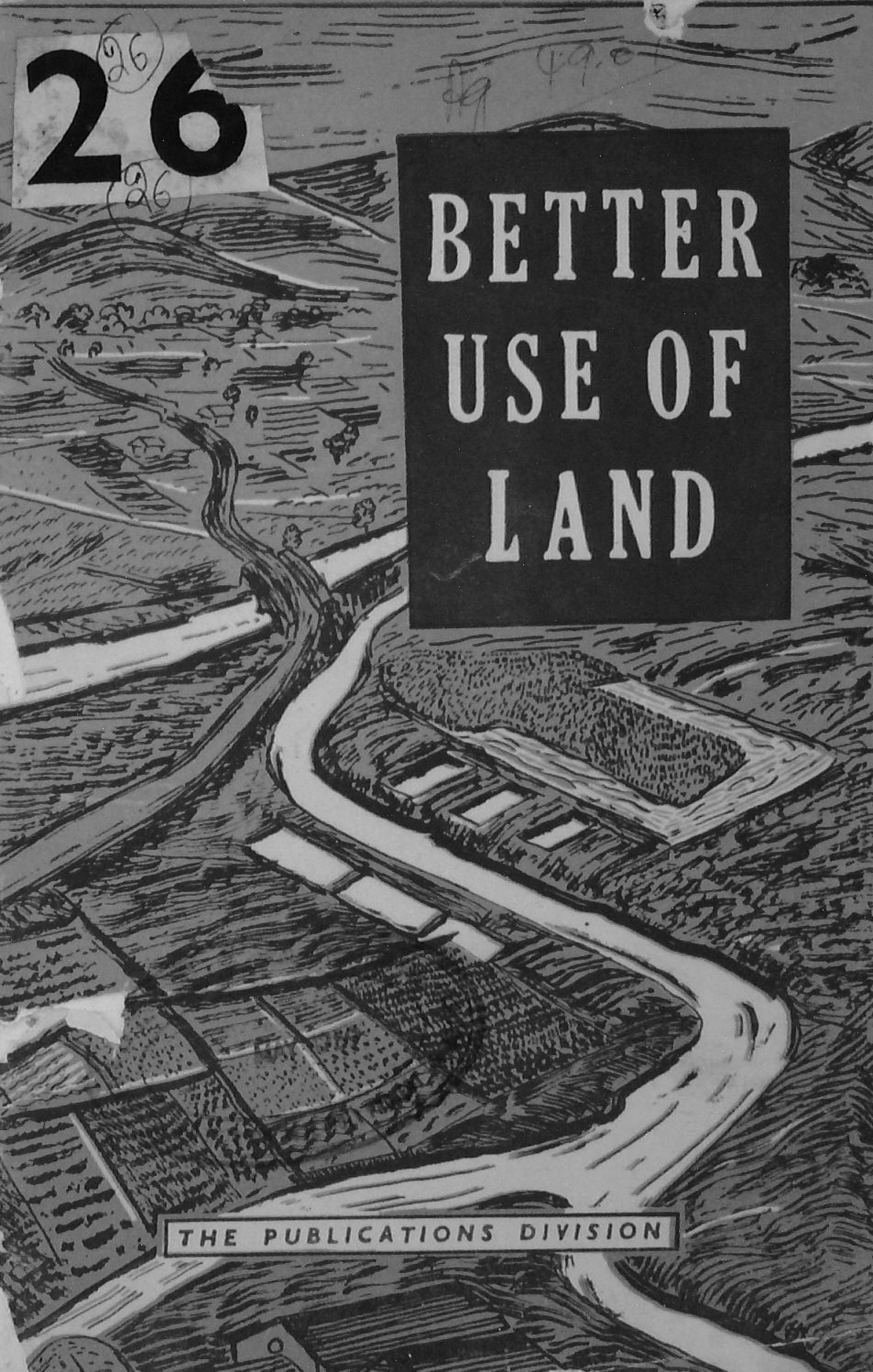


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BETTER
USE OF
LAND

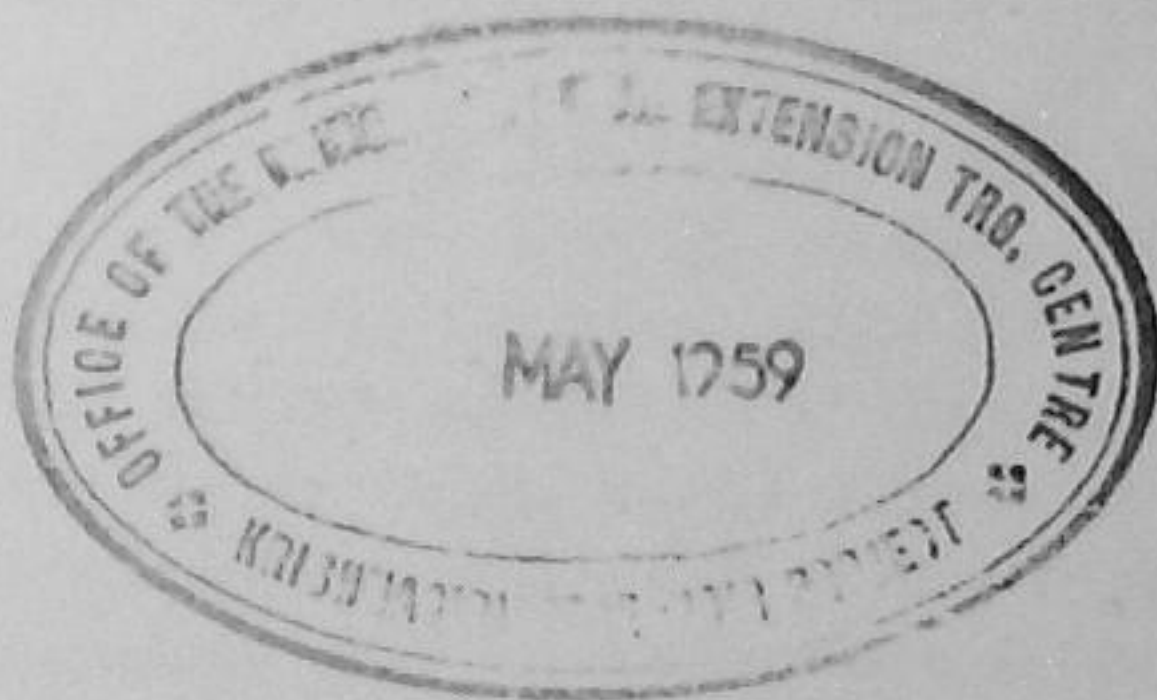
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BETTER USE OF LAND

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Issued on behalf of
MINISTRY OF COMMUNITY DEVELOPMENT
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June 1957 (Jyāistha—Asādha 1879)

Ever since the beginning of time, man and the soil have been linked together. All the man's needs come directly or indirectly from the soil which forms our mother-land and is the store-house of nourishment for all living beings. Good land management is, therefore, the key-note to better living for the individuals as well as the community as a whole. That food production in the East is not keeping pace with the growth of population despite technological possibilities available through the advance of science, is well known.

In India, out of a total area of 811 million acres, some 315 million acres are under cultivation for producing food and other raw materials for the industry. This cultivated area supports nearly 360 million population of the country. If one were to calculate the per capita land available on the basis of the entire population, it will come to .8 acre, and if the population depending only on agriculture is taken into account, the per capita land comes to 1.25 acres. Thus the average size of holding per family comes to about 7.5 acres. Obviously, this is much too small a holding for economic cultivation. The result is that agriculture in its present state cannot sustain the existing pressure of population.

Scattered Holdings

Inequalities in land in respect of productivity, social customs and laws and also non-availability of alternative means of employment have enhanced the process of fragmentation. Scattered holdings result in much waste of time and labour. They make supervision and control irksome and finally render investment under irrigation, drainage and

land improvement difficult, if not altogether impossible. The topography of the fields also adversely affects the consolidation. These conditions are partly responsible for falling productivity.

Stray Cattle and Land Erosion

Numberless goats and cattle denude the countryside of all vegetation. Many pastures have been ploughed up to provide food for the man, and the remaining pastures are overgrazed and unsystematically managed. The practice of letting loose numerous cattle after the harvest of the main crop prevents the wider adoption of double or multiple cropping. There is a great scarcity of fuel, resulting in the burning of cow-dung and crop residues, which should have been better utilised for maintaining the fertility of the soil. High humidity and temperature destroy the organic matter in the soil and leave the land poorer. The water, which is a limiting factor to our expanding agriculture, sometimes causes erosion, water logging and salinity. There are areas where wind erosion also accounts for a heavy toll on the productive capacity of the land.

Land Use Planning

These are the limitations with which Indian agriculture is broadly faced. It is, therefore, necessary that the planning in the scientific use of land be taken up as quickly as possible not only to feed our people and the cattle but also to balance the economy. This is also essential for financing the large-scale programmes being taken up to develop the country.

This re-planning of our land use will consist of the following:—

- (1) Consolidation of holdings.
- (2) Soil and water conservation measures.
- (3) Re-alignment and re-modelling of water course to increase the efficiency of irrigation and drainage and to accelerate the wise use of water.
- (4) The classification of land according to its suitability.

bility for different crops, and adoption of better land use methods.

- (5) Reduction in the number of marginal holdings and provision of adequate credit facilities coupled with savings campaigns and reduction in unproductive social expenditure.

CONSOLIDATION OF HOLDINGS

Fragmentation of holdings has been, to a large extent, responsible for the backwardness of our rural areas in general and for unintelligent use of our soil in particular. In the villages, where consolidation of holdings has not taken place, a farmer may own land in half a dozen or more small strips, widely scattered. He cannot afford to fence all these, nor can he bring them under improved methods of cultivation. Irrigation often becomes uneconomical. Time and energy are wasted in going from one field to another. Feuds occur frequently. After consolidation the village presents a new picture altogether. Since fragmented holdings are put together and converted into blocks, fewer wells, tube-wells, and pumping sets can irrigate a larger area; investment on irrigation, drainage and land development becomes worth-while. Out of the common pool of land roads, channels and drains can be demarcated. Sites can be set apart for schools, play-grounds, libraries, dispensaries, panchayat-ghars and compost pit etc. Grazing grounds and fuel plantations can also be provided.

Most of the State Governments have taken up land reforms wherein the Zamindaris and Jagirdaris have been abolished. The farmers have been given the ownership of land. This is the time when consolidation of holdings can be taken up with the best advantage.

Mayadas in his book 'Between us and Hunger' says :

"Economists calculate that the income from farming compact holdings is 20 per cent higher than that from equivalent scattered or fragmented ones. Expenditure on cultivation or tillage increases by 5.3 per cent for every 500 metres of distance that men and bullocks have

to travel; by 20 to 35 per cent on transport of manure, and 15 to 25 per cent on transport of crops.

