td>
<td>Marichbutti</td>
<td>Badkalamkati-65, Chur- nakati</td>
<td>Jhingasari, Mal- tu, Ajan -246, Haknum</td>
<td>Indra saill, Tilak- kachari, Asra tol/1</td>
<td></td>
</tr>
<tr>
<td>Birdwan</td>
<td>Bhumuri-36, Ashkata</td>
<td>do.</td>
<td>do.</td>
<td>Bhasamanik, Ra- ghussail, Sin- durmakhi</td>
<td>Manikkalma, Bansmoti, Ra- ndhunipagal</td>
</tr>
<tr>
<td>Bankura</td>
<td>Jhanji-34, Bhumuri-36, Ash- kata</td>
<td>do.</td>
<td>do.</td>
<td>Bhasamanik, Ra- ghussail, Malu, Hurkum, Badkalamkati-144</td>
<td>Sinshurmakhi, Raghussail, Bansmoti, Raghunipagal, Bhasamanik</td>
</tr>
<tr>
<td>Birbhum</td>
<td>do. and Marichbutti</td>
<td>do.</td>
<td>do.</td>
<td>Bhasamanik, Ra- ghussail, Bans- moti</td>
<td></td>
</tr>
<tr>
<td>Part of West Dinaj- pur (Raiganj)</td>
<td>Marichbutti</td>
<td>do.</td>
<td>do.</td>
<td>Indra saill, Talak- kachari, Asra tol/1</td>
<td></td>
</tr>
<tr>
<td>Part of Malda</td>
<td>do.</td>
<td>do.</td>
<td>do.</td>
<td>do.</td>
<td></td>
</tr>
</tbody>
</table>

#### Laterite Tract (Saline)

<table>
<thead>
<tr>
<th>District</th>
<th>High to medium high land</th>
<th>Situation I Medium high land</th>
<th>Situation II Medium land</th>
<th>Situation III Low land</th>
<th>Situation IV very low land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part of Midnapur</td>
<td>Puthai-26, Patna saill, Rupail, Sitasail</td>
<td>Kumarsore, Asra tol/1, Asra X</td>
<td>Puthai cross</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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on 10th June as this would seem to be ideal for a number of reasons. Since the yield is better with the earlier plantings, seedlings from the above sown seed-bed, irrespective of the age, could be uprooted and planted from the middle of July, should the seasonal conditions facilitate early planting. The same seedlings could be used for late planting in August as well, if conditions are not favourable for early planting.

It is recommended to plant one or two seedlings per hill distanced 9 inches apart either way. In normal years, however, in the early plantings, i.e. within July, a wider spacing of 12’ between plant to plant with double seedlings can be adopted without the yield being affected. Under late planted conditions, i.e. beyond the middle of August, a close planting of 6’ apart either way should be adopted invariably.

**Manuring.** Green manuring has proved to be the most profitable method of manuring rice in the alluvial tracts. The incorporation of 8,000 lb. of green manure like daincha or mustard, castor or groundnut cake to supply 40 lb. of nitrogen, in combination with 200 lb. of single super phosphate or 100 lb. of double super phosphate as a basal dose is recommended. In the place of green manuring, 150 to 200 lb. of ammonium sulphate can be applied as a top-dressing about 35 days after transplanting.

**Recommendations for the lateritic tract**

1. **Aur crop.** Dibbling the seed with 6 seeds spaced 6’ in the furrow (9’ between furrow to furrow), in the well prepared soil with the receipt of the pre-monsoon showers in May-June is recommended. Cattle manure at the rate of 2 tons per acre or green leaf manure at the rate of 3,000 lb. per acre is worked into the soil before sowing. Interculturing with hand hoes or working light ploughs in the times with optimum moisture in the soil should be carried out.

2. **Aman crop.** The plantings, carried out within the middle of July give the best yields. Raising the seed-bed in the first week of June and planting within the middle of July with about 7 weeks old seedlings is recommended for obtaining bigger crop yields. However, from practical point of view, due to the vicissitudes of the monsoon, raising seed-beds on 26th June would seem to be preferable for obvious reasons. Should conditions permit planting within the middle of July, the seedlings of 3-4 weeks of age from the above sown seed-bed can be used without the yield being affected. The seedlings of 5 weeks of age from the same seed-bed can be used for late planting at the end of July without much reduction in yield.

For soils, similar to that of the Rice Research Station, Bankura, a spacing of 9 inches either way with two seedlings per hole is recommended. For the soils of Suri Farm conditions, it would be advantageous to adopt a spacing of 5’ for Bud land and 7’ to 9’ for Kanali and Shoal lands. However, for late plantings, a closer spacing of 4’ to 6’ should be adopted.

**Manuring.** For areas having soils similar to that of the Rice Research Station, Bankura, an optimum dose of 40 lb. of N<sub>5</sub> and P<sub>5O<sub>3</sub></sub> each may be applied in organic or inorganic form. But for the soils allied to Suri Farm conditions, the optimum dose of N<sub>5</sub> should be 60 lb. per acre. The fertilizer ammonium sulphate may be applied in two split doses, one half at the time of last puddling and the other half 6 weeks after planting.

Installation of filter point pumps wherever feasible in suitable centres is recommended with a view to carry out the transplanting of the rice crop within the month of July. This important operation is bound to mitigate the ill-effects of unfavourable monsoon and thus stabilise the crop production of the State.
Assam

Rice is the most important staple crop of the state. The main rice area is confined in the two valleys of the Brahmaputra and Surma rivers. The mean annual rainfall is 128 inches in the Surma valley and 91 inches in the Assam valley. Monsoon ordinarily sets in by the middle of May, the rainiest months being June, July and August. A fairly good quantity of pre-monsoon showers is also received in April. The warm-moist climate of the two valleys makes the areas admirably suited to rice cultivation.

Various classes of paddy are grown in Assam. These include a large number of varieties which are suited to different localities depending mostly on their water requirements. These are divided into six agricultural classes, classified according to their harvesting seasons.

1. The **ahu or aus** Surma valley (Summer paddy) is sown broadcast, either dry or wet in March—April and harvested in June and July. Early types of this class of paddy are sown at the end of February in low-lying areas and harvested in the beginning of June before the advent of floods.

2. The transplanted **ahu or aus** (Autumn paddy) is sown in seed-bed mostly in April, transplanted in May and early part of June and is harvested in August—September.

3. The **sali or Sali**, Surma valley (Transplanted winter paddy) is sown in seed-bed in June transplanted in July—August and harvested in November—December.

4. The **bao or ara**, Surma valley (Shallow water winter paddy) which stands water up to a depth of 5 to 6 feet is generally sown broadcast in March—April and harvested in December.

5. The **aman** (Deep water winter paddy), is the long-stemmed winter paddy having a prostrate stem which remains floating on water. It is sown in March—April either dry or wet on low marshy lands which are subject to heavy floods during the monsoons. It can be grown in 6 to 12 feet of water or even more. The paddy is harvested in November—December.

6. The **boro paddy** (Spring paddy) is sown in seed-bed during November and transplanted in low-marshy areas, in the margin of beels or natural depressions in December—January and is harvested in April—May.

The improved strains of paddy recommended for the different tracts are given below:

A. **Released from the Rice Experimental Station at Karinganj in the Surma valley**:

I. **Broadcast ahu (aus)**: Kmj. D. 136-6 (Kala Dumai), Kmj. D. 204-1 (Lal Dumai), Kmj. M. 142 (Koilumra), Kmj. M. 36-30 (Murali group), Kmj. M. 175-1 (Dhola Jali), Kmj. C. 203-3 (Chengri).

II. **Transplanted ahu (aus)**: Kmj. As. 3 (Basmati), Kmj. As. 24-1 (Bastababahar), Kmj. As. Kasalath, Kmj. As. 46 (Aus Faria), Kmj. As. C. 536-143 (Hybrid 1).

III. **Sali (sail)** (Transplanted winter paddy): Kmj. S. 22 (Lati Sali), Kmj. S. 156 (Nagra Sali), Kmj. S. C. 94-97 (Kerr Sali) (Hybrid 2), Kmj. S. 155 (Badsabagh), Kmj. S. 61 (Prasadbhog), Kmj. S. C. 1177-5, Kmj. S. C. 412-56 (Swarna Sali) (Hybrid No. 4), Kmj. S. C. 1177-36 (Sali) (Hybrid No. 5).

B. Released from the Rice Experimental Station at Titabor on the Brahmaputra valley:

Ahu (Summer paddy): TTB.As. 86 (Rangaduria), TTB.As. 25 (Fapari), TTB.As. 35 (Farma) TTB. As. 20-1 (Garem Ahu), TTB. As. 48 (Dubaichenga), TTB. As. C. 313-11 (Ahu cross).

Sali (Transplanted winter paddy): TTB. S.L. 70 (Ahom Sali), TTB.S.115 (Latamaguri), TTB. S.J. 226 (Bengali Joha), TTB. S.B. 279 (Gomiri Bora), TTB. S. 126 (Laudumra), TTB. S.L. 250 (Johari), TTB. S.L. 533 (Kanaimuluk), TTB. S. C. 306-51 (Hybrid) (Andrew Sali), TTB. S. L 202 (Kalamdani), TTB. S. C. 308-372 (Sali hybrid), TTB. S. J. 311 (Lakshmi Joha).

C. Under Experiment at the Bao and Boro paddy Research Station, Raha in the Brahmaputra valley:

Aman or deep water winter paddy: Aman I (Bagdar) Aman II (Godalaki), Boro I (Boro) Boro II (Tupa), Boro IV (Boro), Boro V.

The following are the improved methods of cultivation that could be put into practice in the Surma and Assam valleys of this State:

**Broadcast ahu (or ahu-Surma valley)**
1. Best time of sowing—March—April.
2. Best seed rate (dry)—1 md. per acre.
3. Best seed rate (wet)—30 seeds per acre.
4. Optimum number of weedings—2.
5. Best stage of harvesting—When the grains are still somewhat green in the lower part of the panicle.

**Transplanted ahu (or ahu)**
1. Best seed rate in seed bed—2-3 md. per acre (with proper manuring).
2. Best time of planting—May.
3. Best age of seedlings—4-5 weeks (late types), 3-4 weeks (early).
4. Best spacing—4 inches (late type), 3 inches (early type).
5. Optimum number of seedlings per hole—2 to 3.

**Sali (or sali, Surma valley)**
1. Best seed rate in seed bed—2-3 md. per acre.
2. Preparation of land—(a) 6 ploughings and 6 laddering; the deeper the puddle, the bigger will be the crop. (b) Water is the limiting factor for the growth of the paddy crop. The *alii* (soil, Surma valley) should be made broad and high, completely water-tight, to retain at least 3'-4' of water during the growing period.
3. Best age of seedlings—3 to 6 weeks.
4. Best time of transplanting—July to middle of August.
5. Best spacing—6-9 inches. If the soil is rich and transplanting is early, 9 inches will be better than 6 inches.
6. Optimum number of seedlings per hole—2-3.
7. Late transplanting—There is a progressive decrease in yield if transplanting is done after the middle of August. In the case of late transplanting, spacing should be 6 inches and number of seedlings should be 5-6 per hole.

**Bao (or aha, Surma valley)**: Broadcast method of cultivation
1. Best time of sowing—March—April.
2. Best seed rate (dry)—1 md. per acre.
3. Best seed rate (wet)—30 seers per acre.

Transplanted Method of cultivation:
1. Best time of sowing in seed-bed—Middle of April to Middle of May.
2. Best seed rate in seed-bed—3 md. per acre (with proper manuring).
4. Best age of seedlings—6-7 weeks.
5. Best spacing—9-12 inches.
6. Optimum number of seedlings per hole—2-4.
7. As fodder: One cutting of the top of the growing crop can be done by the first part of August (not below the junction of the leaf) without the yield of the crop being affected in any way. This operation would give about 50 md. of green fodder. This would be valuable in the area where there is a scarcity of fodder.

Aman
1. Best time of sowing—March—April.
2. Best seed rate (dry)—50 seers per acre.
3. Best seed rate (wet)—37 seers (75 lb.) per acre.

Boro
1. Best seed rate in the seed-bed—3 md. per acre with proper manuring.
2. Best time of transplanting—Late December to early January.
3. Best age of seedlings—5 weeks.
4. Best spacing—6-9 inches.
5. Optimum number of seedlings per hole—2-4.
6. Maximum period that can be allowed for resting uprooted seedlings—3 days.
7. Optimum number of weedings after planting—2.
8. There is a progressive increase in yield with every increase in the number of irrigations from two to six.
9. The lower area in a boro field is more productive than the higher area.
10. The variety tapi should be selected for early planting and a boro for late planting. Double transplanting is recommended for the low level lands, especially under late planted conditions. The benefit accrued by this practice is two-fold, i.e. a higher output of the crop by about 40 per cent as compared with single planting and an early maturing of the crop by about seven days and thus escaping the damages due to flood.

Double transplanting is also found beneficial for the high level lands especially with boro strains under either early or late planted conditions, while for the tapi strain, it is advantageous only under late planted conditions.

Mansuring: The growing of dainchha and incorporating the same in situ for green-manuring has proved to be very beneficial. Wherever it is feasible, the above practice should be adopted.

Cattle manure or compost to supply up to 80 lb. of nitrogen (i.e. 200 md.) per acre is found to give very good result in view of the comparative cheapness of these bulky manures.
It would appear that, if the inherent fertility status of the field is maintained at such a level so as to produce a yield of about 40 mds. from an acre there is little useful purpose served in fertilizing the crop with any of the nitrogenous and, or phosphatic fertilizers except with farm yard manure to give 80 lb. of nitrogen per acre. For poor and average soils, it is recommended to manure the crop with 200 lb. of ammonium sulphate or ammonium phosphate (20/20) plus 200 mds. of cowdung or compost per acre. On 

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phosphate do not show any response here. In general the response to all manures and fertilizers appear rather low here. The usual practice of the indigenous cultivators is to sow seeds in seed-bed (for the transplanted rices) at the rate of 6-8 mds. per acre without any manuring. However, recent experiment on the intensive (Japanese) methods of cultivation has shown that 2 to 3 mds. of seeds (depending upon the size of the grains) is enough for an acre of seed-bed if properly manured with ammonium sulphate. Seedlings raised from an acre of seed-bed can cover about 14 acres in the field on transplantation.

Bihar

Rice occupies nearly 50 per cent of the cultivated area of the State.

Rice Zones in the State

There are three rice zones in the State, viz.

(i) South Bihar, which comprises the low-lying area, south of the river Ganges with heavy and moderately heavy soil types; there are irrigation facilities in this area.

(ii) North Bihar, which lies to the north of the river Ganges, the soil being light alluvium with good moisture retaining capacity. Here the crop is entirely dependent on rain and there is diversity in cropping. Sugarcane and wheat crops, are also grown.

(iii) The terraced hill area of Chotanagpur, comprising mostly of reddish gravelly soils dependent upon the South-West monsoon rains for successful harvest. Rice is the chief crop here.

Cropping season

The rice season commences with the break of the South-West monsoon. In a large portion of the rice area in Chotanagpur and in portions of North Bihar, rice is sown broadcast, while the practice of transplanting is followed in places where better water facilities exist.

The rice varieties of Bihar may be grouped into two main divisions

(i) The aus or the autumn rice (June—July to September—October)

(ii) The aman or the winter rices, early, medium and late (June—July to November—December), mostly transplanted.

The recommended aus and aman varieties are the following:

AUS paddy : B.R.16, BR.2 for upland areas in Chotanagpur and Bhagalpur area, B.R.1 and BR.2 are for the intermediate class of lands in the above areas.


Purple paddy : B.R.11
Flood resistant: B.R. 13


Late aman: 111/8-10. It gives 10% more yield than B.R. 7.

Recommendations for increased production:

The following are the recommendations that could be put into practice to increase production:

1. Winter or summer ploughing of the rice lands is done with a view to getting the fields ready for either direct sowing or transplanting.

2. Dibbling 3-4 seeds in the plough furrows at 4" apart is preferable to broadcast sowing. The plough furrows may be spaced 9" apart. A seed rate of 40 lb. per acre would be sufficient. Interculturing twice with country plough during the growth phase of the crop should be carried out, the first being 4-6 weeks after sowing and the second 4 weeks after the first interculturating.

3. Dibble sowing in the upland and low lands is preferable to transplanting.

4. In general, transplanting of the rice crop in the medium wet lands is desirable for obvious reasons but under optimum condition of sowing, direct sowing of seed is also as good as transplanting in point of yield.

5. For the tract represented by Sabour farm, it is recommended to raise seedlings in the third week of June and complete the planting by the end of July with seedlings of 3 weeks of age. If late planting is inevitable due to the vagaries of the season, seed-beds may be raised from the middle of July and the plantings carried out with 3-4 weeks old seedlings. The earlier the planting is done, the better is the yield. A spacing of 6 to 9" inches apart either way with 2 seedlings per hole is desirable.

For the tract represented by the Gaya farm, the seed-bed can be raised from the middle of June and the planting is started from the third week of July finishing it by the first week of August, using seedlings of 6-7 weeks of age. For early planting, a spacing of 9 inches apart either way with 3 seedlings per hole is recommended, while for late plantings that are started from the first week of August, a spacing of 6 inches apart either way with single or two seedlings is found economical.

Under late planted conditions, seedlings of the age 9 and 11 weeks from the early sown seed-bed (i.e. 15th June), can be used, with advantage instead of young seedlings from late sown seed-beds (i.e. July) though the yield might a little be affected as compared with the seedlings of 6-7 weeks of age from normal sown seed-bed (i.e., 15th June).

Manuring practices: For the tract represented by Gaya Farm wherever timely growing of green manure crop is possible, *dahua* or *saindheep* to supply 40 to 60 lb. of nitrogen (i.e. 8000-10,000 lb. of green matter) should be incorporated into the soil in conjunction with 200 lb. of superphosphate.

Wherever green manuring is not possible, 200 lb. of ammonium sulphate should be used for getting higher yields, and this dose is applied in full at the time of planting.

Cattle-manuring also at the above level of nitrogen gives equally good response and wherever possible cattle manure in combination with the fertilizer ammonium sulphate to supply 40 to 60 lb. of nitrogen is advocated for maintaining the physical texture of soil in good heart.
For the tract represented by Sabour and Kanke Farms the above-mentioned practices can be adopted with the following exceptions. Since $P_2O_5$ shows very little response in the Sabour and Kanke Farms, the application of superphosphate at the rate of 100 lb. per acre may be done in alternate years.

The application of the fertilizer ammonium sulphate is recommended to be applied a month after planting.

Irrigation: There is no special advantage in practising Nigar, i.e., (completely dewatering the paddy field in Uttar Nalwa (14th to 28th September) and filling up again in Hathia (28th September to 12th October). The practice of supplying water wherever the crop needs it seems to be the sound practice. The present practice of Nigar is not warranted as a course of agricultural routine, as this may cause undue pressure on irrigation sources at the particular period of Hathia, when the demand and also the quantity of water will be more and pressing from around.

Harvesting

The harvesting of the crop (Dahiya variety) can be done about a week ahead of the normal time of harvesting that is 17th November, as this practice does not in any way affect the yield nor the value of the grain as seed.

Rotation

It is recommended to grow cash crops like gram, peas, khesari, either on the high or low rice lands. This practice, if not beneficial on the succeeding paddy crop, has no deleterious effects either.

Uttar Pradesh

Paddy is the most important Kharif crop of the State, claiming an annual cultivated area of about ten million acres. The paddy area in the State can be classified into three distinct regions:

(i) The high mountainous region in the North-West areas of the State. This is characterized by abundant rainfall of 80 inches or so, and porous gravelly soils. The land is terraced and well drained.

(ii) The Tarai region consisting of a broad strip of land, varying in width and stretching along the Northern boundary at the foot of the Himalayas, with a rainfall of about 40 to 50 inches. The soils are clayey, rich in humus and have retentive capacity of moisture.

(iii) The flat fertile Gangetic alluvium, lying in the centre and the east of the State, bounded by the rivers Gogra and Jamuna, with soils containing varying proportions of clay and sand.

Cropping season

The cultivation of paddy crop all over the State starts with the break of South-West monsoon. During the period of May-September an average rainfall of about 90 inches is received. Nearly 90 per cent of the total rice is cropped with the help of monsoon rains. As a corollary, early paddy predominates claiming about two-thirds of the total area, the rest being taken up by late varieties, which are usually supplied with water from other irrigation sources.

Early varieties are generally sown broadcast at the advent of South-West monsoon, while the medium and late varieties are transplanted. Transplanting of early paddy crop is practised in areas having facilities of irrigation for raising nursery in the months of May and early June. Transplanting early paddy crop whenever it is done early enough before the end of June, results in the higher yield of about 10-20% over the broadcast crop.
### Varieties recommended

The improved varieties of paddy, recommended for the irrigated and non-irrigated areas of the State are given below:

<table>
<thead>
<tr>
<th>Strain No. and Name of variety</th>
<th>Suitable for the tracts</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Early varieties:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. For non-irrigated areas—sown broadcast, but can be transplanted with benefit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.196, A hybrid, ((T_1 \times T_{100}))</td>
<td>Eastern, Central and Western parts of the States.</td>
<td>Does particularly well when transplanted, grain breaks during hulling. Should be converted into as rice to get better hulling performance.</td>
</tr>
<tr>
<td>N.22, Rajdhog.</td>
<td>All over U. P.</td>
<td>Does particularly well under broadcasting.</td>
</tr>
<tr>
<td>Ch.10, Twanda White China</td>
<td>Lakhimpur Kheri, Goonda, Basti and hill districts.</td>
<td>Very popular in hill districts.</td>
</tr>
<tr>
<td>B. Early varieties (mid-early) for irrigated areas—do particularly well under transplanted conditions but can be broadcast also.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N.10B, Basmati, Pilibhit.</td>
<td>Bijnor, Pilibhit, Bareilly, Sitapur</td>
<td>Must be sown early to avoid Gandhi attack.</td>
</tr>
<tr>
<td>N.12 safeda, Punjab.</td>
<td>Lucknow, Sitapur, Harda and Unnao</td>
<td></td>
</tr>
<tr>
<td>Ch.4.</td>
<td>Western U. P. and Tarai area</td>
<td>Must be sown early to avoid Gandhi attack, responds well to heavy manuring.</td>
</tr>
<tr>
<td>T.137, A hybrid ((T_1 \times T_{27}))</td>
<td>Bijnor, Dehradun, Muzaffarnagar, Saharanpur and Tarai area</td>
<td>Must be sown early.</td>
</tr>
<tr>
<td>T.198, Anjana, Pilibhit</td>
<td>Western and Central U. P.</td>
<td>Must be sown early.</td>
</tr>
<tr>
<td>T.43, Sondhi.</td>
<td>Etah, Bareilly, Jhansi, Bijnor, Basti.</td>
<td>Wherever a table rice is in demand Must be sown early to avoid Gandhi.</td>
</tr>
<tr>
<td>T.1, Ramjjswain.</td>
<td>Saharanpur, Muzaffarnagar, Fatehpur, Jhansi.</td>
<td>Suitability for areas where the crop is damaged by birds and wild beasts.</td>
</tr>
<tr>
<td>T.9, Basmati.</td>
<td>Saharanpur, Muzaffarnagar, Fatehpur, Jhansi.</td>
<td>Suitable for areas where the crop is damaged by birds and wild beasts.</td>
</tr>
<tr>
<td>T.1, Chaul.</td>
<td>Mainpuri, Bijnor, Shahjahanpur, Sitapur, Barabanki, Pilibhit, Unnao.</td>
<td>Suitable for areas where the crop is damaged by birds and wild beasts.</td>
</tr>
<tr>
<td><strong>II. Late varieties:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suitable for low-lying areas and areas subject to inundation, almost always transplanted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.9 Duniapat.</td>
<td>Banda, Basti and other districts, where quality is in demand.</td>
<td></td>
</tr>
</tbody>
</table>
Strain No. and Name of variety

<table>
<thead>
<tr>
<th>Strain No. and Name of variety</th>
<th>Suitable for the tracts</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.17, Bansi.</td>
<td>Shahjahanpur, Pilibhit.</td>
<td></td>
</tr>
<tr>
<td>T.22/A, Bansi.</td>
<td>Mainpuri, Bareilly, Shahjahanpur, Farukhabad, Bahrach, Rawash, Gonda and Basti.</td>
<td></td>
</tr>
<tr>
<td>T.36, Jathar.</td>
<td>Most widely grown in Mirzapur.</td>
<td></td>
</tr>
<tr>
<td>T.88, Chakia.</td>
<td>Ghanspur, Ballia, Gonda, Gorakhpur, Basti and Mirzapur.</td>
<td></td>
</tr>
<tr>
<td>T.100, Bhamlot.</td>
<td>Mainpuri, Bareilly.</td>
<td>Stands water-logging.</td>
</tr>
</tbody>
</table>

III. Deep water paddies:


Recommendations for increased production:

The following are the recommendations that could be adopted by farmers for obtaining bigger crop yields:

1. Where the growing of rabi crop is not feasible, the lands should be opened up in winter with an iron mould-board plough to a depth of about 4 to 5 inches, and subsequently, five to six ploughings with a desi plough during summer months, before the sowing of paddy. In the rabi cropped areas, summer ploughing is advocated. Summer ploughing of fields, wherever practised, results in the opening up of soil, suppression of weeds and removal of self-sown paddy plants, which usually bring about admixture in paddy fields. Summer ploughing is helpful to the succeeding rice crop also.

2. The sowing of broadcast crop should be done in the wake of the pre-monsoon showers in the first fortnight of June, earlier it is done, the better. In tracts having facilities for irrigation of the paddy crop e.g., Western and Central districts of the State, the seed rate of broadcast paddy crop should be 50 to 60 lb. per acre. Higher seed rate up to 80 to 90 lb. per acre may be used in case of broadcast paddy crop grown in non-irrigated areas e.g., in Eastern districts. Seed rate in the case of heavy coarse grained varieties is higher than in the case of thin and light seeded varieties.

3. In broadcast crop, inter-ploughing 3 to 4 weeks after sowing is advocated with a view to minimising the expenditure on weeding. Dibbling the seed behind the country plough is preferable as this would facilitate inter-culturing operations and effect a saving in seed rate by about 25 per cent. as compared with broadcasting.

4. The seed-bed should be well manured with well rotted farmyard manure or compost before sowing, the rate of application being 10-15 cart-loads per acre. The seed rate varies with varieties, it being generally higher in the case of coarse varieties, i.e., 20 lb. for transplanting one acre of field and lower in the case of fine varieties i.e., about 12-14 lb. only. Using higher seed rate results in the unnecessary wastage of seed as also production of weak and unhealthy seedlings.

5. Seedlings, in the case of early varieties should be transplanted when they are 3 to 4 weeks old. Late transplanting of seedlings of early varieties in the month of July is undesirable as it brings about lowered crop yields. Similarly, medium varieties should be transplanted early so as to avoid the attack of Gandhi pest (Leptocoris varicornis). Transplanting of early and medium varieties in later part of June brings about optimum yield of the crop.
Seedlings, in the case of early and medium varieties should be 3 to 4 weeks old; and in the case of late varieties 4–5 weeks old. Seedlings numbering 1–2 per hole at the distance of 8–9'' apart either way should be used for getting optimum yields. Under late transplanted conditions, the distance between plants in the row should be decreased.