It is not possible to make any accurate calculation of the additional production of foodgrains which an increased income, due to consolidation, represents. But take a family of 4 persons whose holding has been consolidated: Let us assume that before consolidation the holding was divided into 4 fragments, each 0.8 of an acre in area and separated each from the other by an average distance of 150 yards. These assumptions will be found to be reasonably within the average conditions prevailing in a State like Uttar Pradesh. Now suppose that the family of 4 had, before consolidation, a net income of Rs. 20 per month exclusive of the value of the grain they produced and ate. This means that the total value of produce sold by the family, apart from what they ate or otherwise consumed from the produce of their fields, was, excluding production expenses, roughly worth Rs. 240 per annum. Assuming that half of this represents receipts from foodgrains, at an average price of Rs. 15 per maund, this would represent 8 maunds of surplus grain sold. With the same fields consolidated and assuming an increase of net income by 25 per cent, there is now 10 maunds of foodgrains available for sale each year. Translating this increase to overall figures; if all the 224 million acres under food crops in India today were consolidated, the additional production would be as much as 5 million tons".

Precautions Necessary

Prior to taking up consolidation work, it should be ensured that indiscriminate cutting and felling of trees in the holding is prevented and compensation of trees is fixed in consultation with the village panchayats. Consolidation disputes should also be settled within a reasonably short period, as pending these, no development work can take place.

The consolidation of holdings done in Pepsu, now Punjab, has shown that a period of one year is required to

complete the entire process of consolidation work under normal conditions. The cost of consolidation comes to Rs. 4/8/- per acre, excluding the labour provided by Village Panchayats. The following will show the requirement of staff:—

1	625	acres	1 Patwari	Rs. 25-1-35
2	3000	acres	1 Kanoongo-cum-Inspector	Rs. 50-3-80
3	12000	acres	1 Assistant-Consolidation Officer (Naib-Tehsildar)	Rs. 125-300
4	50000	acres	Consolidation Officer	Rs. 270-420
5	2,00,000	acres	Settlement Officer	Rs. 350-850
				plus Rs. 75/- Special Pay

This has been given only as an instance. The experience gathered in States of Bombay, Uttar Pradesh, Punjab, Andhra and Pepsu can be made best use of.

SOIL AND WATER CONSERVATION

The severe erosion of soil, particularly in hilly, undulating tracts, is responsible for the loss of fertile top soil. Large areas in Bombay, Hyderabad, Assam and some other parts of the country have suffered badly in this manner. Contour bunding and terrace cultivation are necessary for the reclamation of undulating eroded land. Such areas should be surveyed to locate compact blocks of eroded soils and contour bunding or terrace cultivation should be practised. Land development and soil conservation measures of this type should be organised on the basis of complete watersheds and not for individual holdings.

Heavy gully erosions have also thrown out of cultivation large areas on the banks of some of the rivers that traverse the soft alluvial tracts of Northern India. The severity of the erosion of this kind has only to be seen to be believed. Hundreds of thousands of acres, out of the deep ravines, are found eroded along the banks of rivers like Mahi, Chambal, and Jamuna etc. The reclamation of such deeply eroded lands by mechanical means or paid labour is a very costly

proposition. Where landless labourers are available in abundance, they may be found willing to reclaim such eroded land, if it is allotted to them and assistance is given to them by way of providing bullock power, seeds, fertilizers, manures, etc., for bringing under cultivation the land which they may gradually reclaim with their limited resources. Reclamation of this type should invariably be accompanied by proper anti-erosion measures in the adjoining cultivated lands to prevent further erosion.

In Rajasthan, Kutch and parts of Uttar Pradesh and Saurashtra, the gradual extension of desert conditions has driven large areas out of cultivation. The prevention of the march of desert is necessary for reclamation of such land. Planting of belts of quick-growing trees will stem the expansion of the desert areas. The trees selected for planting should be such as can grow well on poor soil and withstand low rainfall conditions and continued shortage of soil moisture. For the names of suitable trees, the assistance of the Desert Afforestation Research Station, Jodhpur, or of State Forest Departments should be sought.

In some areas, hill slopes denuded of forest cover, will require attention. In such cases, trees should be planted in contour trenches dug on hill-sides across the slope. If the soil is highly eroded and unfit for the growing of field crops, the planting of belts of leafy trees, which will protect soil from the impact of heavy rain, should be resorted to. Trees firmly hold the soil and add humus, thereby helping water conservation and increasing soil fertility. Trees should also be planted on boundaries of fields and around irrigation wells. The trees should be such as would meet the requirements of the farmers in respect of fuel, fodder, timber, green manures, fruits and shade for cattle. In addition, there are areas where cultivation of crops is not at all a practical proposition. The same can be afforested to check soil erosion and to provide fuel and timber requirements of the community.

In many areas the reclamation and rejuvenation of village grazing lands is urgently called for. Grazing and tree cutting in village commons has been so continuous,

indiscriminate and merciless that these so called grazing lands are today no better than treeless, grassless wastes during a greater part of the year. They are merely exercising grounds for cattle, providing, if any thing, a small quantity of poor quality grass during the rainy season and one or two months after. Village pasture lands should be reclaimed and improved by arranging rotational grazing. The areas concerned should be divided into compartments. Cattle should be allowed to graze on them by turn, allowing time for the re-establishment of grass. Seed of suitable fodder grasses and leguminous plants should be obtained from the local Agricultural Departments and sown in these fenced plots to improve the nutritive value of the grass cover.

Proper soil conservation and reclamation of land is absolutely necessary. Contour-bunding, terracing, compartment-bunding, contour-ploughing, strip-cropping and proper manuring are the principal measures that should be adopted in this connection. Provision of proper drainage in the rainy season and repeated cultivation in the summer months will prevent soil becoming weedy again.

WISE USE OF WATER

The total water resources have been estimated, allowing for usual evaporation, percolation and transpiration, as approximately 1,350 million acre feet. This quantity is sufficient to provide, if necessary, 50" of water for every acre of land that is cultivated in India. An enlarged utilisation of the water resources for expansion of agriculture already forms an integral part of the first and second Five Year Plans which provide for an increase of 76 per cent in irrigated area (from 50 to 88 million acres) against an outlay of Rs. 2,300 crore. The importance of water can further be appreciated from the fact that once water is provided to land, its price is increased nearly five times.

Though water is so precious, its waste is appalling. In humid areas there is a loss of more than one-third of our annual rainfall through run-off, and at the same time farmers

elsewhere in the country suffer severe crop losses because of inadequacy of rainfall. In many irrigated areas, half of the water diverted from the rivers and streams is lost in conveyance and half of the water given to the fields is lost before it gets to the roots of the plants. Moreover the water that reaches the roots of the plants does not yield optimum benefit due to variations in fertility from field to field.

If the maximum utilisation of water, from the time when the rain falls and snow melts and until the water finds its way again to the sea, is to be achieved, water management must start with an appreciation of the special requirements of each type of land, and the implementation of measures for the conservation of water and the prevention of erosion. The latter especially, results in sedimentation which silts up reservoirs and increases the cost of desilting canals. Water management and development are intimately connected and are inseparable from land management and its use. An important feature of this part is soil conservation. This is needed wherever water is used.

It is widely, though incorrectly, believed that once irrigation water has been provided, permanent stability and prosperity result. In fact, the provision of irrigation water creates new problems with which the farmer is not often familiar. Drainage to a greater or a lesser degree is a necessary part of irrigation system. Seepage from canals, surface run-off and deep percolation from lands contribute to the accumulation of water in lower areas and cause water logging and salinity.

The soil conservation practices, to conserve moisture on the one hand, and supplementary irrigation, for securing maximum quality production on the other, are, therefore, called for. Water conservation, watershed protection, flood protection and development of small irrigation projects are interrelated and unless a co-ordinated approach is made, full benefits from water cannot be achieved. The machinery for such co-ordination as well as securing village participation and the rational utilisation of water already exists in the form of community projects.

From the view point of the practical implementation and rational utilisation in its twin aspects of water management and water development, two further factors have to be borne in mind. An examination of the figures of gross and net irrigated areas reveals that in India, in only about 10 per cent of the land under irrigation, more than one irrigated crop is raised. The performance of different States in this respect varies considerably, as will be observed from the following table :

Area Irrigated More than Once
In million acres

<i>Name of the State</i>	<i>Gross area irrigated</i>	<i>Net area irrigated</i>	<i>Area irrigated more than once</i>
(1)	(2)	(3)	(4)
U.P.	12,800	11,957	843
Madras	5,410	4,412	998
Punjab	5,144	4,817	327
Pepsu	2,283	1,786	497

A detailed examination of district figures of irrigation in each State will reveal the gaps in the utilisation of water.

The specific steps to be taken for obtaining optimum agricultural production from the point of view of the present rational utilisation of water resources that might be suggested are :—

(1) De-silting of canal water.

(2) Adjusting the size of irrigation plot according to the ground fall. In Lower Bhawani Project, Madras, it has been found that the size of the plot may be 2 cents. in the case of ground fall of 1 in 200; 1½ cents where the fall varies from 1 in 200 to 1 in 100; and 1 cent or less with steeper falls.

(3) Shortening of too long water courses in sandy areas to avoid loss through seepage.

(4) Providing separate water courses for high and low

lands to prevent interception of water by more favourable lands at the expenses of the less favourable ones.

(5) Studying the operation of distribution and the management of water distribution to improve the efficiency of irrigation.

(6) Levelling of the fields and consolidation of the bunds to reduce the loss of water through seepage and leakage.

(7) Introducing block system of irrigation where compact blocks under the same crop are planted and harvested at the same time. This will avoid delay in planting of the succeeding crop and speed up water utilisation through timeliness of operation.

(8) Educating farmers to grow two different irrigated crops in separate blocks so that the peak demand for the water is reduced and its consumption properly utilised.

(9) Introducing and educating farmers in fuller exploitation of water through heavy fertilisation of land.

(10) Organizing of co-operative marketing system for the speedy disposal of the farm produce to secure better prices which will induce farmers to use large quantities of irrigation water and fertilisers.

(11) Preparing advance calendar programmes for making irrigation water available to farmers in time and consequently to obtain fuller utilisation of the same.

(12) Making canal banks suitable for all weather traffic and linking them with the existing thoroughfares to improve the communication which helps in a speedy transport of the produce from the field to the thrashing store and from the village to market. This serves as an incentive for production of crops and consumption of more water.

WISE USE OF LAND

To obtain maximum crop production from land, it is necessary that our land resources are classified according to their suitability for different crops. There will be, for example, areas where paddy crop can be grown with advantage, but there are now considerable areas where precarious crops of paddy are unwisely raised. There will be other

areas which can produce better maize, millet, wheat, gram, etc. There will still be areas where only one crop can be grown like maize, kulthi, jowar, arhar, etc. There are some black soils in Hyderabad, Madras and Bundelkhand (U.P.) which are better suited to cotton. A survey has, therefore, to be made with particular reference to the suitability of the soil for growing particular crops, and accordingly programmes should be drawn up to encourage cultivation of these crops. If it is not done, the crop planning will remain defective, and it will not be possible to obtain maximum results.

Under wise land use, while the soil produces most of that crop for which it is best suited, it does not deteriorate in its fertility. The first and foremost question in this respect is one of maintaining the fertility of the soil. Because fertility of land is low, the average farmer cannot save enough money for investing on the development of agriculture. The non-availability of alternative fuels and the lack of means of purchasing these fuels compel a large number of farmers to burn cattle-dung as fuel though they are quite aware of the value of dung as manure. They are caught in the vicious chain of falling fertility and falling production.

Fertilizers

In recent years, some of our farmers have discovered that the only way out of this dilemma is the use of fertilizers for increasing crop production. It is because of this that extensive credit facilities are provided for the purchase of fertilizers and fertilizer-promotion campaigns are launched.