For late paddy areas in the Eastern parts of the State, the best period for transplanting paddy crop is the month of July. Closer spacing between plants, say about 6’ apart, and using a bunch of 2–4 seedlings per hole brings about increased yield of late paddy crop. Late transplanting in the month of August results in the stunted growth, low tillering and consequently poor yields of late paddy crop.

**Manuring**

Green manuring with *sanai*, *lobia* or *daincha* is the best and the cheapest method of manuring as compared with other organic and inorganic manuring. Green manuring of paddy crop is possible in areas where there are facilities for irrigation in the month of April and May to enable the sowing of green manure crops in time. Sowing of *sanai* for green manuring purposes should be done in time, with a seed rate of 60 to 80 lb. per acre. The crop should be 6 to 8 weeks old before green manuring it at the time of transplanting paddy crop. The whole crop of *sanai* grown *in situ* should be buried 4 to 5 days before transplanting. The following regiment of manuring the rice crop is also recommended:

1. The application of 100 to 200 lb. of sulphate of ammonia about four weeks after transplanting in the case of early varieties and 6 weeks after transplanting in the case of late varieties is advocated for bigger yields. The sub-surface application of this fertilizer results in the better yield's response as compared with surface application.
2. Application of 200 lb. sulphate of ammonia per acre along with 15 cart-loads of farmyard manure gives higher yield of paddy than that obtained from the use of either organic or inorganic manures separately or in other combinations. Farmyard manure should be applied to fields before preparing them for transplanting. Sulphate of ammonia is best applied about a month after transplanting.
3. The application of potassic or phosphatic fertilizer to paddy crop under Nagina conditions does not bring about any increase in yield of paddy.
4. For late paddy crop in eastern parts of the State, manuring with oil-cakes like castor cake or groundnut cake, at the rate of 50 lb. of nitrogen per acre gives higher yield of the crop than that obtained by the use of any other type of manure.

**Irrigation**

It is recommended to give small doses of water say 2'' at short intervals of 4 days to the rice crop as this practice has resulted in giving good yield.

**Rotations**

The growing of a *rabi* legume crop either gram, pea or berseem after paddy is recommended. Berseem can be sown in areas having facilities for irrigation in winter months. Berseem seed can be sown in the standing crop of paddy just before harvest. It gives a bumper yield of 400 to 500 mds. of green fodder, in three to four cuttings, at the interval of 3 to 4 weeks between two successive cuttings. In addition, it gives a yield of 2–3 mds. of seed. The paddy-berseem rotation is particularly good for the irrigated regions of Western U. P. For early paddy tracts of Eastern U. P. the best rotation is early paddy-pea.

**Punjab**

The area under rice in the Punjab is about 5½ lakh acres, of which a little over one lakh acres, i.e., 20 per cent is concentrated round Kangra Hills and the remaining area is spread in submontane and plain area of Gurdaspur, Hoshiarpur, Ambala, Amritsar, Ferozepore, Karnal and Hisar districts. About 40 per cent of the rice acreage is rain-fed, most of it being in the hills, and the rest is irrigated by wells, khals and perennial and seasonal canals. The bulk of the crop in the hilly areas is sown broadcast but in the plains where the crop is mostly irrigated, transplanting method is adopted by the cultivators.
The results of experiments conducted at the Rice Breeding Sub-Station, Gurdaspur show that the best time for transplanting is from the middle of June to the middle of July. It is also recommended that seed rate of 8 chhattas per marha (1/160 acre) be used in nursery beds and about five weeks old seedlings, i.e., before they get noded, be transplanted 6 inches apart either way with 2-3 seedlings per hole.

Application of about 200 lb. of ammonium sulphate has been found to be a profitable and economical dose. Application of superphosphate alone is ineffective but it has been found to be useful in early planting in conjunction with high doses of ammonium sulphate, where it helps the crop to withstand lodging.

Following varieties are recommended for different situations:
1. For the plains—Strain No. 349 (Jhona), No. 246 (Palman suffaid,) and No. 370 (Basmati).
2. For Kangra Hills—Strain No. 100 (Raman Jwain), No. 72 (Phulpattas) and No. 41 (Lsl Nakanda).
3. For high hills—(Kulu valley)—No. 43 (Dundar).

Kashmir

In Kashmir, rice is grown on an altitude of about 5,000 feet under temperate climatic conditions. The soil varies from loam to clayey loam. Medium duration varieties of paddy (130 days) are grown in the season May-September. A mean maximum temperature of 81.3°F and mean minimum temperature of 60.4°F prevails during the growth season of the crop. Though an average annual rainfall of about 14'' only is recorded in the crop season, water is available throughout the growth period for the irrigation of the crop. The terrace system of cultivation is largely adopted.

Recommendation for higher yields:

The following practices should be adopted for obtaining bigger crop yields:

Varieties: China Nos. 1039, 988, 1007, 1040 and 97; No. 1039 has a pigmented sheath and is non-shedding.

Russian Nos. 3073, 1331 and 566, American (USA. No. 729) varieties for altitudes of 7000 feet.

Seeding practices:

Sowing seed by broadcast method should as far as possible be done early in the season within the third week of May with a seed rate of 72 lb. per acre, as this has proved to be the best.

The existing seed rate of 24 lb. of seed sown in one cent of seed-bed, can be reduced to one-fourth, i.e., 6 lb. sown in a cent of seed-bed. To protect the sprouted seeds from the ill effects of cold, and to promote the quick growth of the seedlings, covering of the seed with oil-paper should be adopted.

The seed-bed should be manured with farmyard manure (15 tons per acre) and wood-ash (2 tons per acre).

The transplanting should be done between the last week of May to first week of June with seedlings of 28 days old at a distance of 6" x 6" with two seedlings per hole. The earlier the planting, the better is the yield.

Manuring:

Lentil as a green manure should be grown after rice as this appears to be the best form of manuring. It is best to apply 30 lb. of super phosphate to the green manure crop. The application of farmyard manure as a basal dose (to supply 45 lb. of N) in conjunction with ammonium sulphate as a top dressing 4-6 weeks after planting (to supply 45 lb. N) has given increased yield with economic return.
Inter-culturing

Hand weeding should be done twice, as it has proved to be the best method of inter-culturing as compared to Hoji (ploughing with local plough without tip after first weeding), or harrowing or cattle treading after the first weeding. The next best to hand weeding is Hoji.

Irrigation

Continuous irrigation to the rice crop, no doubt, gives the highest yield; but there is no significant difference in yield between the treatments namely continuous irrigation, irrigation at 2 days interval or 4 or 6 days interval.

Harvesting

As the Chinese varieties shed their grain, it is suggested to harvest the crop about 3 days ahead of the normal time of harvesting. The shedding of the grains from the bundles while transporting from the field to the threshing floor could be minimised to a very great extent if the following method of bundling is adopted. At first a handful of sheaves is placed on the ground with the ear-heads brought over to the central portion of the sheaves by bending the stalk of the ear-heads and over that, another handful of harvested sheaves is laid with the ear-heads at the opposite end of the previous one, the ear-head being well within sheaves and not projecting outside the bundle. In the above manner, the rest of the sheaves are arranged alternately so that the ear-heads at both the ends do not project outside the bundle. This kind of bundling does prevent the shedding of the grains during transporting. Even if shedding does take place, the shed grains will be within the sheaves and not lost.

Rotation

It will be better to divide one's holding into three parts, one part to be grown with rape as a subsidiary, the second one under lentil as green manure and the third part paddy seed sown by broadcast method where growing period for paddy is enough.

Bombay

The area under rice is about 3 million acres. The rice cultivation is spread over a wide range of soil and climatic conditions, extending from one end of the State to the other. It is mostly confined to the Western coast, with small areas extending over the pockets of the Sahyadri range. The rice area of the State can be divided into the following distinct zones.

1. North Konkan tract which has a rainfall of 75 to 150 inches with the soils blackish and heavy. The tract mostly grows fine types of rice.
2. South Konkan tract with a rainfall slightly heavier than the above zone and soils mostly gravelly. Here varieties of coarse white grained rice are predominantly grown.
3. North Kanara with the southern most talukas of South Konkan where coarse red kernelled rice varieties are predominantly grown. A narrow strip of land bordering all along the sea-cost grows salt land paddy varieties which are generally coarse and red grained.
4. Malnad tract has a very low rainfall of about 35 to 40°. Mostly rice in this tract is drilled; the varieties grown are very coarse and usually white grained.
5. The Maval tract which comprises of the Eastern strip of the Ghat, where rainfall is about 50° and above and mostly scented rice varieties are grown.
6. Gujarat tract (South) which has a rainfall of 40 to 60° where mostly coarse varieties are grown.
7. Gujarat tract (North) which has a rainfall of 35 to 40°. Paddy is transplanted and grown under tank or canal irrigation and the varieties grown are fine grained.

Cropping season. There is only one main cropping season which commences in June with the advent of South-West monsoon. In some pockets where enough water facilities are available, a summer crop of paddy is taken. In the Malnad area, rice is mostly drilled while in the rest of the major area the crop is transplanted.
The improved paddy strains suitable to the different zones are given below:


Blast resistant types—A. 67, A. 90, A. 200, M. 249. New promising types evolved at various research stations are undergoing trials in the cultivators' fields and are in various varieties of the different zones; they are about 56 in number.

The following are the recommended cultural and manurial practices:

1. Drilling of paddy lands immediately after the harvest and bringing soil to a good tilth with the help of summer showers either for direct sowing or transplanting.
2. Drilling the seed, or sowing in line on the nursery seed-beds, is beneficial to broadcast as it facilitates weeding, manuring etc.
3. Thin sowing with low seed rate per acre, i.e. a spacing of 15" between rows with a seed rate of 60 lb. per acre appears to be optimum in drilled tract. Similar seed rate is also found optimum for ryaba sowing (i.e. sowing of sprouted seed on salt lands where standing water is present from the beginning). 10-15 lb. seed in 5 cent sown on raised seed-bed with proper manuring gives enough seedlings to plant an acre of land, in the case of fine varieties.
4. The wasteful process of rabbing, i.e. burning of the seed-bed area with cow-dung, grass, toppings of trees, etc., can be substituted by manuring seed-beds with cow-dung, compost and either groundnut cake or ammonium sulphate or the manure mixture prepared by the Department.
5. The planting of seedlings with fewer number of vigorous seedlings per bunch is found to be optimum under adequate manuring conditions and sufficient water supply.
6. Green manuring of the rice crop with sanamph, or daincha, or with leaves of Pongamia glabra, Ipomea carnea, Calotropis gigantea, Terminalia paniculata and Styrchnos toxonica is the best and cheapest method of manuring. Wherever conditions permit, green manure crops are to be sown in the field at the first showers and the crop is to be buried in soil a week before transplanting.

In addition to the bulky manures, the following inorganic fertilizers are recommended, for paddy crops:

(a) For the lateritic soils—64 lb. P₂O₅ and 32 lb. N per acre.
(b) For the non-lateritic soils—64 lb. N—32 lb. P₂O₅ per acre.

The N dose preferably to be given as Groundnut cake and/or sulphate of ammonia, with P₂O₅ in first zone as bonemeal and in latter zone as superphosphate.

8. The fertilizer to be applied in three stages; once at transplanting (half dose), one-fourth at tillering stage and the remaining one-fourth at pre-flowering stage. All P₂O₅ dose to be given at the transplanting time.

19–10 I.C.A.R./57
9. **Rotations.** Pulses like **wal**, gram, peas, lentils are recommended for growing after-harvest of paddy crop in rabi season. Growing of **wal** seems to have beneficial effects on the succeeding rice crop. Especially the application of superphosphate to **wal** crop gives beneficial effects to the succeeding cereal crop.

**Madhya Pradesh**

The area under rice in this State is about 8.9 million acres. Rice is grown exclusively as a monsoon crop. The principal rice areas may be divided into three zones:

(i) The tract comprising the districts of Drug, Raipur, Bilaspur, Bastar, Surguja and Raigarh. Here rice is mostly sown broadcast and depends for its success on a well distributed and adequate rainfall.

(ii) The Wainganga basin in the south comprising the districts of Balaghat and Chanda. This area has irrigation facilities and 70 per cent of the area is transplanted.

(iii) The Northern portion including Seoni, Mandla and Jubbulpore districts. Rice area here is small and early varieties are the rule.

**Soils.** The rice soils are of two kinds:

(i) A fine grained yellow loam locally termed **matasi** which is considered ideal for a single crop of rice.

(ii) **Dorsa** a mixture of the light **matasi** and the black heavy **kankar**, dark grey in colour supporting a rabi crop of pulse after rice. The soils of Wainganga valley are crystalline in origin and resemble those of Chhattisgarh but are slightly lighter in texture. Rice soils in the North Province are very light.