Though the consumption of fertilizers in the country is now gradually increasing, still compared with some other advanced countries of the world, our level of consumption is negligible. The cultivated area of Europe is only 10 per cent larger than that of India, but the fertilizer consumption in Europe is 80 times that of India. The cultivated area in India is 27 times that of Japan, but the fertilizer consumption of Japan is nearly 10 times that of India. This

shows the extent of our backwardness in the matter of fertilizer utilisation and the opportunities that we are missing for the rehabilitation of Indian agriculture.

The most striking thing about Indian fertilizers is that we use very little quantity of phosphatic fertilizers. In Europe, the quantity of phosphoric acid or potassium oxide consumed is much more than the quantity of nitrogen. In India, mostly nitrogenous fertilizers are in common use. In Japan, large quantities of phosphoric acid or potassium oxide are used along with the nitrogenous fertilizers as may be seen from the following ratios of consumption :

	<i>Nitrogen</i>	<i>Phosphoric Acid</i>	<i>Potassium oxide</i>
Europe	2.3	2.9	3.0
Japan	4.5	3.1	2.1
India	8.0	1.6	0.5

In India, not only we use much less fertilizer but we also use it in a very unbalanced manner. If only one element is applied to the soil there will soon be no response or very low response because of the deficiency of other plant nutrients. Some farmers, who have used only nitrogenous fertilizers for a period of five years or more, complain that their yields are declining even though they are applying more fertilizers to the soil than before. Many of these cases are due to the non-application of phosphatic fertilizers and, in some cases, of potassium also.

Often, experiments on Government farms show that it is not necessary to apply phosphatic or/and potassic fertilizers, but when similar experiments are repeated on farmers' fields, it is found that the application of phosphatic or/and potassic fertilizers is necessary. A very large number of experiments have been carried out on farmers' fields and they have emphasized the anomaly between the results on the farmers' fields and Government farms.

The explanation for these differences is very simple. On Government farms no cow-dung is allowed to be burnt and all of it goes for application to the land. Moreover,

green manuring, rotations of crops and use of composts are much more widely prevalent on Government farms than on the average private farm. These practices prevent the depletion of soil fertility on Government farms, but the situation is quite different in the case of farmers' fields.

One often comes across the argument that it is best to apply cattle-dung and to bury the green manure; and if this is done, no fertilizer is required for the land. This ideal, however, is not practicable for most farmers. There is not enough dung to go round, and in many places the farmers cannot apply any green manure for a variety of reasons.

With the application of balanced fertilizers, the fertility of the soil improves. In fertilized fields, the grain as well as straw production increases. The latter particularly benefits cattle, and the quantity of dung also increases. In fertilized fields, not only the crop above ground grows luxuriantly, but also the roots below ground which are not visible. In fertilized fields, more stubbles and roots are left in the soil than in unfertilized fields, leading to improved soil fertility.

One often comes across cases where the application of low doses of fertilizers is found uneconomic, due to which the owners conclude that it is not worth-while trying out the higher doses. Where the higher doses have been tried out, it is often found that such doses are profitable, because the increase in yield is much more than what was expected. Such data are available with all the Departments of Agriculture and it will be very educative to the Extension Workers as well as farmers if leaflets based on this data are prepared and distributed. Just as it is wrong to waste the farmer's money by recommending an unwarranted high dose, it is equally wrong to hold up his progress by recommending too conservative a dose.

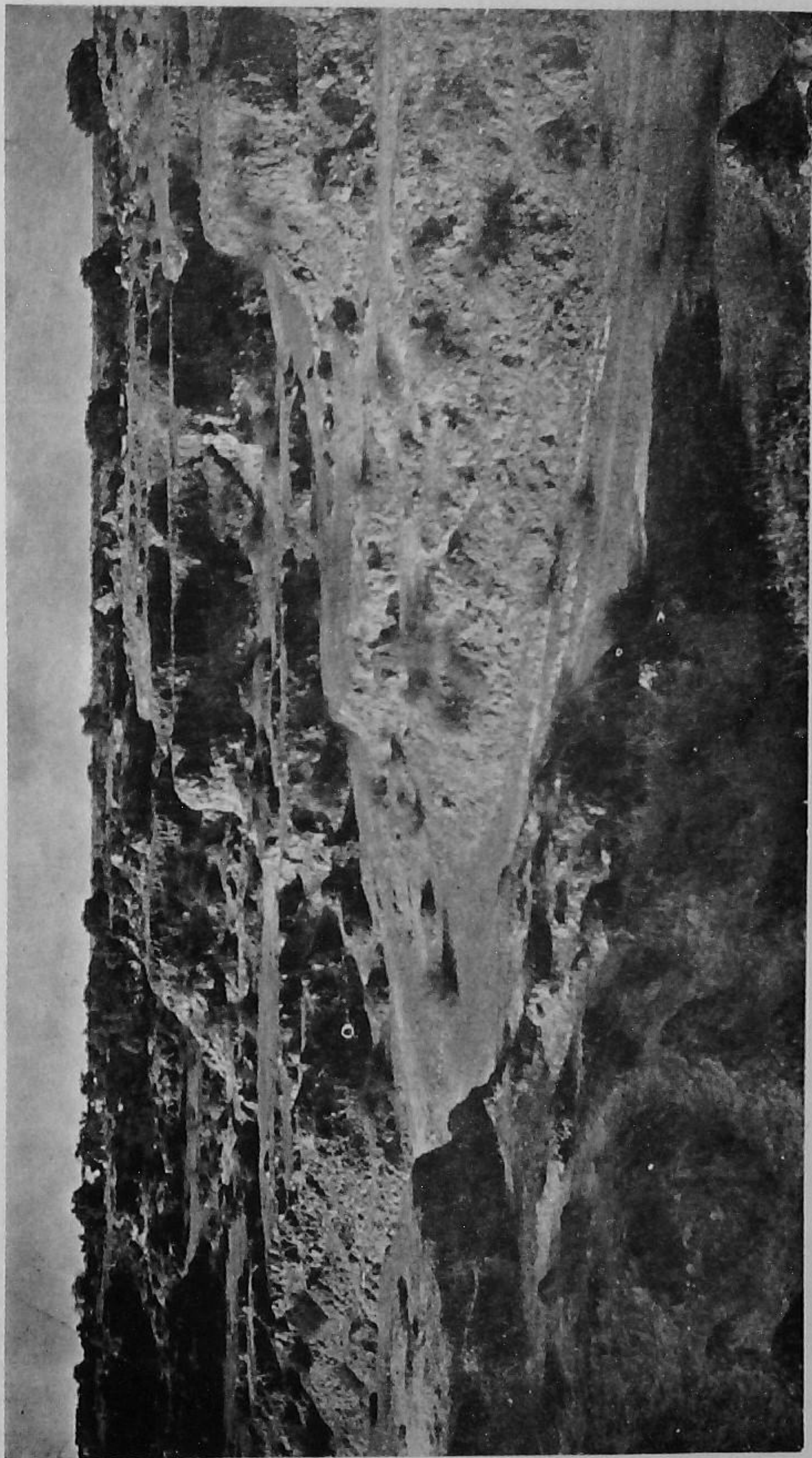
Many a time it is thought that the use of fertilizer should be limited to irrigated land or areas which have adequate rainfall. This is incorrect. Even in areas of inadequate rainfall fertilizer application can yield profits under the dry farming conditions. Both phosphate and potash hasten the maturity of the crop and reduce the water requirements of

the plant, thus increasing the yield under any farming conditions. Both these fertilizers are not likely to be lost from the soil under such conditions. In the dry farming areas, an application of a small quantity of nitrogen can even give spectacular results, provided phosphatic fertilizers are also applied. Fertilization of legumes including green manures with phosphates at the time of their sowing has given spectacular benefits. This is a relatively new and uncommon practice and needs to be popularized.

Farmers often think of giving up growing of such crops as require heavy irrigation or where the cost of irrigation is very high, and there is a fall in the price of the crops. Under such conditions, if larger doses of fertilizers are used, though the total cost of irrigation will go up slightly, the production often will increase substantially, making it worthwhile for the farmer to produce the crop. Where water is expensive or limited, the most profitable use of the water can be made only when the crop is adequately fertilized. Extension workers should work out the economics before the cultivation of an irrigated crop is abandoned or before the use of fertilizers is given up.

Farmers are reluctant to use fertilizers till good rains are received. When such rains are received, it is not uncommon to find that the fertilizers they need are not available in adequate quantities nearby and have to be transported at high cost. Roads often become impassable during the rainy season. It should be the duty of the Extension Organization to educate the farmers to place their orders in time and keep their needs in stock. Facilities should, however, be provided for returning substantial quantities of the unconsumed fertilizers or for extending the period of repayment of loans on quantities of fertilizers carried forward to the next year because of the failure of the monsoon. If such arrangements can be made, a timely supply of fertilizers can be arranged for nearly every farmer and there will be no shortages and failures in the supply organization.

Arrangements have been made for supplying the fertilizers to farmers on credit either through credit co-operative



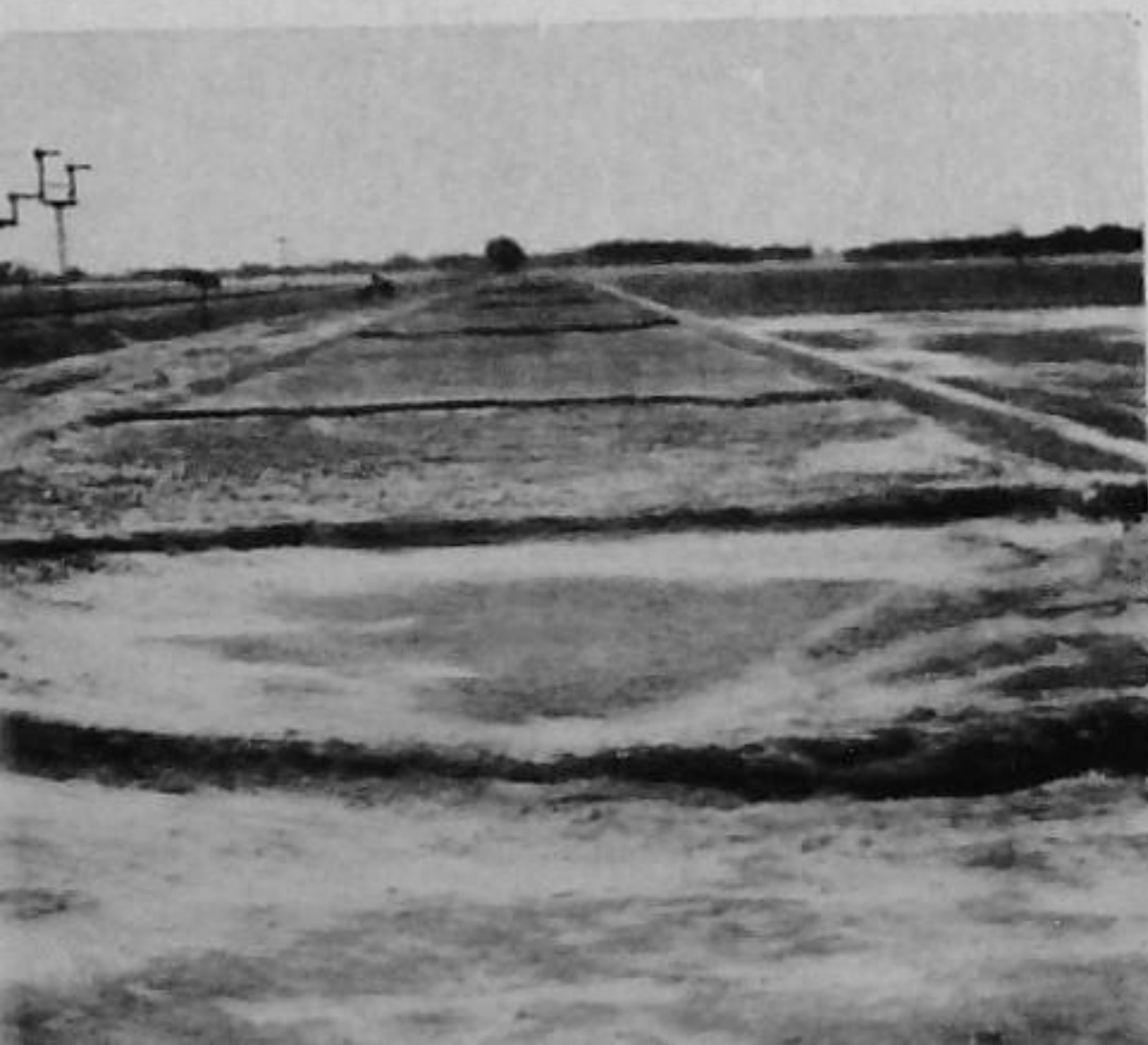
Gully erosion in Jhansi (U.P.)