**Cropping season**—Rice cropping commences with the break of the South-West monsoon. Since the monsoon wanes by the end of September, early and medium varieties are more common. Late rice are confined to those areas where facilities for irrigation are available. The following paddy strains are recommended:

**Medium and coarse varieties**

<table>
<thead>
<tr>
<th>Strain</th>
<th>Date of ripening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td></td>
</tr>
<tr>
<td>R 3. Nungi (No. 17)</td>
<td>16th October.</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Cross 116 or 22</td>
<td>10th November.</td>
</tr>
<tr>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>Budhia boko × Luchai (No. 4)</td>
<td>17th November.</td>
</tr>
<tr>
<td>Ajan × Luchai (No. 4)</td>
<td>22nd November.</td>
</tr>
<tr>
<td>R 8. Luchai</td>
<td>30th November.</td>
</tr>
<tr>
<td>R 8. Beniar</td>
<td>30th November.</td>
</tr>
<tr>
<td>Luchai × Gurmatia × Burma (No. 2)</td>
<td>29th November.</td>
</tr>
<tr>
<td>Luchai × Gurmatia × Burma (No. 18)</td>
<td>29th November.</td>
</tr>
</tbody>
</table>
Medium and coarse varieties

<table>
<thead>
<tr>
<th>Strain</th>
<th>Date of ripening</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fine scented varieties</strong></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>R 10. Chhatri</td>
<td>7th November.</td>
</tr>
<tr>
<td>R 11. Dubraj</td>
<td>9th November.</td>
</tr>
<tr>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>R 15. Chinoor</td>
<td>1st December.</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td></td>
</tr>
<tr>
<td>Cross No. 1</td>
<td>14th October</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Cross 1 x Sultagurmatia (No. 51)</td>
<td>9th November.</td>
</tr>
<tr>
<td>Cross 4 x Ajan (No. 34)</td>
<td>15th November.</td>
</tr>
<tr>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>Cross 5 Luchai (No. 18)</td>
<td>26th November</td>
</tr>
</tbody>
</table>

Purple—seeded hybrids for fields infested with wild rice

<table>
<thead>
<tr>
<th>Cultural practices.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely sowing</td>
<td>is most important for ensuring a successful crop. Wherever possible, rice fields are opened and brought to tilth with the help of summer or premonsoon rains and seeds are sown just before the S.W. monsoon sets in:</td>
</tr>
<tr>
<td>Transplanting rice crop is the best method for obtaining bigger yields and it should be practiced wherever facilities exist. Since it has many limitations the practice of direct sowing is resorted to. Drilling or dibbling the seed in furrows 9&quot; apart instead of broadcast sowing is advisable.</td>
<td>For drilling or dibbling, seed rate of 45 lb. per acre is sufficient.</td>
</tr>
<tr>
<td>Where <em>biasi</em> is followed, a seed rate of 80 lb. per acre has been found to be the best. The practice of <em>machhua</em> (i.e., sowing sprouted seed in puddle) is adopted when conditions do not permit timely sowing.</td>
<td>Where <em>biasi</em> is followed, a seed rate of 80 lb. per acre has been found to be the best. The practice of <em>machhua</em> (i.e., sowing sprouted seed in puddle) is adopted when conditions do not permit timely sowing.</td>
</tr>
<tr>
<td>Where transplanting is practised, seedlings 4 weeks old are planted 6 inches apart either way with 2 seedlings per hole.</td>
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</tr>
<tr>
<td>Manuring. Application of 100 pounds of ammonium sulphate with 100 lb. single superphosphate is recommended. Superphosphate should be drilled before sowing and ammonium sulphate given as top-dressing in August.</td>
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</tr>
<tr>
<td>Oil cakes as groundnut or <em>til</em> could be applied up to 60 lb. nitrogen, if available, at reasonable prices. In clayey soils, <em>til</em> cake is slightly better than groundnut cake, particularly at lower levels of nitrogen.</td>
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</tr>
</tbody>
</table>
Compost or cattle manure to supply 60 lb. nitrogen for late varieties is also found to give equally good response to yield.

Green manuring or application of green leaf at 8-10 thousand pounds per acre in conjunction with 100 lb. of bone meal has been found to be very effective. Wherever facilities exist, the practice of green manuring in situ is recommended.

Since late varieties respond better than early varieties to both nitrogen and phosphorous manuring, it is desirable to manure late varieties with heavy doses of manuring.

Irrigation. Irrigating late varieties in dura soil has resulted in giving a strikingly increased yield of about 44 per cent over no-irrigated soil. It is suggested that filter point pumps should be installed, if feasible at suitable centres for wetting the rice crop at critical junctures. This would also facilitate the raising of seed-bed and transplanting of the rice crop.

**Hyderabad**

Hyderabad State has an annual area under rice of nearly fifteen lakhs of acres. Till last year, the total produce from this area amounting to nearly 4.75 lakh tons used to fall short of the State's requirements by nearly 60,000 tons. However, during the year 1954-55, the State was not only self-sufficient but offered for export 20,000 tons of paddy. This improvement has been brought about, not by increasing the area under rice, but by increasing the yield per unit area. There is scope for further improvement and the agronomic practices that are expected to contribute to this are outlined below.

**Agronomic Practices adopted and recommended.**

1. In parts of Telangana where the semi-dry (Wattu wett) system of cultivation is practised, it is recommended that instead of broadcasting the dry seed, it be sown in straight rows by means of a country seed drill as is done in Marathwara and Karnatika where the dry system of cultivation is in vogue. Sowing in straight rows will enable the farmer to use the rotary weeder with all its advantages in lowering weeding costs, deep placing the manure and aerating the fields. A seed rate of 80 lb. per acre for broadcast sowing both for abi and tabi crops has been found to be optimum. Wherever dibbling or drilling is practised under ideal soil conditions, a seed rate of 40-60 lb. per acre would be sufficient.

2. In areas where swamp paddy is cultivated, there is ample scope of rapidly replacing the broadcast method with transplanting. About ten years ago, transplanting was confined to small areas in Nizamabad district. But now transplanting in straight rows is the rage. Transplanting in straight rows with a spacing of $10\times6'$ for the first crop or abi and $6'\times4'$ for the second or tabi crop is sure to increase yields and at the same time cut down cost of production.

3. With the above spacing, a seed rate of 15-20 lb. per acre will suffice.

4. The best time of starting the abi nursery where late maturing varieties are cultivated is the second fortnight of May, i.e., before the South-West monsoon breaks out. For areas cultivating early varieties, the nurseries can, with advantage be started with the break of the monsoon.

5. To enable timely sowing of the nurseries, filter point pumps may be tried wherever the water table is high as in Karimnagar district. If the water yield is high then a crop of green manure can also be sown about the same time as the nursery sowing.

6. Sesbania speciosa planted along bunds in abi will yield substantial quantities of green matter for the tabi crop.

7. In Nizamabad district where the stem borer is a menace in tabi, experience has shown that starting the nursery about mid-January and transplanting in about middle of February avoids the pest. RDR. 7, a variety having fine grain, giving good yield and maturing in about 100 days is recommended for this delayed sowing and for tabi, in general.
8. Other varieties recommended are:

<table>
<thead>
<tr>
<th>Early</th>
<th>Intermediate</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR.3</td>
<td>HR.5</td>
<td>HR.1</td>
</tr>
<tr>
<td>HR.15</td>
<td>HR.19</td>
<td>HR.35</td>
</tr>
<tr>
<td>HR.21</td>
<td>MTU.9</td>
<td>HR.38</td>
</tr>
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<td>HR.39</td>
</tr>
<tr>
<td>HR.35</td>
<td></td>
<td>HR.59</td>
</tr>
<tr>
<td>HR.47</td>
<td></td>
<td>MTU.19</td>
</tr>
<tr>
<td>HR.67</td>
<td></td>
<td>RDR.4</td>
</tr>
</tbody>
</table>

9. In the matter of application of fertilizers it is found that the black soils of Telangana, more especially of Nizamabad district, respond very well to an initial dose of about 100 lb. \( P_4O_6 \) followed in later years by about half or less this quantity. The phosphate is best applied in the form of super phosphate at the time of the final puddling. The nitrogen should be applied in split doses. Roughly half of the total quantity should be given at final puddling and the remainder in one or two equal doses 1-2 months after transplanting; latter depending on whether the variety is early or late maturing. A dose of 60 lb. N and 30 lb \( P_4O_6 \) is remunerative at present prices of paddy and manure.

10. Frequent use of the rotary weeder during the interval of a fortnight after transplanting and about a month before heading is strongly recommended for reasons of economy and efficiency.

**Mysore**

The area under rice cultivation is about 8 lakhs of acres. Rice is grown as follows:

(i) as a purely rainfed crop, usually broadcast on the hilly *Malnad* tract. Soils here are generally poor and only coarse rices are grown

(ii) the flat rainfed portions which have facilities for irrigation from channels

(iii) the summer rice grown in the low level lands which get some regular supply of water from tanks during January-April.

There are two seasons for rice, viz., *Hain-*June to December; and Summer—January-February to May-June.

The varieties recommended are the following:

<table>
<thead>
<tr>
<th>Irrigated varieties (monsoon)</th>
<th>S.661</th>
<th>S.695</th>
<th>S.701</th>
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<tr>
<td>S.139</td>
<td>S.716</td>
<td>S.749</td>
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<tr>
<td>S.246</td>
<td>S.624</td>
<td>S.199</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer paddy varieties</th>
<th>S.705</th>
<th>S.317</th>
<th>S.497</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><em>Malnad</em> varieties</th>
<th>B.181</th>
<th>B.194</th>
<th>B.199</th>
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</thead>
<tbody>
<tr>
<td>B.1370</td>
<td></td>
<td></td>
<td>B.16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Promising strains under trial</th>
<th>S.1086</th>
<th>S.1084</th>
<th>S.1064</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.1081</td>
<td>S.1075</td>
<td>S.&lt;1679</td>
<td></td>
</tr>
</tbody>
</table>
The following are the recommended cultural and manurial practices:

**Cultural methods.** Wherever direct sowing is practised, the fields are ploughed thoroughly and kept in good tilth for sowing at the opportune moment.

A seed rate of 55 lb. per acre is recommended for broadcast sowing both for the *Haine* (June-December) and summer crops.

Instead of broadcasting, drilling or dibbling the seed in plough furrows is recommended. 3 to 4 seeds are to be sown in the plough furrows at a distance of 4 inches apart, the space between the plough furrows being about 9-10 inches. This would facilitate subsequent interculturing operations.

In the case of transplanted *Haine* crop, optimum time for planting seems to range from 2nd week of July to 1st week of August while for the summer crop the period middle of January to first week of February seems to be ideal.

For the *Haine* crop, seedlings of 30-35 days of age should be planted with a spacing of 6" x 6" with 2-3 seedlings per hill, while for the summer crop, seedlings of 25 days old are to be planted with a spacing of 6" x 6" with 2 seedlings per hole. It is suggested to adopt a still closer spacing of 6" x 4\(\frac{1}{2}\) for the summer crop for bigger yields.

**Manurial practices.** Plough in 7,000 lb. of green manure per acre 7 to 10 days before sowing or transplanting. Drill 56 lb. of superphosphate before sowing and broadcast a mixture of 1 cwt. of groundnut cake and 56 lb. of ammonium sulphate just before sowing or transplanting.

Besides, the crop is to be top-dressed with 100 lb. of ammonium sulphate per acre, 6 weeks after transplanting.

A green manure crop of *dainchla* or *samhemp* should be raised in the rice fields in the wake of the pre-monsoon showers of the S.W. monsoon in June. It is recommended to apply one hundredweight (cwt.) of superphosphate to the land before sowing the green manure crop.

Green leaves, such as that of *lantana* in Irwin Canal Farm and *samhemp* in Babbur are found to be very useful for reclaiming alkaline soils.

With regard to irrigation practices, supplying water to the crop whenever required seems to be the sound practice, as the practice of giving water once in 5 days seems to lower the yield of the crop by about 6 per cent.

**Travancore-Cochin**

The system of paddy cultivation has peculiar features of its own in the different zones of the State on account of the diversity of the soil conditions, lay of the land and amount of rainfall and the irrigation facilities.

There are three well marked paddy seasons in the year locally termed as *Viruppu*, *Mundakam* and *Panja*. The *viruppu* is the first crop and starts with the pre-monsoon showers in April-May. It occupies the ground during the South-West monsoon and is a rain-fed crop. The second crop *mundakam* is put in the ground in September-October and is harvested in January-February. This crop is only partly rain-fed and depends upon irrigation facilities for its success. The third crop *panja* is cultivated between December, January, March and April, and is mainly an irrigated crop.

There is a small area in which all the three crops are cultivated successively in an year, but the extent is negligible. A large portion amounting to about two-thirds of the paddy area of the State, is double-cropped, i.e., two successive crops are taken in the *viruppu* and *mundakam* seasons respectively. High level lands along hill sides and margins are possible to be cultivated with one crop *viruppu* only. Cultivation of the *panja* crop is carried on in what are normally fresh water lakes adjoining the backwaters. The level of water in these lakes generally get low after the North-East monsoon and they are drained by using power pump and cultivated with a short duration variety of paddy.
Varampu season paddy. The paddy tracts may be classified into high rainfall zones and low rainfall zones. Nanjinad area in the extreme south of the State, and Chittur taluk in the extreme north-east get rainfall of 40 to 50 inches only, and the crops unless sustained by irrigation will be often subject to drought. The central districts of Quilon and Kottayam and the south-eastern portion of Trichur district get heavy rainfall of 100 inches and over, and the crop is oftentimes subject to floods.

The varampu crop is generally sown broadcast on a dry seed-bed. Transplantation is however done in a small area, where on account of the low lying nature of the land water easily accumulates and dry sowing is rendered impossible.

ASD 1, the strain evolved in the Ambassanadram Station of Madras is recommended to be cultivated in the Trivandrum district and particularly in the Nanjinad area, many portions of which are alkaline in nature. For the other parts of the State no definite strains have been evolved, and farmers are advised to use the best of their local types. PTB 10, the strain from the Pettambi Research Station in Malabar, is recommended to be cultivated wherever a short duration crop is necessary to be taken in this season.

Cattle manure, compost, bone-meal, groundnut cake and ashes are recommended before sowing, while ammonium sulphate and super phosphate are advised to be top-dressed after the plants have grown about a month old.

Mundakan season paddy. The variety Cochin 1 is recommended for the northern half of the State, ADR strains for the central eastern tracts and UR 19 is advised for the sandy areas of the Kottayam and Quilon districts.

The second crop is invariably transplanted. The fields are prepared in a puddled condition by incorporating large quantities of green leaves and cattle manure. Bone meal and groundnut cake should be applied at this time. Ammonium sulphate and superphosphate are applied a month after transplantation.