Wind eroded
slopes in Bom-
bay's Southern
Circle being ter-
raced for affore-
station

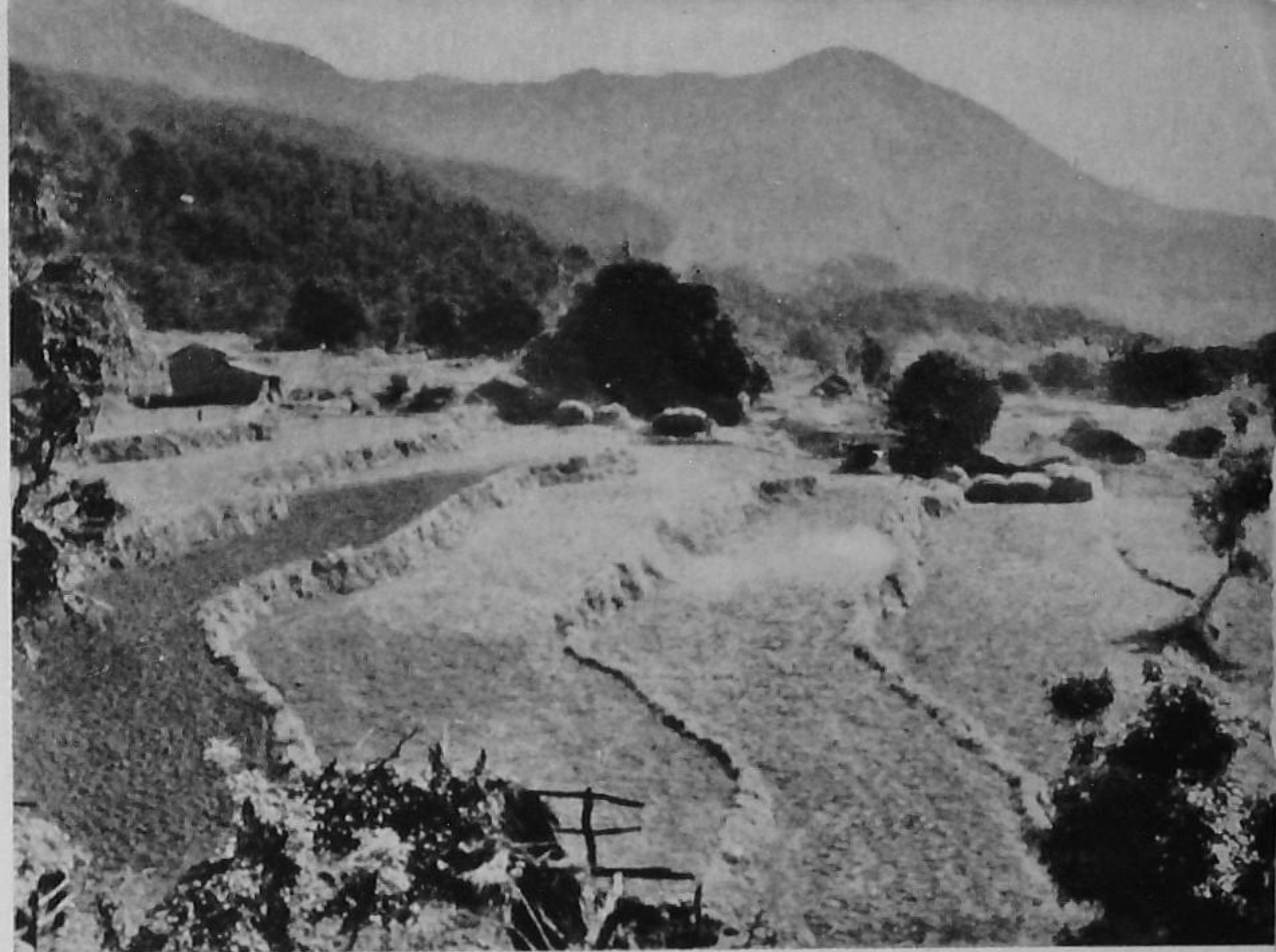


Contour planting

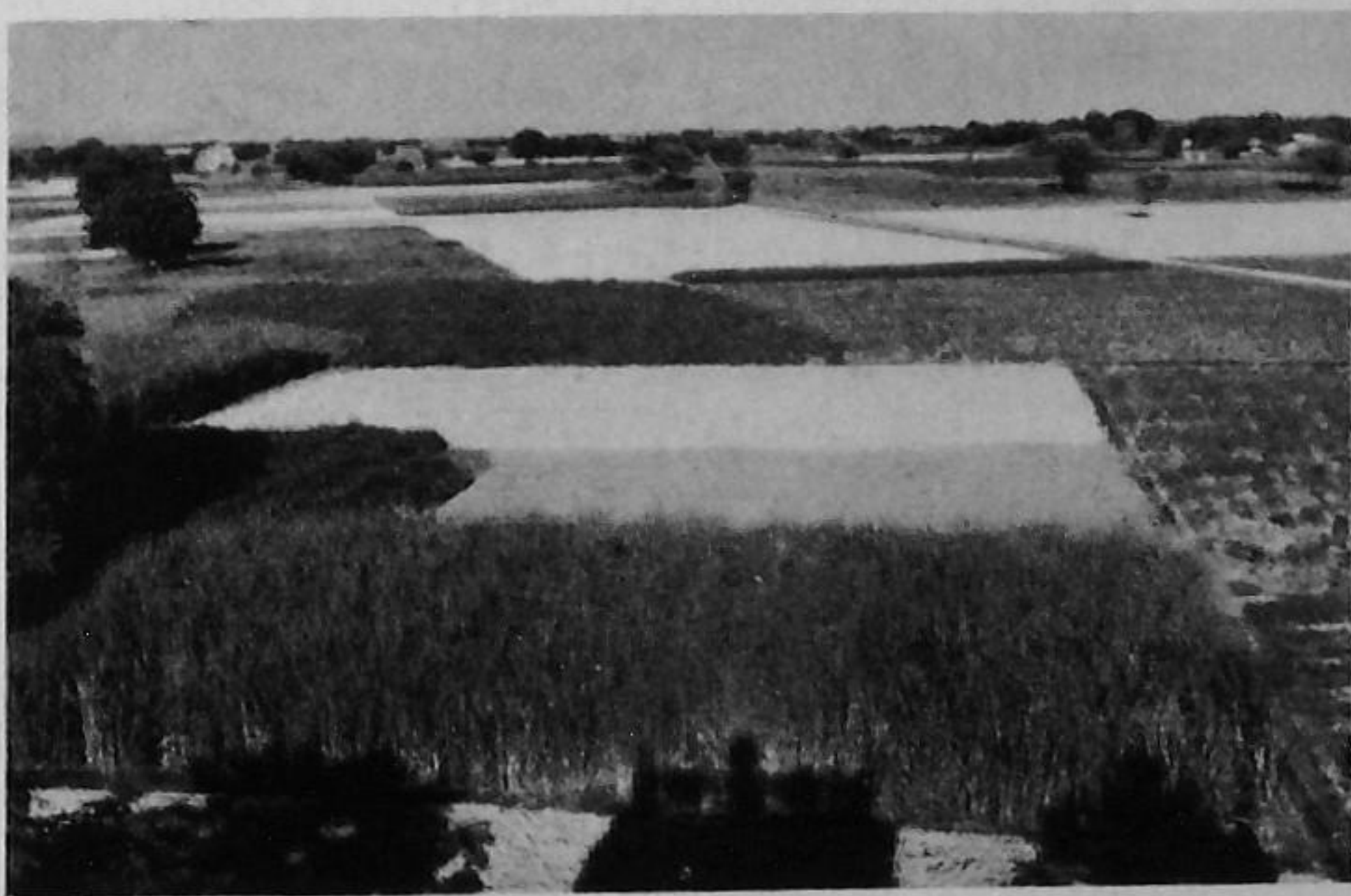


Compartment bunding for
conservation of rain water





Terraced fields for paddy cultivation in hill tracts

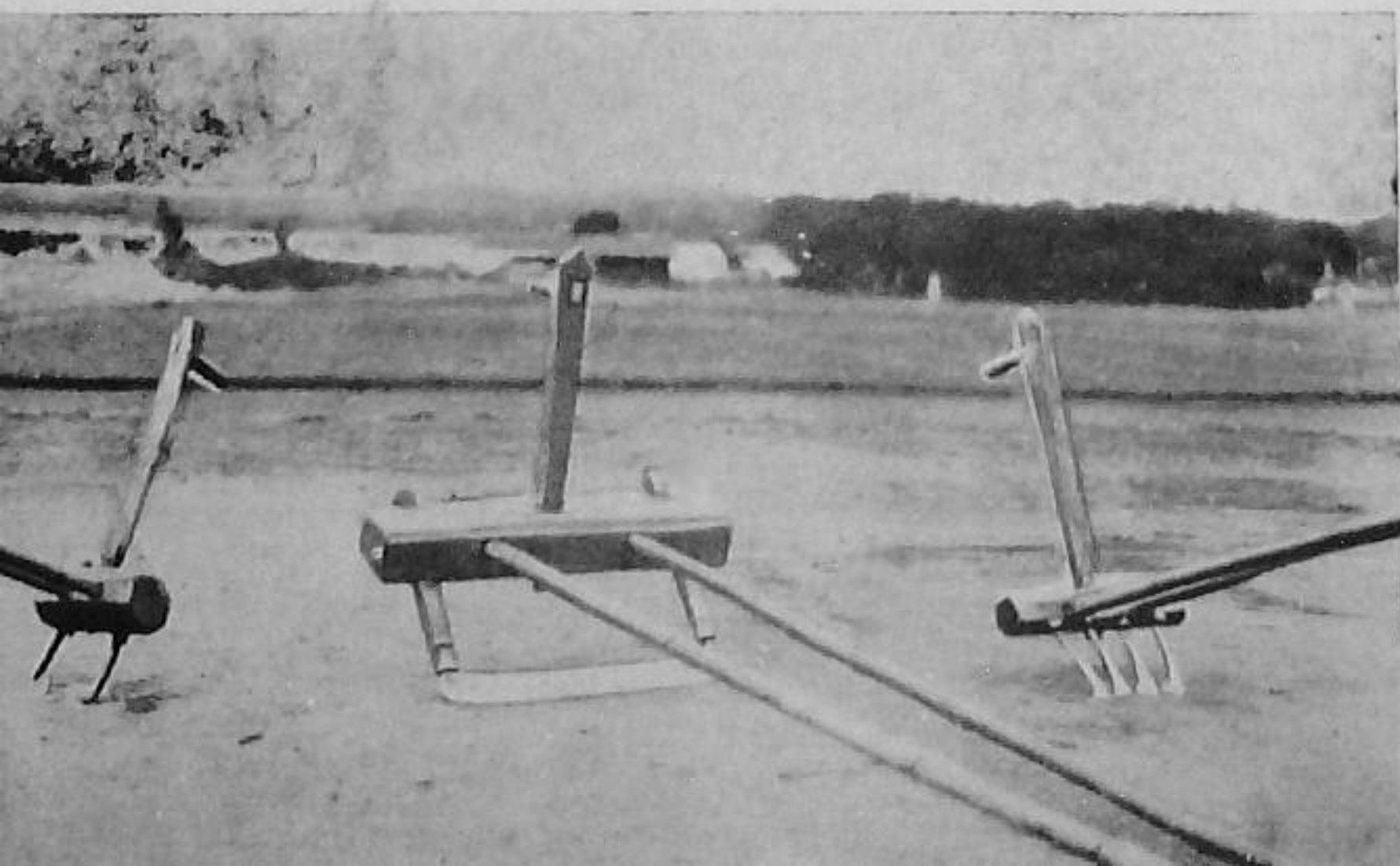
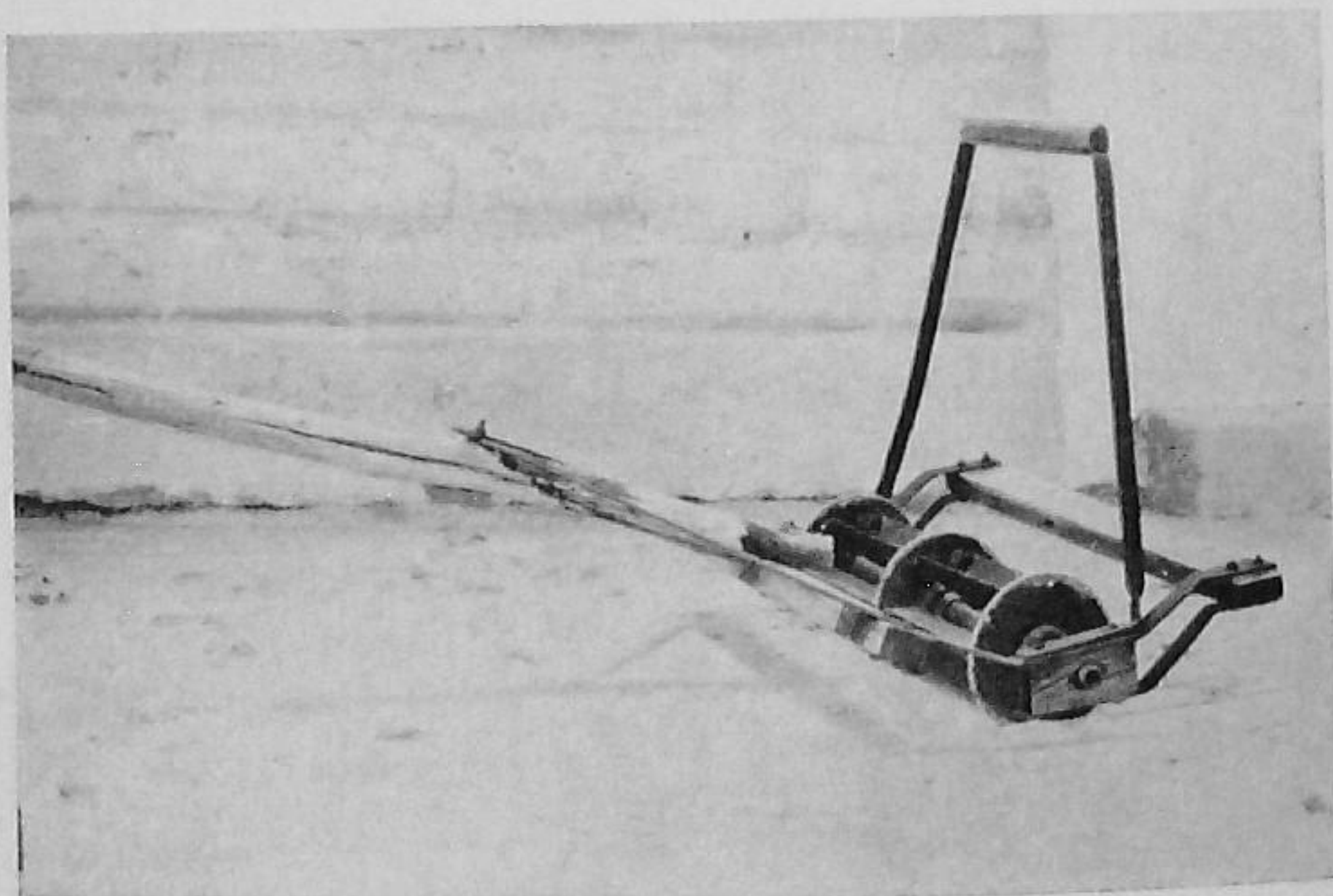


View of crops in a piece of land brought under consolidation



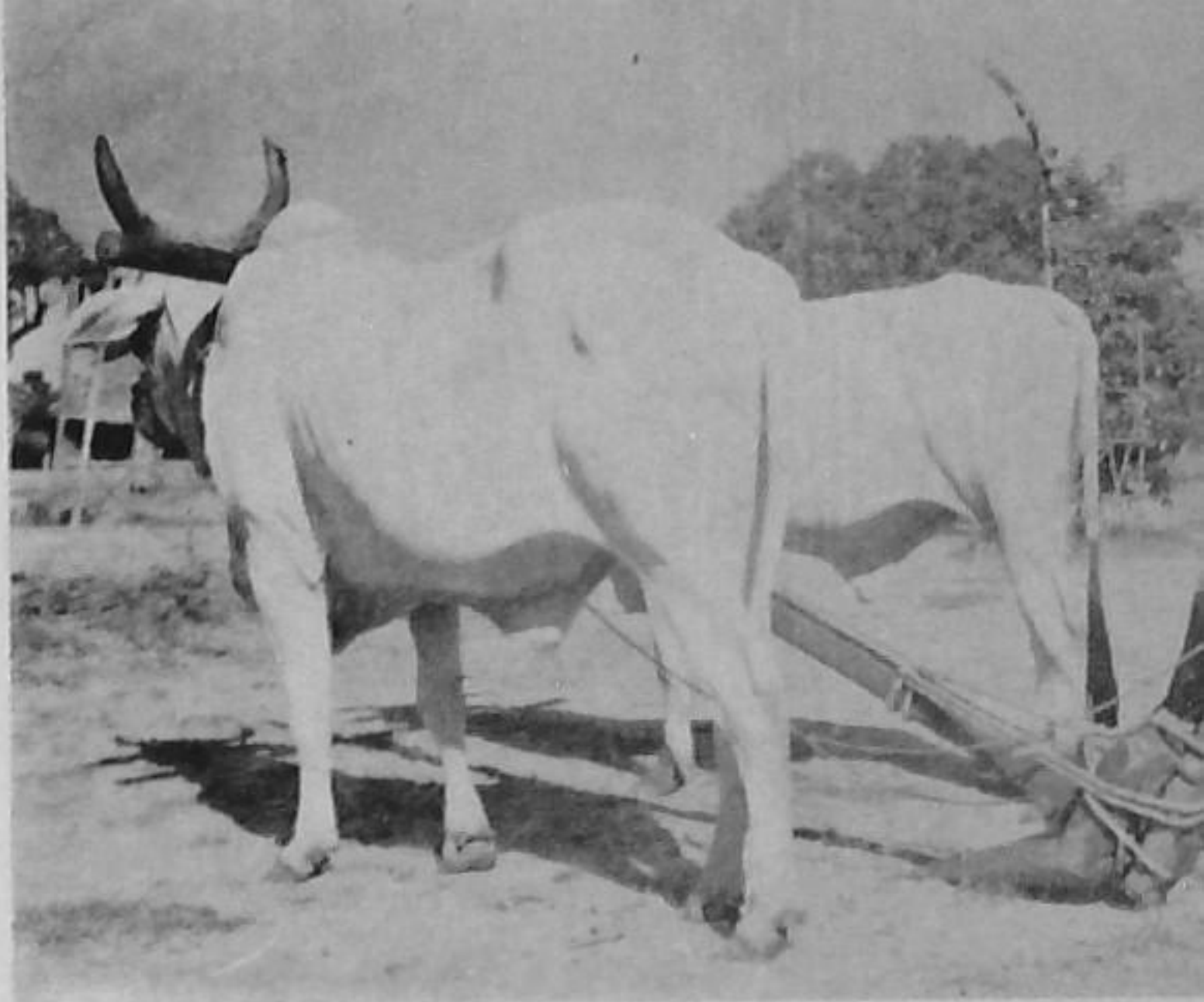
*Ridging plough
at work*

*Green manure
trampler for
paddy fields*



*Split blade hoe (left),
Bakhar or blade har-
row (centre) and
tooth-hoe (right) in
common use in black
soils in Central India
and Deccan.*