Panja season. The varieties Mo. 1, Mo. 2, PTB 10 and Siam. 3 are recommended for this cultivation.

The seeds are sprouted and sown at the rate of 90 lb. per acre, when there is still about a foot deep water in the fields. The water is then drained away. Bone-meal, hyper-phosphate and calcium carbonate are applied in the dry months of April and May after the panja crop is harvested and the land ploughed up. Groundnut cake, hyper-phosphate, super-phosphate and ammonium sulphate are recommended as top-dressings.

The usual recommended doses of manures for a seasonal crop are about one to two tons of cattle manure, 5,000 lb. of green leaf, and one to two thousand pounds of ashes. Calcium carbonate is recommended for soils showing acidity, and gypsum for alkaline conditions. The use of large quantities of green leaves is also advised for alkaline troubles. Groundnut cake is recommended at the rate of 2 cwt. per acre and bone-meal at 1 to 1.5 cwt. per acre. The usual dose of ammonium sulphate and superphosphate recommended is 1 cwt. per acre.

Cultivation of low lying lands. There are two types of paddy lands which need special mention. One type relates to the cultivation of low lying lands subject to heavy floods in the monsoon. Deep water varieties of paddy are cultivated here. The seeds are sown broadcast in the dry fields during the months of March-April. As soon as South-West rains commence, these fields get submerged, but the plants remain growing above water level. The level of water may reach 15 ft. deep and more. The crop is a long duration one, and harvest gets ready only in September-October. The harvest is done in waist-deep water or even in boats. Deep water varieties like Habiganj are recommended for these tracts.

Cultivation of lands joining Backwaters. The other pertains to the cultivation of lands adjoining backwaters, which are subject to tides from the sea. The soil gets saline after the North-East monsoon rains are over and continues to be so till the next South-West season rains commence vigorously. The soil in these fields is worked up into circular mounds about 3 to 4
feet in diameter and 2 to 3 feet in height, before the commencement of the South-West rains. When the rains appear the salt in these mounds is washed away, and sprouted seeds are sown on the top of each mound. When the seedlings have grown to a height of one to two feet, the mounds are broken up, and the seedlings distributed evenly over the entire field. The varieties of paddy grown can tolerate floods and salinity to a certain extent.

Lastly mention may also be made of the practice of sowing virippu and mundakan seeds mixed together at the beginning of the South-West season. The virippu and mundakan seedlings grow mixed together, but the virippu seedlings flower early and get ready for harvest in August-September. The earheads alone are harvested. The mundakan seedlings continue to grow and come into harvest in October-November.

PREPARATION OF SEED-BEDS FOR RICE

There are two methods of raising the seed-beds, namely (i) the wet and (ii) dry nursery and the methods of preparation are given below:

1. Wet nursery. It is desirable to raise wet seed-bed if water facilities exist as the seedlings raised under this system grow very quickly and become fit for planting even after 24 to 30 days. The most fertile portion of one's holding is usually earmarked as the seed-bed area. The seed-bed is ploughed twice either under dry or wet conditions at the first instance and thereafter it is puddled by giving two or three more ploughings. Care should be taken to see that a film of water is always kept in the field and on no account it should be allowed to dry. After ten days, the field should be ploughed twice and finally levelled perfectly with a levelling board.

Before the last ploughing, well decomposed cattle-musure or compost may be applied at the rate of 8 to 10 tons per acre and buried under. If green leaf is available, it may be applied at the rate of 10,000 lb. per acre just after the second ploughing and buried into the soil. When the leaves have decomposed in about three weeks, the field is ploughed a number of times until the soil is stirred into a soft puddle.

When the field is thus brought to a fine soft puddle, it is conveniently divided into small raised beds of 4' width. The field is marked into beds by means of laying ropes at 4 ft. apart, leaving a space 14 ft. between them for a channel. The loose soil from the demarcated channel is taken by hand to a depth of about 9 inches and thrown on either side of the beds and thus raising the beds slightly. These beds are then thoroughly levelled by working the hand-leveling board twice. The formation of a channel all round and in between the small beds facilitates the sower to go round the beds twice or thrice for sowing the seed evenly. Further, they facilitate drainage of water after sowing. It may be mentioned here that the preparation of the nursery bed as described above may be done in the morning, allowing one or two inches of clear water in the bed. This helps the colloidal particles to settle down and leave the water very clear. The sower can thus see the soil through the water and do the sowing uniformly. The sowing may be done in the evening. The sprouted seeds may be taken in a convenient receptacle, say a winnow or small basket and the sower, taking a handful of seed in his hand drops the seed gently through his fingers by shaking his hand and manipulating his fingers simultaneously.

The water in the seed-bed should be drained off completely the next day. If splashing rain is expected on the day of draining, it is advisable to let in water into the nursery as otherwise the beating rain will gather the seeds to some sides besides burying the seed inside the mud. This would result in the unsatisfactory germination and uneven stand and growth. Should water accumulate in small pockets in the beds it should be drained away by means of a thin stick. One standing in the channel should draw out the water through the trail formed by the stick from the pocket to the channel, as otherwise the seeds lying there may rot. After 3 or 4 days, depending upon the physical texture of the soil, when hair cracks are forming, the nursery should be irrigated lightly. This may be continued till the seedlings are about 2 inches and thereafter it is desirable to maintain always half an inch of water. However, the water should be changed frequently.
In case the growth of the seedlings is not up to the mark, it is recommended to top-dress the seedlings with 50-100 lb. of ammonium sulphate per acre, a week or 10 days before uprooting the seedlings for transplanting.

Sprouting of the seeds. The seeds are best sprouted by adopting the following procedure.

The seed required for the nursery bed can be taken in a gunny bag and loosely tied at the mouth and put in a channel or pond, say, in the evening at 4 P.M. and removed the next day at about 8 A.M. The water in the bag is completely drained off by keeping the bag under shade on two bamboo sticks kept in a slanting position. After an hour or so, the bag is kept in the corner of a room, placing one or two wet gunnis over it. This ensures optimum conditions for good germination. The next day i.e., the second day after soaking, it will be found that the seedlings have sprouted well. The seed thus sprouted should be sown in the well prepared seed-bed described above. Thus pre-germination, by giving every seed a good chance, undoubtedly aids in getting a quick and even stand in the seed-bed.

Dry seed-bed. The field selected for the seed-bed should be thoroughly ploughed by giving six or seven ploughings if need be, so that a fine tilth is obtained. Care should be taken in initially opening the soil. The field should be taken up for ploughing at the right time when it is neither too moist nor too dry. If it is very moist, it will throw clods but if it is too dry it will be difficult to plough. After giving 2 or 3 ploughings, the small clods should be broken by piling the ladder twice weighted by the ploughman standing on it if it need be, to break the big clods.

Well decomposed cattle manure or compost at the rate of 8 to 10 tons to an acre or 8-10 mds. of well-powdered groundnut cake should be evenly spread and incorporated by giving one or two ploughings. On the date of sowing, the field should be ploughed once and perfectly laddered. Thus after getting a fine tilth the seeds can be sown broadcast at the rate of 4 lb. to a cent if the variety is a coarse type or 3 lb. if it is a fine one. When the seed is sown uniformly, a light country plough can be worked without going deep into the soil, and then laddered. The seed may thus be covered. If it is found necessary laddering may be done for 2 days subsequently with a view to consolidating the soil and thereby stimulating quick germination. But if there is water facility, a light irrigation may be given on the third day. When the sprouts have come out and are seen clearly it is necessary to give very light irrigation once in 3 or 4 days depending upon the nature of the soil. The irrigation must be done judiciously. If the seed-bed is continuously and too frequently irrigated with a view to getting the seedlings to grow quickly, then there will be difficulty in uprooting the seedlings. Due to the deeper root system caused by the above method of irrigation, the seedlings may break while uprooting, and there may be heavy mortality of seedlings coupled with heavy cost of labour required for pulling these seedlings.

It may be noted here that the seedlings raised by this method may not grow so quickly as under wet seed-bed but they are hardy and they establish very quickly and make much headway in the growth soon after they are transplanted in the field.

Special treatment of seed-bed. At the Agricultural Research Station, Maruthru (Andhra) a special treatment is given to the second crop seed-bed with a view to tiding over the water difficulty experienced at the maturing phase of the crop and also to minimise the incidence of stem-borer attack. The method is as follows:

The seed-bed is prepared well as is done for wet nursery. Sprouted seeds are sown in mid-December and the usual wet treatment is given for about three weeks by which time the seedlings grow to a height of 8 to 10 inches. Thereafter the water supply is completely cut off and the seed-bed is allowed to dry up. Deep fissures and cracks are formed and the seedlings appear as if they are scorching up. At the time of planting i.e., last week of January or first week of February the seedlings are pulled out dry and kept heaped up in a puddled plot for about 24 to 36 hours by which time the seedlings will strike plenty of roots. Such seedlings

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when planted in the field establish quicker and the crop matures by about 10 days earlier than the usual crop. It has also been observed that such seedlings resist unfavourable weather conditions including stem-borer attack much better than the seedlings raised in the normal wet nurseries.

This special practice of raising seed-bed is worthy of adoption after trial in tracts where similar conditions are obtained to get over water scarcity and the bad effects of weather conditions and insect damage.

It is recommended to sow 4 lb. of seed in one cent of seed-bed (435'5 sq. ft.) in the case of coarse varieties and 3 lb. of seed in the case of medium and fine varieties. For the coarse varieties 10 to 12 cents of nursery and for the fine varieties 7 to 8 cents would be sufficient to transplant an acre of land.

Salient points of practical value. The salient points of economic and practical value which are of general nature in the cultural practices and which are recommended for practical application are given below:

(i) Dry ploughing before rains to enable paddy to be broadcasted or transplanted in time is advisable.
(ii) Drilling or dibbling seed at definite spacing is preferable to broadcast sowing.
(iii) A seed rate varying from 60-80 lbs. for broadcasting and 30-40 lbs. per acre for drilling or dibbling gives best results.
(iv) The sowing of seed should be done in appropriate time.
(v) Paddy should be sown mixed with 15 lbs. of daicha which should be buried as green manure, at the time of 'hospital' or weeding, 4-6 weeks after sowing. In the drill sown crop, alternate lines should be sown with 'daicha'.
(vi) Weeding or hoeing the crop in time with cultivator is beneficial.
(vii) Timely raising of seedlings in nurseries using lower seed rate i.e., 3-4 lb. of seed in one cent of seed-bed is essential.
(viii) The time of planting is the most vital and important factor and the planting should be done within the optimum period.
(ix) The green manuring of rice with suitable legumes like daicha, Sesbania speciosa, Sesban, Pilipea and Tephrosia purpurea grown in situ is the most useful and economic form of manuring. Legumes should be fertilized with phosphatic manures.
(x) Placement of fertilizers (100-150 lbs. of ammonium sulphate) in split doses at the root zone of the plants is also advocated for bigger yields and economic returns.
(xi) Interculturing the transplanted crop by thorough raking of the soil all round the plant; and the burial of the weeds twice or thrice at suitable interval should be carried out.
(xii) Bundling of fields for conserving moisture in the case of dry paddies and timely and proper irrigation at frequent intervals of 2-3 days with fresh water in the case of wet rice, should be practised for getting satisfactory yields.
(xiii) Seed should be treated against seed borne diseases with Agroan or Cercasan.
(xiv) The growing of high yielding paddy strains suitable for the different types of soil, locations and the season is of utmost importance in increasing the average acre yield of the land.

It has been roughly estimated that the cultural operations, if delayed, result in loss of yield amounting to 20-30 per cent of normal yields. It is, therefore, obvious that the timely execution of appropriate cultural operation should be given the top priority by the cultivator for obtaining bigger crop yields.
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## APPENDIX I

### Table I

Grain yield lbs. acre (The figures in brackets give the percentage)

<table>
<thead>
<tr>
<th>Name of Station</th>
<th>Variety</th>
<th>Experimental details</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Year of trial</td>
<td>Date of sowing</td>
</tr>
<tr>
<td>Ambassamudram</td>
<td>ASD. 1</td>
<td>1948-49</td>
<td>20-6-48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1949-50</td>
<td>26-6-49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average of two years</td>
<td></td>
</tr>
<tr>
<td>Tirukkappan</td>
<td>CO. 13</td>
<td>1948-49</td>
<td>28-5-48</td>
</tr>
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<td></td>
<td></td>
<td>1949-50</td>
<td>28-6-49</td>
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<tr>
<td></td>
<td></td>
<td>Average of two years</td>
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148
<table>
<thead>
<tr>
<th>Variety</th>
<th>Date of sowing</th>
<th>Yield in pounds per acre</th>
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<tbody>
<tr>
<td></td>
<td>Date of Transplanting</td>
<td>Early</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>Early</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47-5-37</td>
</tr>
<tr>
<td>PTB.1</td>
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<td>1938-39</td>
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<td></td>
<td>1939-40</td>
<td>25-4-39</td>
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<td></td>
<td>Average of three years</td>
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<td></td>
<td>Percentage of increase over transplanting</td>
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<td>1938-39</td>
<td>17-4-38</td>
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<td></td>
<td>Average of three years</td>
<td>2065</td>
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<tr>
<td></td>
<td>Percentage of increase over transplanting</td>
<td>129.7</td>
</tr>
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## APPENDIX II

*Experimental results on the relative merits:

A—Transplanting;
B—"Biai" (Broadcast sowing and subsequent cross ploughing)
C—Broadcast sowing

Name of the Station—Lahibandi Farm (M. P.)