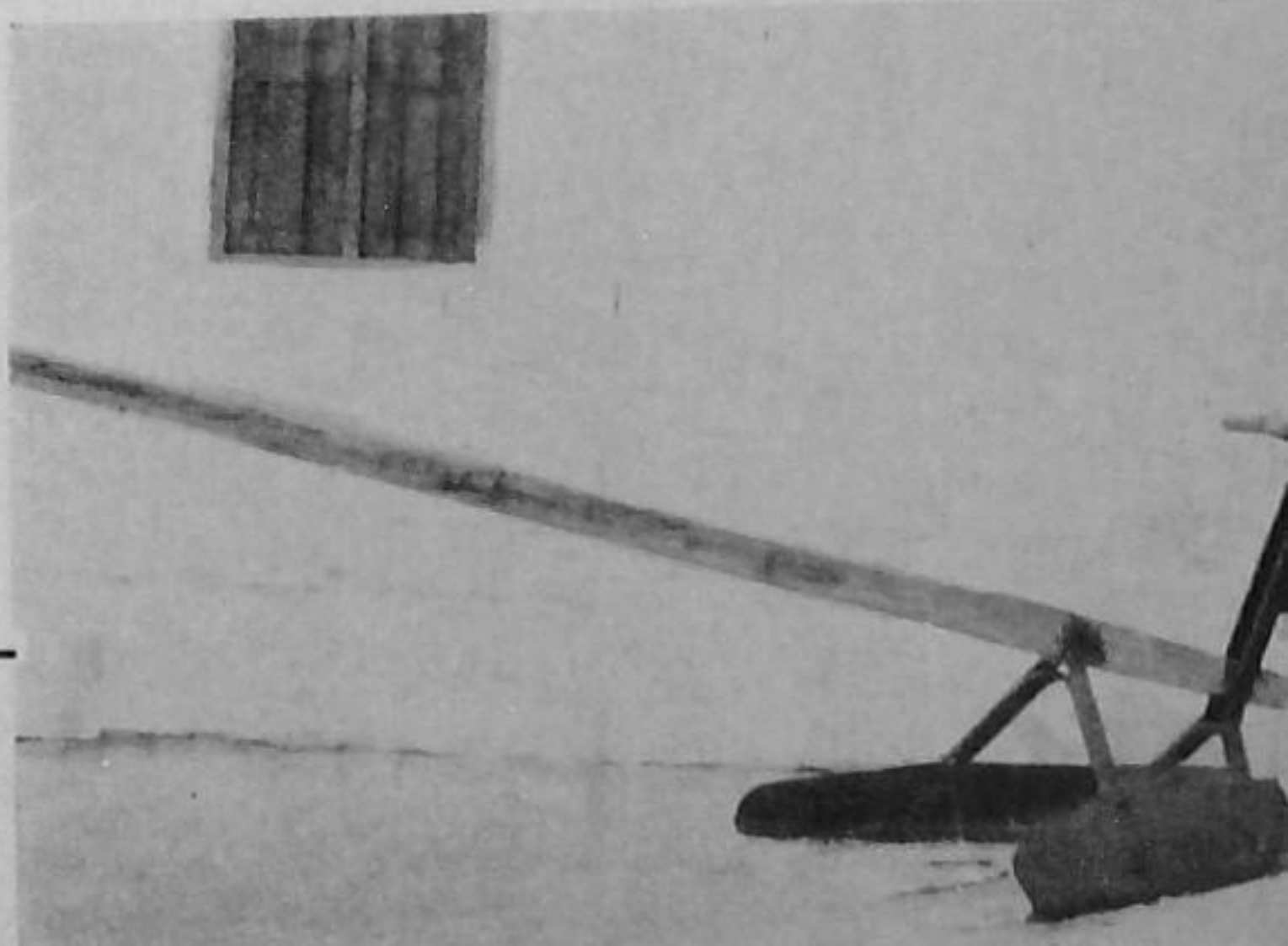
Desi plough



Pegged



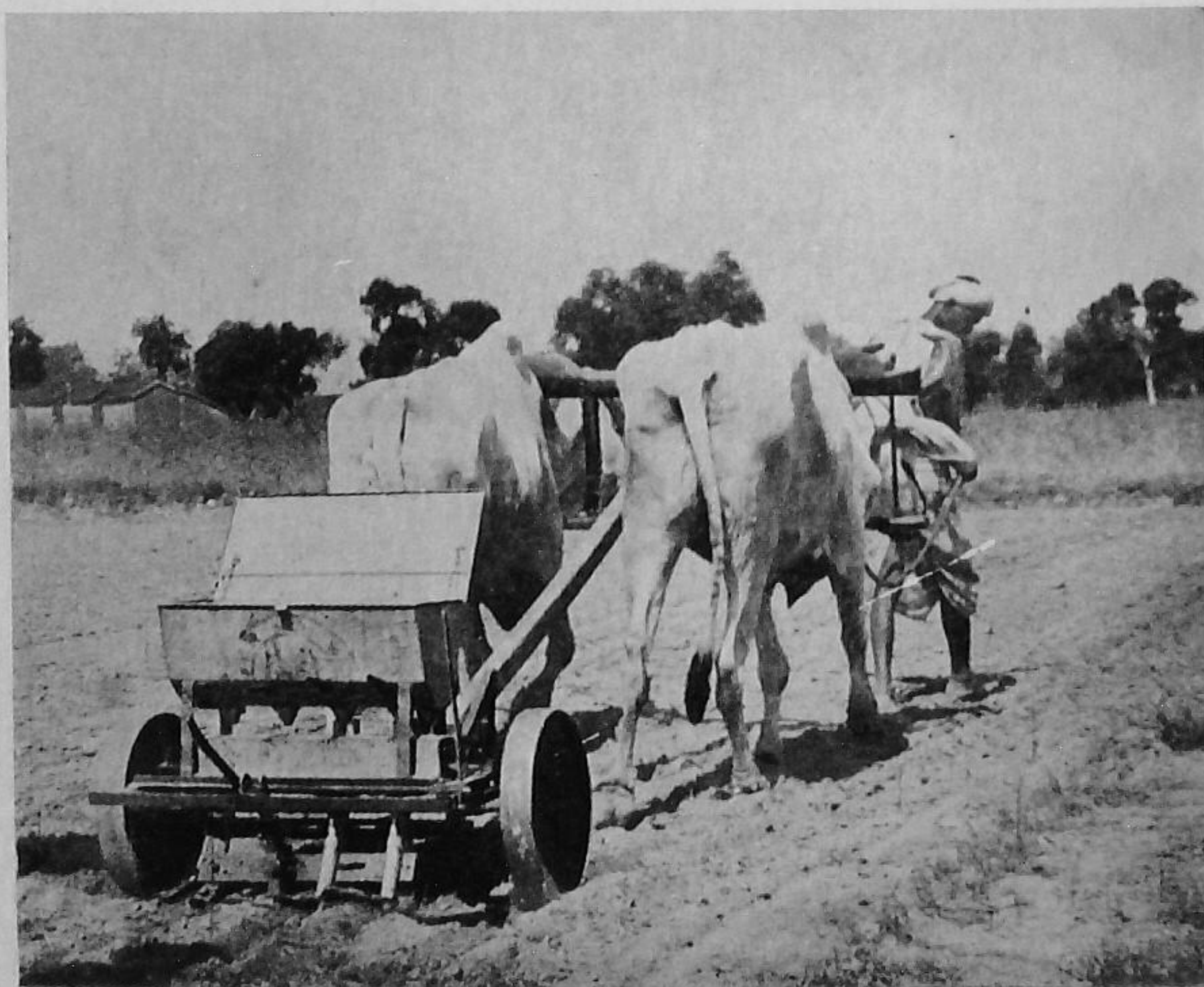
Bund farmer

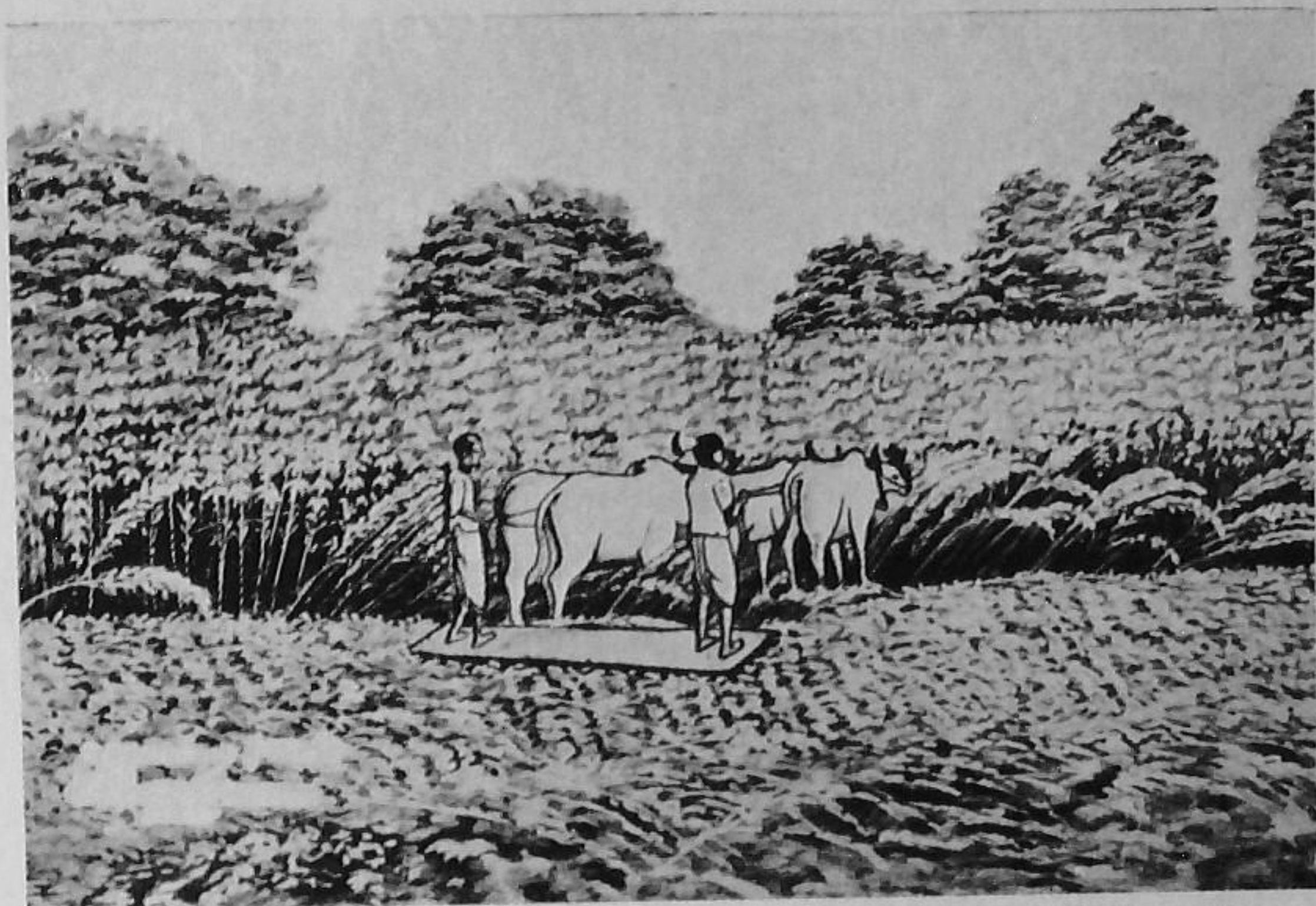




Compost pit filled and plastered with mud and cow-dung

Improved seed-drill operated by bullock power





Felling green manure crop (sunn-hemp) before ploughing into the soil



*Composting farm
weeds and stubbles*



*Persian wheel (showing
chain of buckets inside the
well)*



*Intercultivating paddy
field with Japa-
nese hoe*

societies or *takavi* loans. The Extension Organization should persuade farmers to repay the fertilizer loans in time, as, otherwise, the entire credit system will fail and agricultural improvement delayed. At the time of the issue of the loan, the Extension agency should educate the farmers regarding the proper doses to be used and the need for timely repayment of loans. Informal written understanding regarding the doses to be used and the time of repayment have helped very considerably.

Green Manures

We have not yet succeeded in developing regular use of organic manures to an appreciable extent. It is, therefore, necessary to make a determined effort in the Second Five Year Plan to produce and use organic manures on a large scale.

Green manures used in conjunction with chemical fertilizers on the same field result in remarkable improvement in the yield, amounting to about 3 to 4 times the average yield. Experience has shown that a regular addition of even 3 to 4 thousand pounds of green manure or green leaf each year is adequate when practised in combination with balanced chemical fertilization. Under tropical conditions the organic matter of the soil is depleted very rapidly. The addition of 12,000 lbs. of green manure once in three years does not, therefore, yield the same result as the addition of 4,000 lbs. of such matter each year. As this fact is not adequately appreciated, green manures are recommended to be applied once in three years instead of a lighter dose each year. When we look for green manures which yield a high tonnage, the selection of green manure crops naturally becomes restricted. This is one of the factors which has hampered the wider adoption of green manuring.

Dhaincha and Sunn-hemp are the two green manure crops which give a very high yield per acre. The seeds of these two crops are not available in enough quantity. Their production in larger quantities is handicapped because the

producer of seeds is not sure of the demand, and the seeds of these crops cannot be used for any other purpose except green manuring. They are not eaten by men and commonly not fed to cattle. In popularising Sunn-hemp and Dhaincha, it is necessary to ensure that the production of seed is taken up in each village so that the village is independent of outside seed. Just at present, the farmers who wish to use these two crops as green manures desire to secure the seeds at a low price. This discourages production of the seed. It is, therefore, necessary that the farmers agree to pay a reasonable price for the seed so that it becomes worth-while for their brother farmers to produce the seeds.

Many of the kharif pulses which are commonly grown in different parts of India can also be used as green manures, provided the idea of a high tonnage is given up. Crops like Kulthi, Meth (moth), Urad (Kalai), Moong, Lobhia (Vigna Katjang Maskalai) can be used as green manures. The advantages are that the cultivation of these crops is already known to the farmers, the seeds are locally available and the seed rate is somewhat lower than in the case of Sunn-hemp. These crops if sown after the first good shower yield in a period of four to five weeks adequate green matter. In areas where paddy is transplanted and where paddy nurseries are raised with the help of rain and not with the help of irrigation water, there is generally a gap of four to five weeks between the first good shower and the transplanting time for paddy. It is so because it generally takes three to four weeks for raising a paddy seed nursery. When the seedlings are ready and there is enough water for transplanting, the green manure crop should be ploughed in the field without waiting for further growth of the green manure crop. By this time most of these crops will have grown sufficiently, to yield 3,000 to 4,000 lbs. per acre. Even in the case of Sunn-hemp, it is not necessary to wait till the flower buds appear as this waiting delays the transplanting and prevents the wider adoption of green manuring.

In Uttar Pradesh and Bihar, on fallow lands as well as on paddy lands, an early crop of Moong is sown with the

first shower and the first flush of pods is hand-picked and kept as seed. The vines are immediately ploughed under to serve as green manure. This results in a production of 20 to 60 lbs. of Moong seeds per acre, which can be used next year. At the same time it also provides some green manure to the field. Here the farmer has only to spend his labour for ploughing the land and no monetary investment is required. In Assam, Bihar and Bengal, an early maturing variety of ground-nut can be sown with the first shower of April-May and the crop harvested after 90 to 100 days. Where facilities are available for irrigation, this crop can also be sown in other months. Such a crop yields from 10 to 12 maunds of ground-nuts per acre and the haulms or vines are buried under to serve as a green manure either for paddy or for some other kharif crop.

In certain parts of Madras, Andhra, Hyderabad and Mysore, *Til* or *Gingelly* is also used for green manuring. Though this is not a pulse crop, it can add a fair quantity of organic matter and can thrive on a limited rainfall.

In Punjab, Pepsu and Bombay, *Guar* (Guara) is commonly used as a kharif green manure. This crop also grows on a limited rainfall and can yield good tonnage. In Kutch, between the two rows of irrigated cotton or Bajra or Juar, a row of Guar is sown and the crop is ploughed under when it is about 15 to 18 inches high. This practice may be feasible even on unirrigated crops in those areas where the rainfall is generally higher than 30 inches. Similarly, between two rows of millets or maize or cotton, crops like Meth, Lobhia and Urid can also be grown for green manuring purposes provided the rainfall is higher than about 30 inches. In some areas, after the maize is earthed up by working a ridger, Urid (Kalai) is soon broadcast, and after the harvest of maize cobs and stalks, the Urid is ploughed under before the rabi crop is sown.

In one area the spacing between the rows of maize has been increased from 2 to 3½ feet and a row of Dhaincha or Sunn-hemp is sown between the two rows of maize. The green manure plants, when they have grown to a height of

about 2½ feet, are uprooted leaving only a thinned stand for seed production. The uprooted plants are either used for green manuring in adjoining paddy field or are left to rot near the maize to serve as green manure. This practice is also feasible where paddy is sown on uplands in lines either behind the country plough or with the help of a drill. When the green manure crop grows to a height of 15 inches or above, it is cut and left to rot between the two lines of paddy.

In some areas where the paddy is sown by broadcast method and after it has attained a height of 9 to 12 inches, the field is ploughed up for destroying the weeds. In some, a pulse or Sunn-hemp or Dhaincha crop may be sown mixed with paddy. The green manure crop is ploughed in when the field is ploughed up to destroy weeds. In some cases, where Dhaincha is sown along with broadcast paddy, both Dhaincha and paddy are allowed to grow and Dhaincha is then uprooted and trampled by feet when it has grown to a height of about a feet.

In South India, a variety of Dhaincha (*Sesbania Speciosa*) is sown in a nursery bed and its seedlings are transplanted on the borders (not bunds) of paddy fields. Since the plants are only planted on the borders of paddy fields they do not affect the paddy crop. One plant out of every four or five is left for seed and the remaining plants are ploughed under after the harvest of the first crop of paddy. The green manuring plants that are ploughed under serve as a green manure for the second crop of paddy which follows. In Northern India, this practice can be adopted with advantage where wheat is grown after paddy. The advantage of this method is that the seed of green manure is produced locally and the green manures help to raise the fertility which ultimately helps even the first crop of paddy.

Where a bumper yield for a green manure is obtained a farmer can apply the production of green manure from one acre to four or five acres of his land. In such a case it might even be worth-while for the farmer to sow the green

manure crop with the help of irrigation so that complete control is obtained.

Where fields are located near forests, jungle leaves can very well be used as a green manure. The leaves are collected and applied to the paddy fields at the time of puddling. Four to five days after puddling, the twigs and branches are picked up and the leaves would have rotted by then.

Where irrigated Berseem or Lucerne is grown as fodder, the last flush or the cut may be ploughed under to serve as green manure.

The green manuring is the means for improving the agricultural production particularly for a poor farmer as it requires practically no investment of money and can be carried out without much labour. In soils which are deficient in phosphates, bonemeal or super phosphate is applied at the rate of $1\frac{1}{2}$ mds. to $2\frac{1}{2}$ mds. to an acre before sowing the seeds of green manure crop. The fertilizers can be had on loan, the cost being payable after the harvest of the main crop and not the green manure crop.

It is often argued that the growing of a green manure crop involves the loss of the kharif crop. This is not true in the case of paddy. Experience has shown that where irrigated wheat is grown, the increase in the yield of wheat consequent on green manuring often compensates for the loss of the kharif crop; but even in the case of rabi irrigated wheat, it is possible to practise green manuring crop between two lines of the kharif crop. If necessary, distances between two rows of the kharif crops may be increased to accommodate the green manure crop or to prevent the green manure crop from competing for soil moisture with the kharif crop. The average yield of most of the grain crops is generally below 10 mds. per acre and the green manuring increases the yield by 2 to 3 mds. per acre. Even where the growing of green manures involves a loss of kharif crop, it should be possible for the farmer to put $\frac{1}{5}$ th of his area in the first year under green manure. The increase in yield that he would get from the $\frac{1}{5}$ th green manured area will compensate him for the loss of the kharif crop. In the

second year he can green manure 1/4th of his land and one-third in the third year.

In many areas of India, the early showers are not dependable and the green manure crop which is raised with early showers may not grow well or even may fail, say in two years out of five. This should not be regarded as a handicap as the investment on green manuring is largely in the shape of family labour. As the organic matter and fertility of the soil are built up by regular green manuring, the failures of green manure crop will be less frequent and the yield of kharif crop will be stabilised and would be less subject to fluctuations.

If a wide variety of crops are selected to serve as green manure, it should be possible to cover every acre of fallow land with the green manure and every acre of paddy and irrigated wheat with green manure. For unirrigated land which produces millets, cotton or maize green manures can be grown between the rows of these crops by adjusting the spacing between the rows except in those areas where the rainfall is below 30 inches. For such areas, there should be a programme of planting trees, shrubs and green leaf yielding plants along bunds, borders of fields, tank and canal banks and on waste lands so that the supply of green leaves is available for composting. These leaves may be periodically plucked and added to the compost pit. Choice of trees for planting should be made with reference to its rapid growth and its capacity to yield leaves.

In some areas the growing of green manures is not popular because the stray cattle graze and destroy the green manure crops. For such areas the village Panchayats should be persuaded to take action against the owners of cattle so that stray cattle are controlled. Blocks of 50 or 25 acres may be enclosed or fenced with live fences of plants like *Prosopis*, *Juliflora* through group action so that the fields are protected against the stray cattle. The village Panchayats or village Councils may be asked to prepare the programme of green manuring for the village and the production of seeds so that the village is self-sufficient in res-

pect of green manure seeds. A campaign should be launched in the village and a few leading farmers should be persuaded to experiment with new types of green manures or novel practices of growing green manure crops so that on the basis of their experience others may learn. If every village plans for the systematic production of its own seed of green manure, not more than 10,000 tons of green manure seeds are likely to be required from the outside for any State in any year.

There are over 67 million acres of irrigated land on which green manuring can be introduced immediately. Between 30 to 40 million acres of un-irrigated lands which have assured rainfall can also be benefited by adopting green manuring practices.

Compost

To supplement the green manuring programme, it is desirable that all farm and village waste material along with cow-dung, cattle urine, human urine, etc., should be composted properly. The use of composted night-soil should be introduced as quickly as the conditions permit. Demonstrations in the proper methods of composting and propaganda in digging and filling of compost-pits in rural areas should be taken up on a large scale, and for this, special campaigns should be organized when there is leisure in the village for the filling of compost-pits with farm waste, tree-leaves, weeds, cattle dung, etc. The aim should be to produce adequate compost to apply to all the non-green-manured lands every year. The compost production should be related to the land under cultivation. Instead of applying a heavy dose once in three years, one-third dose should be applied every year. The compost-pits should be located in or near the fields so that all available waste is utilized and long distance transport of compost is avoided. The quality of compost is generally very poor and it can be improved considerably by adopting sectional filling and proper covering.

Improved Seeds

It has been observed that the use of improved seeds is

the quickest, easiest and cheapest method of increasing the yield. There are 75 million acres under paddy and about 24 million acres under wheat. Improved seeds for these two crops are available in every State that grows these crops, and in some States improved varieties of millets and pulses are also available. Every acre for which suitable improved seed is available should be brought under improved seeds. It is proposed to have a seed farm in each Block during the Second Five Year Plan. Pedigree seed will be produced on these farms and it will be further multiplied at registered growers' farms and subsequently on cultivators' fields. It is necessary that nucleus seeds from the farms are first supplied to only such farmers as produce bumper crops and economise seeds by following the Japanese Method of Paddy Cultivation or the dibbling method of wheat cultivation evolved in Uttar Pradesh. During subsequent stages of multiplication, good progressive farmers, who can spare a substantial production of seeds for distribution to other farmers, may be preferred. Negligent, careless and non-co-operative farmers may be weeded out from the chain of seed multiplication programme as early as possible. In this programme it is also desirable that the sale or exchange of seeds is made immediately at the time of harvest and not deferred till the sowing time. To ensure reasonable coverage under improved seeds, it is imperative that such seeds are secured in bulk from nearby areas in which they are in surplus quantity. Such transfers should be completed immediately after the harvest.