<table>
<thead>
<tr>
<th>Nature of soil</th>
<th>Variety</th>
<th>E. B. 17 (Early duration)</th>
<th>Parewa (Medium duration)</th>
<th>Gurmatia (Late duration)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Masa (sandy loam)</td>
<td>Grain yield percentage on control</td>
<td>1188</td>
<td>769</td>
<td>556</td>
</tr>
<tr>
<td>Dora (clay loam)</td>
<td>Grain yield percentage on control</td>
<td>904</td>
<td>732</td>
<td>679</td>
</tr>
</tbody>
</table>

Yield in pounds per acre (average of 4 years)
## APPENDIX III

Broadcasting Vs. Transplanting experiment (df design)

Name of Station: Rice Research Station, Sabour (Bihar)

<table>
<thead>
<tr>
<th>Variety—10 RL.</th>
<th>Yield in pounds per acre</th>
<th>Average of two years (1959-40)</th>
</tr>
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<tbody>
<tr>
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<td>Broadcasting</td>
<td>Transplanting</td>
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<tr>
<td></td>
<td>E0</td>
<td>E1</td>
</tr>
<tr>
<td>NOPO</td>
<td>1204</td>
<td>1382</td>
</tr>
<tr>
<td>NOP1</td>
<td>1399</td>
<td>1514</td>
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<tr>
<td>N1PO</td>
<td>1212</td>
<td>2153</td>
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<tr>
<td>N1P1</td>
<td>1219</td>
<td>2433</td>
</tr>
<tr>
<td>Mean</td>
<td>1454</td>
<td>1931</td>
</tr>
<tr>
<td>Mean of E0 &amp; E1</td>
<td>1687.5</td>
<td>1728.0</td>
</tr>
</tbody>
</table>

EO = Indefinite spacing
E1 = Definite spacing
N0 = No nitrogen
N1 = 30 lb. nitrogen per acre
P0 = No phosphoric acid
P1 = 30 lb. phosphoric acid per acre
**APPENDIX IV**

**Table 1**

Rice Research Station, Ambassadum

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Spacings 4' × 4'</th>
<th>6' × 6'</th>
<th>6' × 12'</th>
<th>12' × 12'</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of seedlings per hole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Average yield of 3 years</td>
<td>3529</td>
<td>3796</td>
<td>3961</td>
<td>3767</td>
</tr>
<tr>
<td>Percentage on control 6' × 6' (3)</td>
<td>104.1</td>
<td>105.6</td>
<td>107.1</td>
<td>105.4</td>
</tr>
<tr>
<td>Second Crop: Strain AKD 3</td>
<td>2827</td>
<td>2873</td>
<td>2867</td>
<td>2831</td>
</tr>
<tr>
<td>Average yield of 2 years</td>
<td>101.0</td>
<td>97.4</td>
<td>92.0</td>
<td>92.0</td>
</tr>
</tbody>
</table>

**Table 2**

Paddy Breeding Station, Coimbatore

Variety Co. 5 (Main)

<table>
<thead>
<tr>
<th>Year</th>
<th>A 6' × 12'</th>
<th>B 6' × 12'</th>
<th>C 6' × 12'</th>
<th>D 6' × 12'</th>
<th>E 5' × 12'</th>
<th>F 5' × 12'</th>
<th>G 6' × 12'</th>
<th>H 5' × 15'</th>
<th>J 5' × 15'</th>
<th>K 5' × 10'</th>
<th>L 5' × 10'</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1938-39</td>
<td>2832</td>
<td>2789</td>
<td>2846</td>
<td>2743</td>
<td>2531</td>
<td>2797</td>
<td>2715</td>
<td>2572</td>
<td>2742</td>
<td>2603</td>
<td>2705</td>
<td>The figures in brackets represent the number of seedlings planted per hole.</td>
</tr>
<tr>
<td>1939-40</td>
<td>3347</td>
<td>3131</td>
<td>3212</td>
<td>3300</td>
<td>3162</td>
<td>3282</td>
<td>3251</td>
<td>2978</td>
<td>3175</td>
<td>2918</td>
<td>3061</td>
<td></td>
</tr>
<tr>
<td>1940-41</td>
<td>2656</td>
<td>2492</td>
<td>2353</td>
<td>2428</td>
<td>2999</td>
<td>2487</td>
<td>2416</td>
<td>2252</td>
<td>2493</td>
<td>2166</td>
<td>2427</td>
<td></td>
</tr>
<tr>
<td>Average of three years</td>
<td>2952</td>
<td>2804</td>
<td>2866</td>
<td>2842</td>
<td>2704</td>
<td>2784</td>
<td>2715</td>
<td>2618</td>
<td>2803</td>
<td>2763</td>
<td>2741</td>
<td></td>
</tr>
<tr>
<td>Percentage on control</td>
<td>100.0</td>
<td>95.0</td>
<td>96.9</td>
<td>96.2</td>
<td>91.6</td>
<td>94.8</td>
<td>95.1</td>
<td>87.6</td>
<td>95.0</td>
<td>86.3</td>
<td>92.9</td>
<td></td>
</tr>
<tr>
<td>Table 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Agricultural Research Station, Mauritius*

The experiment on different spacing and varied number of seedlings per hole

<table>
<thead>
<tr>
<th>Variety: Krishna Karukku</th>
<th>The percentage of grain yield on control (Average of 3 years 1933-35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>74'' × 20'' 10'' × 15'' 12'' × 12'' 74'' × 20'' 10'' × 15'' 18'' × 12'' 74'' × 74''</td>
</tr>
<tr>
<td>No. of seedlings per hole</td>
<td>single single double double double single</td>
</tr>
<tr>
<td>Percentage on control (74'' × 74'')</td>
<td>119.4 113.3 110.0 115.0 116.1 106.6 100.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variety: MTU-9 (main crop)</th>
<th>1941-42</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>4'' × 4'' 74'' × 74'' 12'' × 6'' 18'' × 12''</td>
</tr>
<tr>
<td>Grain yield in lb. per acre</td>
<td>3645 3573 3406 3441</td>
</tr>
<tr>
<td>No. of seedlings per hole</td>
<td>singles doubles trebles fours</td>
</tr>
<tr>
<td>Percentage on control (4'' × 4'')</td>
<td>99.7 100.0 95.4 94.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variety: MTU-10</th>
<th>Grain yield (lb./acre) (average of two years 1940-41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>6'' × 6'' 6'' × 12'' 12'' × 6'' 12'' × 12'' 12'' × 15'' 18'' × 9'' 18'' × 15''</td>
</tr>
<tr>
<td>No. of seedlings per hole</td>
<td>1 2 4 1 1 3 4 5</td>
</tr>
<tr>
<td>Acre yield in lb.</td>
<td>2910.0 2911 2807 2811 2803 2894 2840 2946</td>
</tr>
<tr>
<td>Percentage on control (6'' × 6'') singles</td>
<td>100.0 95.9 94.4 95.1 94.4 97.3 98.2 99.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variety: MTU-10</th>
<th>Experiment on increasing the number of seedlings per hole with constant spacing 74'' × 74''. (Average of two years 1939-1940)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of seedlings per hole</td>
<td>singles doubles trebles fours fives sixes sevent eights</td>
</tr>
<tr>
<td>Acre yield in lb.</td>
<td>2844 2949 2817 3138 3992 3069 3118 3153</td>
</tr>
<tr>
<td>Percentage on control (doubles)</td>
<td>100.0 107.3 106.4 104.8 104.1 105.7 106.9</td>
</tr>
</tbody>
</table>
### APPENDIX IV—contd.

#### TABLE 4

Spacing-cm seedlings per bunch experiment on Paddy Summary of results (Figures in lb. per acre)

<table>
<thead>
<tr>
<th>Farm</th>
<th>Average of 4 years (1948-49 to 1951-52)</th>
<th>Farm—Kharagpur</th>
<th>Average of 2 years 1949-1951</th>
<th>Farm—Igatpuri</th>
<th>Average of 4 years (1948-49 to 1951-52)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spacing</strong></td>
<td><strong>No. of seedlings per bunch</strong></td>
<td><strong>8&quot; x 8&quot;</strong></td>
<td><strong>10&quot; x 10&quot;</strong></td>
<td><strong>12&quot; x 12&quot;</strong></td>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2592</td>
<td>2565</td>
<td>2534</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>2560</td>
<td>2525</td>
<td>2491</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>2536</td>
<td>2494</td>
<td>2450</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>2512</td>
<td>2470</td>
<td>2426</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>2490</td>
<td>2447</td>
<td>2404</td>
<td></td>
</tr>
</tbody>
</table>

**S.E.** = Standard Error
### Farm—Bulbul

Average of 4 years (1948-49 to 1951-52)

<table>
<thead>
<tr>
<th>Spacing</th>
<th>No. of seedlings per bunch</th>
<th>6&quot; x 6&quot;</th>
<th>9&quot; x 9&quot;</th>
<th>12&quot; x 12&quot;</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2190</td>
<td>2072</td>
<td>1351</td>
<td>2077</td>
<td>2087</td>
</tr>
<tr>
<td>8</td>
<td>2161</td>
<td>1932</td>
<td>1077</td>
<td>1960</td>
<td>2033</td>
</tr>
<tr>
<td>10</td>
<td>2203</td>
<td>2077</td>
<td>1871</td>
<td>1930</td>
<td>2010</td>
</tr>
<tr>
<td>12</td>
<td>2231</td>
<td>2080</td>
<td>1932</td>
<td>1906</td>
<td>2006</td>
</tr>
<tr>
<td>Mean</td>
<td>2176</td>
<td>2084</td>
<td>1898</td>
<td>2007</td>
<td></td>
</tr>
</tbody>
</table>

S. E. = 35.1

S. E. = for the body of the table = 60.8.

### Farm—Navagam

Average of 2 years (1950-51 and 1951-52)

#### Variety: Sukhwel No. 10

<table>
<thead>
<tr>
<th>Spacing</th>
<th>No. of seedlings per bunch</th>
<th>6&quot; x 6&quot;</th>
<th>9&quot; x 9&quot;</th>
<th>12&quot; x 12&quot;</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3934</td>
<td>3752</td>
<td>3356</td>
<td>3774</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3936</td>
<td>3736</td>
<td>3668</td>
<td>3779</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3782</td>
<td>3638</td>
<td>3464</td>
<td>3792</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3817</td>
<td>3673</td>
<td>3527</td>
<td>3756</td>
<td></td>
</tr>
</tbody>
</table>

#### Variety: Jinsar No. 274

<table>
<thead>
<tr>
<th>Spacing</th>
<th>No. of seedlings per bunch</th>
<th>6&quot; x 6&quot;</th>
<th>9&quot; x 9&quot;</th>
<th>12&quot; x 12&quot;</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3934</td>
<td>3752</td>
<td>3356</td>
<td>3774</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3936</td>
<td>3736</td>
<td>3668</td>
<td>3779</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3782</td>
<td>3638</td>
<td>3464</td>
<td>3792</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3817</td>
<td>3673</td>
<td>3527</td>
<td>3756</td>
<td></td>
</tr>
</tbody>
</table>
**APPENDIX V**

**Table 1 (a)**

*Habiganj Farm*

Experiment: Double transplanting versus single planting

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1943-44</th>
<th>1944-45</th>
<th>1945-46</th>
<th>Mean</th>
<th>Percentage over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single transplanting</td>
<td>1754</td>
<td>2175</td>
<td>1646</td>
<td>1881</td>
<td>100.0</td>
</tr>
<tr>
<td>Double transplanting</td>
<td>2893</td>
<td>3342</td>
<td>2134</td>
<td>2609</td>
<td>139.8</td>
</tr>
</tbody>
</table>

**Table 1 (b)**

*Grain yield lbs. acre (average of 3 years)*

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Method of planting</th>
<th>Early single planting</th>
<th>Late single planting (control)</th>
<th>Double transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.III-17 Boro</td>
<td>Yield</td>
<td>1759</td>
<td>1940</td>
<td>2252</td>
</tr>
<tr>
<td></td>
<td>Percentage on control</td>
<td>100.0</td>
<td>115.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flowering duration in days</td>
<td>117</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>B. 45 III Toya</td>
<td>Yield</td>
<td>2564</td>
<td>1405</td>
<td>2380</td>
</tr>
<tr>
<td></td>
<td>Percentage on control</td>
<td>176.2</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flowering duration in days</td>
<td>123</td>
<td>130</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3

*Nagina*

**Experiments:** Double transplantation *versus* single transplantation

**Varieties:** T. 21 (Early) T. 23, T. 100, T. 17 (Late)

**Grain yield lbs./acre**

<table>
<thead>
<tr>
<th>Year of trial</th>
<th>Early variety</th>
<th>Late variety</th>
<th>General Mean</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single planting</td>
<td>Double planting</td>
<td>Single planting</td>
<td>Double planting</td>
</tr>
<tr>
<td>1934-35</td>
<td>Yield % on G.M.</td>
<td>308 110.4</td>
<td>333 126.3</td>
<td>245 80.7</td>
</tr>
<tr>
<td>1935-36</td>
<td>Yield % on G.M.</td>
<td>319 128.1</td>
<td>487 119.5</td>
<td>316 78.4</td>
</tr>
<tr>
<td>1936-37</td>
<td>Yield % on G.M.</td>
<td>149 65.8</td>
<td>203 86.8</td>
<td>270 118.7</td>
</tr>
<tr>
<td>1937-38</td>
<td>Yield % on G.M.</td>
<td>30 50.4</td>
<td>308 91.7</td>
<td>365 109.8</td>
</tr>
</tbody>
</table>

### Table 3

*Central Rice Research Institute, Cuttack*

**Experiments:** Double transplanting *versus* single transplanting (1948-49)

**Variety:** FR. 43-B (5 month's duration)

<table>
<thead>
<tr>
<th>Yield lbs./acre</th>
<th>T. 1</th>
<th>T. 2</th>
<th>T. 3</th>
<th>Mean</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2301</td>
<td>1646</td>
<td>1848</td>
<td>1926</td>
<td></td>
<td>T. 1—Single planting early with 30 days old seedlings.</td>
</tr>
<tr>
<td>Percentage on control</td>
<td>100 71.5</td>
<td>80.1</td>
<td></td>
<td></td>
<td>T. 2—Single planting late with 60 days old seedlings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T. 3—Double transplanting late with 60 days old seedlings</td>
</tr>
</tbody>
</table>

C.D. at 5 per cent level = 152.5
### TABLE 4

Central Rice Research Institute, Cuttack

Experiment: Double transplanting vs. single transplanting

<table>
<thead>
<tr>
<th></th>
<th>T.1</th>
<th>T.2</th>
<th>T.3</th>
<th>T.4</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949-50</td>
<td>2251</td>
<td>1983</td>
<td>2104</td>
<td>1573</td>
<td>Mean of 3 varieties</td>
</tr>
<tr>
<td>1950-51</td>
<td>2795</td>
<td>2206</td>
<td>2576</td>
<td>2001</td>
<td>Mean of 2 varieties</td>
</tr>
<tr>
<td>Average</td>
<td>2523</td>
<td>1945</td>
<td>2340</td>
<td>1787</td>
<td></td>
</tr>
<tr>
<td>Percentage on control T.4</td>
<td>141.2%</td>
<td>108.8%</td>
<td>131.0%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

T.1—Single planting early in the season with 30 days old seedling (planting date 10th July in 1950-51 and 27th July in 1949-50).
T.2—Single planting late in the season with 60 days old seedling (planting date 10th August in 1950-51 and 10th August in 1949-50).
T.3—Double transplanting late in the season with 60 days seedling (planting date 10th August in 1950-51 and 30th August in 1949-50).
T.4—Single planting late in the season with 30 days old seedlings (planting date 10th July in 1950-51 and 30th August in 1949-50).
APPENDIX VI

Table 1 (a)

Agricultural Research Station, Moratuwa

The yield data of the experiment on the water requirements of rice crop  

<table>
<thead>
<tr>
<th>Treatments</th>
<th>A—1&quot; in 9 days</th>
<th>B—2&quot; in 6 days</th>
<th>C—3&quot; in 9 days</th>
<th>D—4&quot; in 6 days</th>
<th>E—4&quot; in 12 days</th>
<th>F—4&quot; in 18 days</th>
<th>G—Normal for 4 weeks and 4&quot; in 12 days</th>
<th>H—Normal—standing water</th>
</tr>
</thead>
</table>

Yield of grain in lb. per acre

<table>
<thead>
<tr>
<th>Year</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940-41</td>
<td>2772</td>
<td>2783</td>
<td>2599</td>
<td>2731</td>
<td>2422</td>
<td>2702</td>
<td>2880</td>
<td></td>
</tr>
<tr>
<td>1940-41</td>
<td>2661</td>
<td>2710</td>
<td>2653</td>
<td>2232</td>
<td>2612</td>
<td>3025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1939-40</td>
<td>2592</td>
<td>2481</td>
<td>2470</td>
<td>2291</td>
<td>2349</td>
<td>2057</td>
<td>2412</td>
<td>2463</td>
</tr>
<tr>
<td>1939-40</td>
<td>700</td>
<td>3025</td>
<td>3016</td>
<td>2981</td>
<td>3190</td>
<td>2975</td>
<td>3086</td>
<td>3152</td>
</tr>
</tbody>
</table>

Season: First crop
### APPENDIX VI—contd.

**Table 1 (b)**

Agricultural Research Station, Mysore.

The yield data of the experiment on the water requirements of rice crop

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Season: First crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>A—1&quot; minus rainfall</td>
<td>once in 33 days</td>
</tr>
<tr>
<td>B—1&quot; ignoring rainfall</td>
<td>once in 33 days</td>
</tr>
<tr>
<td>C—2&quot; minus rainfall</td>
<td>once in 33 days</td>
</tr>
<tr>
<td>D—2&quot; ignoring rainfall</td>
<td>once in 7 days</td>
</tr>
<tr>
<td>E—3&quot; minus rainfall</td>
<td>once in 7 days</td>
</tr>
<tr>
<td>F—4&quot; minus rainfall</td>
<td>once in 7 days</td>
</tr>
<tr>
<td>G—5&quot; minus rainfall</td>
<td>once in 7 days</td>
</tr>
<tr>
<td>H—6&quot; of water at all times (control)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1943-44</td>
<td>3118</td>
<td>3094</td>
<td>3133</td>
<td>3091</td>
<td>3245</td>
<td>2671</td>
<td>3004</td>
<td>3311</td>
</tr>
<tr>
<td>1944-45</td>
<td>3211</td>
<td>3289</td>
<td>3276</td>
<td>3070</td>
<td>3063</td>
<td>3098</td>
<td>3131</td>
<td>3189</td>
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<tr>
<td>1945-46</td>
<td>2200</td>
<td>2336</td>
<td>2248</td>
<td>2314</td>
<td>2340</td>
<td>2445</td>
<td>2395</td>
<td>2476</td>
</tr>
<tr>
<td>1946-47</td>
<td>2914</td>
<td>2911</td>
<td>3953</td>
<td>2914</td>
<td>2960</td>
<td>2992</td>
<td>3262</td>
<td>2982</td>
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<tr>
<td>Average</td>
<td>2861</td>
<td>2908</td>
<td>2948</td>
<td>2847</td>
<td>2902</td>
<td>2853</td>
<td>2948</td>
<td>2990</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1943-44</td>
<td>2251</td>
<td>2406</td>
<td>2474</td>
<td>2383</td>
<td>2302</td>
<td>2499</td>
<td>2354</td>
<td>2599</td>
</tr>
<tr>
<td>1944-45</td>
<td>2289</td>
<td>2320</td>
<td>2381</td>
<td>2298</td>
<td>2333</td>
<td>2354</td>
<td>2397</td>
<td>2522</td>
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<tr>
<td>1945-46</td>
<td>1870</td>
<td>1977</td>
<td>1932</td>
<td>1464</td>
<td>1472</td>
<td>1692</td>
<td>1562</td>
<td>2033</td>
</tr>
<tr>
<td>1946-47</td>
<td>1558</td>
<td>1587</td>
<td>1372</td>
<td>1430</td>
<td>1502</td>
<td>1381</td>
<td>1442</td>
<td>1963</td>
</tr>
<tr>
<td>Average</td>
<td>1995</td>
<td>2023</td>
<td>2040</td>
<td>1684</td>
<td>1685</td>
<td>2114</td>
<td>1921</td>
<td>2235</td>
</tr>
</tbody>
</table>
Table 2

Paddy Breeding Station, Coimbatore

Season: Single crop

Yield of grain in lbs. per acre

Treatments:  
A—2" in 3 days  
B—3" in 6 days  
C—5" in 9 days  
D—4" in 6 days  
E—4" in 12 days  
F—4" in 18 days  
G—Normal for 4 weeks and 4" in 12 days  
H—Normal—standing water

<table>
<thead>
<tr>
<th>Year</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1938-39</td>
<td>2596</td>
<td>2430</td>
<td>2281</td>
<td>2394</td>
<td>2495</td>
<td>2399</td>
<td>3016</td>
<td>2915</td>
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<tr>
<td>1939-40</td>
<td>2840</td>
<td>2663</td>
<td>2559</td>
<td>2819</td>
<td>2566</td>
<td>2394</td>
<td>2719</td>
<td>2900</td>
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<td>1940-41</td>
<td>2706</td>
<td>1730</td>
<td>1806</td>
<td>2110</td>
<td>2192</td>
<td>1663</td>
<td>1806</td>
<td>1950</td>
</tr>
<tr>
<td>1941-42</td>
<td>4320</td>
<td>3976</td>
<td>3117</td>
<td>4357</td>
<td>3141</td>
<td>2940</td>
<td>3714</td>
<td>4222</td>
</tr>
<tr>
<td>Average</td>
<td>3013</td>
<td>2712</td>
<td>2981</td>
<td>3097</td>
<td>2599</td>
<td>2314</td>
<td>2814</td>
<td>2847</td>
</tr>
</tbody>
</table>
**APPENDIX VI.——cont’d.**

**Table 3**

*Rice Research Station, Nagina (Utar Pradesh)*

Year of trial: 1947

Yield of grain in lb. per acre

<table>
<thead>
<tr>
<th>Treatments/Quantity of water in inches</th>
<th>14 days after</th>
<th>21 days after</th>
<th>28 days after</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0&quot;</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>1606.6</td>
</tr>
<tr>
<td>3&quot;</td>
<td>1438.5</td>
<td>1559.0</td>
<td>1603.1</td>
<td>1558.9</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1735.6</td>
<td>1549.2</td>
<td>1525.0</td>
<td>1603.6</td>
</tr>
<tr>
<td>9&quot;</td>
<td>1735.6</td>
<td>1537.0</td>
<td>1496.8</td>
<td>1529.8</td>
</tr>
<tr>
<td>Mean</td>
<td>1696.6</td>
<td>1497.1</td>
<td>1568.6</td>
<td>1573.5</td>
</tr>
</tbody>
</table>

Year of trial: 1950

<table>
<thead>
<tr>
<th>Treatments</th>
<th>2&quot; after</th>
<th>2&quot; after</th>
<th>2&quot; after</th>
<th>4&quot; after</th>
<th>4&quot; after</th>
<th>4&quot; after</th>
<th>6&quot; after</th>
<th>6&quot; after</th>
<th>Control</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
<td>No irrigation</td>
<td></td>
</tr>
</tbody>
</table>

(Yield in lb. per acre)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2612</th>
<th>2291</th>
<th>2191</th>
<th>2817</th>
<th>2273</th>
<th>2484</th>
<th>3004</th>
<th>2741</th>
<th>2174</th>
<th>2303</th>
<th>2455</th>
</tr>
</thead>
</table>
APPENDIX VII
Central Rice Research Institute, Cuttack

The comparative costs of threshing by different methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Average cost per maund of clean paddy*</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Threshing</td>
<td>Winnowing</td>
</tr>
<tr>
<td>Hand beating</td>
<td>0 3</td>
<td>0 1</td>
</tr>
<tr>
<td>Bullock threshing</td>
<td>0 5</td>
<td>0 9</td>
</tr>
<tr>
<td>Minoru type Japanese pedal thresher</td>
<td>0 2</td>
<td>0 1</td>
</tr>
<tr>
<td>Tyoda type Japanese power thresher</td>
<td>0 3</td>
<td>0 0</td>
</tr>
</tbody>
</table>

*It includes the cost of operations after the produce is brought to the threshing floor. Does not include the cost of bundling which is done in the field.
† Both these are efficient and time saving machines and reduce the cost of threshing considerably. By the aid of either of these machines the threshing operation can be carried out in time.
### APPENDIX VIII

**List of various research stations in different States dealt with and their soils**

#### MADRAS

<table>
<thead>
<tr>
<th>Station</th>
<th>Soils Typology</th>
<th>Nutritional Analysis</th>
<th>Average Rainfall</th>
<th>Rainy Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coimbatore</td>
<td>Clay loam with good drainage. Deficient in $K_2O$ and $P_2O_5$. Average rainfall 24.06 in., in 86 rainy days. Crops mainly dependent on irrigation.</td>
<td>$K_2O$ and $P_2O_5$ are deficient.</td>
<td>24.06 inches</td>
<td>86</td>
</tr>
<tr>
<td>Maruthur</td>
<td>Heavy black clay (Delatite soils). Cracks widely in summer to such an extent that very little preparatory cultivation is necessary. Average rainfall 42 inches.</td>
<td>$K_2O$ and $P_2O_5$ are deficient.</td>
<td>42 inches</td>
<td></td>
</tr>
<tr>
<td>Aduthurai</td>
<td>Sandy alluvium deficient in $N$ and $P_2O_5$, but well supplied with $K_2O$. Average rainfall 42-92 in. on 66 rainy days.</td>
<td>$K_2O$ is supplied.</td>
<td>42-92 inches</td>
<td>66</td>
</tr>
<tr>
<td>Sanalkot</td>
<td>Sandy loam well supplied with available plant nutrients except $P_2O_5$. Average rainfall 37.77 inches.</td>
<td>$P_2O_5$ is supplied.</td>
<td>37.77 inches</td>
<td></td>
</tr>
<tr>
<td>Anakapalle</td>
<td>Coastal sandy loam deficient in $N$ and $P_2O_5$. Average rainfall is 39.23 inches.</td>
<td>$N$ and $P_2O_5$ are deficient.</td>
<td>39.23 inches</td>
<td></td>
</tr>
<tr>
<td>Palur</td>
<td>Alluvial soil rich in all essential plant nutrients except $N$. Average rainfall is 49 inches.</td>
<td>$N$ is the only nutrient that is deficient.</td>
<td>49 inches</td>
<td></td>
</tr>
<tr>
<td>Pattambi</td>
<td>(Rainfed station). Sandy to red ferruginous loams formed mostly from low level laterite. Generally deficient in $P_2O_5$. The crop depends entirely on rainfall which is on an average 105 inches.</td>
<td>$N$ and $P_2O_5$ are deficient.</td>
<td>105 inches</td>
<td></td>
</tr>
<tr>
<td>Tirukkupam</td>
<td>Sandy coastal alluvium. The average rainfall is 39.87 inches in 39.9 rainy days.</td>
<td>$N$ and $P_2O_5$ are deficient.</td>
<td>39.87 inches</td>
<td>39.9</td>
</tr>
<tr>
<td>Pattukottai</td>
<td>Red loam to sandy loam. The analysis reveals that soils are poor in all nutrients except $K_2O$, of which enough is present for Paddy. Average rainfall is 36.45 inches in 54 rainy days.</td>
<td>$K_2O$ is supplied.</td>
<td>36.45 inches</td>
<td>54</td>
</tr>
<tr>
<td>Ambasamudram</td>
<td>Light soils with a predominant coarse fraction. Sandy red loam. Gravely loam. Soils are acidic. Contain fair amount of $N$ and available $P_2O_5$. The available $N$ varies from 0.0 to 0.03 per cent, $P_2O_5$ from 0.006 to 0.005 per cent. Average rainfall is 40.06 inches in 77 rainy days.</td>
<td>$N$ and $P_2O_5$ are deficient.</td>
<td>40.06 inches</td>
<td>77</td>
</tr>
<tr>
<td>Cuttuck</td>
<td>Laterite low land deficient in $P_2O_5$. Average rainfall 56 inches.</td>
<td>$P_2O_5$ is almost entirely deficient.</td>
<td>56 inches</td>
<td></td>
</tr>
<tr>
<td>Berhampore</td>
<td>Black soil with average rainfall of 54.7 inches in 73 rainy days.</td>
<td>$P_2O_5$ and $K_2O$ are deficient.</td>
<td>54.7 inches</td>
<td>73</td>
</tr>
<tr>
<td>Jeypore</td>
<td>Red soil with sufficient available $P_2O_5$. Average rainfall 68 inches.</td>
<td>$P_2O_5$ is supplied.</td>
<td>68 inches</td>
<td></td>
</tr>
</tbody>
</table>

#### ORISSA

<table>
<thead>
<tr>
<th>Station</th>
<th>Soils Typology</th>
<th>Nutritional Analysis</th>
<th>Average Rainfall</th>
<th>Rainy Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chisura</td>
<td>The soil is low land clay loam of alluvial origin and is rich in plant nutrients. The soil approximately contains 0.194 per cent $N$, 1.51 per cent $K_2O$, 0.06 per cent $P_2O_5$ and 1.37 per cent $CaO$. The average rainfall is 58.79 inches.</td>
<td>$N$, $K_2O$, $P_2O_5$, and $CaO$ are supplied.</td>
<td>58.79 inches</td>
<td></td>
</tr>
<tr>
<td>Bankura</td>
<td>Red soil with laterite origin low in $N$ and $P_2O_5$. Average rainfall is 57 inches.</td>
<td>$P_2O_5$ and $K_2O$ are deficient.</td>
<td>57 inches</td>
<td></td>
</tr>
<tr>
<td>Suri</td>
<td>Laterite soil, low in $N$ and $P_2O_5$. Average rainfall is 56.56 inches.</td>
<td>$N$ and $P_2O_5$ are deficient.</td>
<td>56.56 inches</td>
<td></td>
</tr>
</tbody>
</table>

#### BENGAL

<table>
<thead>
<tr>
<th>Station</th>
<th>Soils Typology</th>
<th>Nutritional Analysis</th>
<th>Average Rainfall</th>
<th>Rainy Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chisura</td>
<td>The soil is low-land clay loam of alluvial origin and is rich in plant nutrients. The soil approximately contains 0.194 per cent $N$, 1.51 per cent $K_2O$, 0.06 per cent $P_2O_5$ and 1.37 per cent $CaO$. The average rainfall is 58.79 inches.</td>
<td>$N$, $K_2O$, $P_2O_5$, and $CaO$ are supplied.</td>
<td>58.79 inches</td>
<td></td>
</tr>
<tr>
<td>Bankura</td>
<td>Red soil with laterite origin low in $N$ and $P_2O_5$. Average rainfall is 57 inches.</td>
<td>$P_2O_5$ and $K_2O$ are deficient.</td>
<td>57 inches</td>
<td></td>
</tr>
<tr>
<td>Suri</td>
<td>Laterite soil, low in $N$ and $P_2O_5$. Average rainfall is 56.56 inches.</td>
<td>$N$ and $P_2O_5$ are deficient.</td>
<td>56.56 inches</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX VIII—contd.

ASSAM

Titabar

Old alluvium, deficient in available \( \text{P}_2\text{O}_5 \) and organic matter. Average rainfall is 72.72 inches.

Karimganj

Low lying heavy clay alluvium not deficient in \( \text{P}_2\text{O}_5 \). The average rainfall is over 100 inches.

Saubour

Alluvial soils of heavy texture having a neutral or alkaline reaction and deficient in \( \text{P}_2\text{O}_5 \).

Gaya

Similar to Saubour with some red gravelly soils as well.

Kanke

Red, acid upland and brown low land.

Labhandi Farm (Raipur)

The rice experiments were conducted on (1) Matasi i.e., light sandy loam with 0.005 per cent \( \text{N} \), 0.001 per cent available \( \text{P}_2\text{O}_5 \), and 0.01 per cent \( \text{K}_2\text{O} \), and (2) Dorasi i.e., medium clay with 0.011 per cent \( \text{N} \), 0.005 per cent \( \text{P}_2\text{O}_5 \), and 0.014 per cent \( \text{K}_2\text{O} \).

Adhartal, Richha

Rice experiments conducted on Sella type which is light sandy and represents Jubbulpore district.

BIHAR

Karjat

Coarse sandy, loam 6 in.-18 in. deep, analysing 0.09 per cent \( \text{N} \), 0.02 per cent available \( \text{P}_2\text{O}_5 \), and 0.28-1.0 per cent \( \text{K}_2\text{O} \). The average rainfall is 72 inches.

Kumta

Laterite soil poor in \( \text{P}_2\text{O}_5 \) analysing 0.006-0.009 per cent \( \text{N} \) and 0.04-0.06 per cent \( \text{P}_2\text{O}_5 \). Soils are well drained except in some parts of low lying soils.

Ratnagiri

Rich laterite soil low in \( \text{CaO} \)—analysing 0.01-0.036 per cent \( \text{N} \), 0.10-0.49 per cent \( \text{P}_2\text{O}_5 \), and 0.005-0.008 per cent \( \text{K}_2\text{O} \).

Padegaon

Medium black soil on trap. Soil analysing—0.05-0.06 per cent \( \text{N} \), 0.05-0.08 per cent \( \text{P}_2\text{O}_5 \), and 0.09-0.11 per cent \( \text{K}_2\text{O} \).

MADHYA PRADESH

Kudwan

Clay loam—temperate climate.

MYSSORE

Irwin Canal Farm

Red to brown and consists of several types being composed of stony, gravelly, sandy, loamy and clayey soils. The soil in lower level contains alkaline patches. The pH ranges from 8.0-9.5. Poor in \( \text{N} \) and \( \text{P}_2\text{O}_5 \). Total \( \text{P}_2\text{O}_5 \) is 0.06 per cent to 0.09 per cent. Available \( \text{P}_2\text{O}_5 \) is 0.005 to 0.0005 per cent.

Nagabally

Mixed red loam and red sandy soil. Soil analyse \( \text{P}_2\text{O}_5 \) from trace to 0.11 per cent and \( \text{N} \) from 0.002 per cent to 0.07 per cent.

UTTAR PRADESH

Nagina

Ternai soil, total \( \text{P}_2\text{O}_5 \) low and higher \( \text{K}_2\text{O} \), poor \( \text{CaO} \).

Himayatnagar

Red loam deficient in \( \text{P}_2\text{O}_5 \).
### Appendix IX

*Normal seasonal rainfall in selected rainfall sub-divisions of India*  
*(in inches)*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sub-division</th>
<th>Winter: December to February</th>
<th>Summer: April to September</th>
<th>Monsoon: June to September</th>
<th>Post-Monsoon: October to December</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Assam</td>
<td>2.36 (2.4)</td>
<td></td>
<td>64.23 (65.8)</td>
<td>5.95 (6.1)</td>
<td>97.66</td>
</tr>
<tr>
<td>2</td>
<td>Bengal</td>
<td>1.53 (2.0)</td>
<td></td>
<td>56.71 (74.5)</td>
<td>5.17 (6.9)</td>
<td>76.13</td>
</tr>
<tr>
<td>3</td>
<td>Orissa</td>
<td>1.85 (3.2)</td>
<td></td>
<td>44.40 (98.2)</td>
<td>6.68 (8.8)</td>
<td>56.91</td>
</tr>
<tr>
<td>4</td>
<td>Chota Nagpur</td>
<td>2.57 (5.0)</td>
<td></td>
<td>42.71 (84.4)</td>
<td>2.26 (4.4)</td>
<td>51.18</td>
</tr>
<tr>
<td>5</td>
<td>Bihar</td>
<td>1.26 (4.0)</td>
<td></td>
<td>4.09 (13.1)</td>
<td>2.54 (5.5)</td>
<td>48.21</td>
</tr>
<tr>
<td>6</td>
<td>United Provinces, East</td>
<td>1.53 (3.0)</td>
<td></td>
<td>34.44 (58.0)</td>
<td>2.04 (5.5)</td>
<td>39.13</td>
</tr>
<tr>
<td>7</td>
<td>United Provinces, West</td>
<td>2.76 (7.0)</td>
<td></td>
<td>56.50 (87.8)</td>
<td>0.97 (2.5)</td>
<td>37.50</td>
</tr>
<tr>
<td>8</td>
<td>Punjab, East and North</td>
<td>2.76 (11.5)</td>
<td></td>
<td>18.25 (58.4)</td>
<td>0.37 (1.6)</td>
<td>23.25</td>
</tr>
<tr>
<td>9</td>
<td>Gujerat</td>
<td>0.22 (0.7)</td>
<td></td>
<td>3.16 (9.2)</td>
<td>0.77 (2.4)</td>
<td>32.59</td>
</tr>
<tr>
<td>10</td>
<td>Bazar</td>
<td>1.01 (3.1)</td>
<td></td>
<td>28.10 (37.4)</td>
<td>2.07 (6.4)</td>
<td>32.14</td>
</tr>
<tr>
<td>11</td>
<td>Central Provinces, West</td>
<td>1.47 (3.0)</td>
<td></td>
<td>41.04 (90.4)</td>
<td>1.76 (2.9)</td>
<td>45.41</td>
</tr>
<tr>
<td>12</td>
<td>Central Provinces, East</td>
<td>1.53 (5.0)</td>
<td></td>
<td>46.37 (80.1)</td>
<td>1.99 (3.8)</td>
<td>52.04</td>
</tr>
<tr>
<td>13</td>
<td>Konkan</td>
<td>0.35 (0.3)</td>
<td></td>
<td>102.45 (63.7)</td>
<td>4.75 (4.3)</td>
<td>109.33</td>
</tr>
<tr>
<td>14</td>
<td>Bombay, Deccan</td>
<td>0.52 (1.2)</td>
<td></td>
<td>74.41 (79.4)</td>
<td>3.62 (12.4)</td>
<td>39.87</td>
</tr>
<tr>
<td>15</td>
<td>Malabar</td>
<td>2.73 (2.6)</td>
<td></td>
<td>71.47 (80.5)</td>
<td>16.33 (16.3)</td>
<td>103.74</td>
</tr>
<tr>
<td>16</td>
<td>Madras, Southeast</td>
<td>4.76 (3.6)</td>
<td></td>
<td>12.01 (34.2)</td>
<td>15.80 (39.3)</td>
<td>35.10</td>
</tr>
<tr>
<td>17</td>
<td>Madras, Deccan</td>
<td>0.24 (3.0)</td>
<td></td>
<td>15.25 (64.3)</td>
<td>6.05 (24.2)</td>
<td>24.32</td>
</tr>
<tr>
<td>18</td>
<td>Madras, Coast North</td>
<td>1.69 (4.4)</td>
<td></td>
<td>25.09 (64.3)</td>
<td>10.09 (24.9)</td>
<td>40.16</td>
</tr>
</tbody>
</table>

**Note:** Figures in brackets indicate the percentage of rainfall during the season on the total rainfall of the year.

**Source:** Rainfall of India, a Brief Review by Dr. L. A. Ramdas.
<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengal gram</td>
<td>Cicer aritinum</td>
</tr>
<tr>
<td>Bticeem</td>
<td>Trifolium alexandrinum</td>
</tr>
<tr>
<td>Black gram</td>
<td>Phaseolus vulgaris var, radiatus</td>
</tr>
<tr>
<td>Cholam</td>
<td>Sorghum vulgare</td>
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<tr>
<td>Cotton</td>
<td>Gossypium indicum</td>
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<tr>
<td>Cumbo</td>
<td>Pennisetum typhoideus</td>
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<tr>
<td>Daincha</td>
<td>Sesbania acutaba</td>
</tr>
<tr>
<td>Daincha</td>
<td>Sesbania speciosa</td>
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<tr>
<td>Glangilly</td>
<td>Sesbania hyalina</td>
</tr>
<tr>
<td>Green gram or Mung</td>
<td>Phaseolus vulgaris var glabur</td>
</tr>
<tr>
<td>Horse gram or Kuthi</td>
<td>Dolichos biflorus</td>
</tr>
<tr>
<td>Jute</td>
<td>Coriandrum sativum</td>
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<tr>
<td>Kallangi</td>
<td>Tephrosia purpurea</td>
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<tr>
<td>Lentil</td>
<td>Lens esculenta</td>
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<tr>
<td>Maize</td>
<td>Zea mays</td>
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<td>Allium cepa</td>
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<td>Ptn</td>
<td>Pisum arvense</td>
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<tr>
<td>Pittipentrae</td>
<td>Phaseolus vulgaris var pinnatus</td>
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<td>Rugi</td>
<td>Eclenose straecnta</td>
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<tr>
<td>Rape</td>
<td>Brassica juncea</td>
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<tr>
<td>Red gram</td>
<td>Cajanus indicus</td>
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<tr>
<td>Sena</td>
<td>Cassia angustifolia</td>
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<tr>
<td>Senhemp</td>
<td>Cajanus flavus</td>
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<tr>
<td>Sweet flag</td>
<td>Acorus calamus</td>
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<tr>
<td>Tobacco</td>
<td>Nicotiana tabacum</td>
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<tr>
<td>Waiat</td>
<td>Trillium vulgaris</td>
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</table>