Improved Implements

The implements which are in common use all over India are few and simple. The mould-board ploughs, bakhar or blade harrow, wooden seed-drill, cultivators, harrows, sickle, etc. constitute the average farmer's agricultural implements. In certain areas use of chaff-cutters has become common. For some time past oil-engines, pumps, cane-crushers, thrashers, rice-hullers, etc. are also gaining popularity. But the use of improved implements has not yet reached the desired

level. Their use results not only in the saving of time but also of labour and money. It also helps better cultivation and thereby increases the yield. The country plough at present in use for multi-purpose operations like ploughing, harrowing, hoeing, burying green manure, etc. does not dig deep enough. The land has, therefore, to be ploughed many times for preparing the seed bed, destroying the weeds and breaking the clods. If mould-board plough is used, it inverts the soil and buries the weeds in one operation. One ploughing with the mould-board plough followed by three or four harrowings can replace ten to twelve ploughings with a country plough which are given for preparing the fields for sowing a Rabi crop. This will reduce the pressure of work, prevent the delays in sowing of Rabi, and often enable the raising of Kharif and Rabi crops on the fields which are now kept fallow during the Kharif.

In paddy growing areas, a larger number of bullocks are maintained by farmers to finish quickly the puddling of fields so that transplantation of seedlings is finished in time. The bullocks have to work very hard during these operations. But thereafter they remain idle and consume lot of feed. The green manure trampler which has been developed in South India can trample green manure crops like Sunn-hemp and Dhaincha with the mud and covers an area of two and a half acres to three acres in a day. Similarly the wet land puddler can do the job of a green manure trampler in addition to puddling in nearly two acres of land in a day.

The blade harrow, commonly known as Bakhar or Guntaka, is another implement commonly used in Bombay, Bundelkhand (U.P.), Madhya Pradesh and Madras. It can be used for pulverising the soil after the land is ploughed in. In many parts, and particularly in clay soils, the use of blade harrow is ideal for the first operations in cultivation. It is also used for interculture between groundnut and cotton. It cuts the roots of the weeds. One pair of bullocks with a blade harrow can do the work of five pairs of bullocks.

Cultivators and harrows are very useful implements

for hoeing and weeding of crops. Bullock-drawn cultivators and harrows cover more than two acres in a day. Ridgers are quite economic and labour saving implements in areas where sugarcane and maize are cultivated. In dry areas, use of bund-formers saves lot of manual labour and time for forming bunds and beds in fields.

Next to seed bed preparation comes sowing operation. There are many types of seed drills used, indigenous as well as improved. A seed drill saves seeds and enables quick and early sowing. Sowing of crops in lines reduces the cost of weeding and good weeding increases the yield. Deva's seed-drill developed in Madhya Pradesh can be fitted on a country plough. One acre can be sown in five hours. There are other seed-drills, which can sow three or four times as much and can be worked with one pair of bullock, thus saving much time and labour per acre.

The Rice Land-Weeder, though a Japanese implement, has become quite popular in areas where Japanese Method of Paddy Cultivation is processed. A man can weed from half an acre to one acre a day with this weeder. It is really an implement which must be had by paddy growers who want higher yields. Another implement for paddy growers is a Japanese Pedal Thrasher. It costs less to thrash paddy. This is simple in construction and can be conveniently carried from one place to another.

Otpad-thrashers or Narag Thrashers are very popular in Punjab, U.P., Rajasthan and Madhya Pradesh. Their use has saved much time, labour and bullock power. Similarly, the use of other improved implements will show that they are labour and time saving. Tractors and tractor drawn implements should also be used where necessary.

The farmers can realise the advantage of these implements only after some time. To popularize them, large scale demonstrations should be carried out on farmers' fields. It would be further useful to arrange for the training of village blacksmiths and carpenters in the manufacture, repair and maintenance of these implements. The equipment of village smithies and carpenteries should also be improved and wherever possible cooperatives should be organised for the

fabrication of such improved implements. These multi-purpose cooperative societies can also undertake the supply of improved implements. Where necessary, short-term credit should be provided to these societies for stocking and sale of implements.

IMPROVED TECHNIQUE

Defective agricultural technique and improper use of land are in most cases responsible for low crop yields. The existing rotations of crops, the method of preparing seed bed, sowing of seeds, inter-culture operations, manuring, irrigation, etc. usually leave much to be desired. The improvement in the present day agriculture technique is, therefore, urgently called for. In certain areas, one and the same crop is grown year after year. In one locality it may be cotton, in another tobacco, and in yet another paddy, jowar, bajra or wheat. Growing of crops successively like this not only impoverishes the soil but also encourages the attack of insect pests and diseases. The introduction of improved crop rotations and particularly the inclusion of one or more leguminous crop in the programme will balance the fertility of the soil and produce good results. In Bombay, Madhya Pradesh and Hyderabad, it has been observed that a rotation of ground-nut and cotton has increased the yield of cotton crop by 15 to 20 per cent. Similarly in Uttar Pradesh, the rotation of moong and wheat has increased the yield of wheat crop. Similar results have also been obtained by the mixed cropping of cereal crops with pulses.

There are areas where preparation of land is haphazard and hurried. Land is ploughed only once in 3 or 4 years and often it receives no cultivation. After the rabi harvest and until the first showers are received in the following monsoon, ploughing and still deeper ploughing in summer is beneficial. Repeated ploughing produces better tilth and thereby encourages crop growing and increases yield. In tracts where broadcast sowing is commonly practised, a high seed rate becomes necessary. The close cropping of plants

in broadcast crops affects their growth adversely and reduces the yield. Sowing of crops in lines will mean economy of seed, more uniform growth and easier inter-culture.

The Japanese Method of Paddy Cultivation and U.P. system of growing wheat through wooden dibbler can be introduced in larger areas to increase yields of paddy and wheat respectively. Similar efforts should also be made to grow other crops like jowar, bajra, maize, gram, etc.

In Saurashtra, it has been observed that while preparing seed-bed, furrows are opened, and farm-yard manure or compost is applied therein. The field is then levelled with a plank. After the first rain the soil where the manure is applied swells up. This gives a clear indication to the farmers to sow jowar or bajra in these furrows. This has two effects. Firstly the crop is grown in lines and secondly the manure is actually provided where the seed is placed.

Proper method of manuring the soil and the knowledge about the correct time and dose of fertilizer application are also necessary. Similarly the proper technique of irrigation for obtaining the best results should be known. Both over-watering and inadequate watering affect the crop yield adversely. Irrigation of large uneven plots needs more time, and causes unnecessary accumulation of water in low plots and inadequate watering of high lying places. Division of the field into small suitably bunded and levelled plots economises the water with good results.

PLANT PROTECTION

Sometimes the pests and diseases of plants create havoc. This can be controlled by changes in rotations or variations in the cultivation practices. Late sowing of cotton can, for example, reduce the attack of '*Tirak*' disease. Similarly, the closer planting of cotton usually lessens the attack of '*Jassids*', and the planting of an early maturing variety of cotton reduces the boll-worm attack. There are some biological controls also, but these should be adopted only on the recommendations of the State Department of Agriculture.

The treatment of jowar seed with sulphur powder protects the crop against 'loose smut'. Similarly the water soaking of wheat seed followed by exposure to hot sun reduces the incidence of wheat smut. The adoption of timely and effective measures to control the outbreak of pests and diseases is essential. Stocking and sale of dusters, sprayers, fungicides and insecticides should be arranged at convenient places to be used when required. Necessary training of farm leaders in plant protection measures is also very essential. In the event of insect pests or diseases appearing as an epidemic, timely campaigns conducted on a mass scale should be carried out. The assistance of the Plant Protection staff can be requisitioned in the conduct of such mass operations.

INTENSIVE CROPPING

There are large areas, in each State, which remain fallow. They may be long fallows or current ones. These areas can be brought under cultivation with careful management of the soil. In some fallow lands grasses, fodders, millets, cow-peas, black gram, green gram, horse gram, and ground-nut can be grown. In U.P. large areas under monsoon fallow are being sown with moong. This practice has resulted in increasing the supply of pulses, checking soil erosion and providing fertility to a successive crop like wheat. Such practices, if adopted, can provide scope for multiple cropping in rain-fed and irrigated lands.

The present intensity of cropping in India as a whole is 110, i.e. the double cropped area is ten per cent of the net cropped area which is taken as 100. The following table will indicate the intensity of cropping State-wise :

Assam	..	..	114
Manipur	..	..	110
Tripura	..	..	116
West Bengal	..	..	113
Orissa	..	..	112
Bihar	..	..	130
Uttar Pradesh	..	..	120
Punjab	..	..	116

Pepsu	..	..	115
Delhi	..	..	110
Ajmer	..	..	113
Rajasthan	..	..	106
Madhya Bharat	..	..	105
Bhopal	..	..	102
Saurashtra	..	..	102
Kutch		..	105
Hyderabad	..	..	101
Madhya Pradesh	..	..	112
Vindhya Pradesh	..	..	117
Andhra	..	..	113
Madras	..	..	116
Bombay	..	..	104
Mysore	..	..	103
Travancore-Cochin	..	..	112
Coorg	..	..	100
Himachal Pradesh	..	..	154
Jammu & Kashmir	..	..	110

The above figures clearly indicate that there is a large scope for increasing this intensity. This can be done by introducing an early or medium-maturing paddy to be followed by rabi which may either be sown on cultivated land after the harvest of paddy, or sown broadcast in a standing paddy crop at the appropriate stage. Jute can be followed by early paddy which will have paira sown khesari. The Kharif green manure crop followed by a medium-duration early or winter paddy instead of a single crop of late paddy, followed by irrigated growing of wheat or gram or peas or barley after taking maize, jowar or bajra, is another good practice which can be followed. Replacement of monsoon fallows with early maturing or green manure crops like cow-peas, black gram or green gram will also help in intensifying the cropping pattern. Similarly introduction of green gram and Philippine cow-peas which mature in 60 days and start yielding pods in 30 to 40 days after sowing, will help. Cash crops like Sesamum, preceding or following the main crop, give the desired effect. There are certain areas where only rabi

crops are grown. These can be converted into the *do-fasli* areas by bunding the fields to conserve the soil and moisture. In addition, there are possibilities of expanding the scope of growing high yielding crops like early paddy in place of millets or smaller millets which do not give farmers enough return for their labour. The extension of the area under maize and sweet potatoes will also be beneficial.

Reduction in the marginal holdings

Generally there are the following two types of the marginal holdings found almost in all the States:—

- (1) Marginal holdings which, though small in area, are cultivated intensively by working improved seeds, using organic manures judiciously, applying balanced quantities of fertilizers, arranging proper utilization of irrigation water, practising multiple cropping, employing family labour and maximising total production per acre. The high income thus earned is used in expanding the size of holding and raising the standard of life.
- (2) Marginal holdings which are owned by the farmers for the sake of ownership, but are cultivated carelessly to the extent that the quality of land deteriorates and crop production becomes uneconomic, resulting in such farmers becoming landless labourers.

Taking into consideration the above facts, it is necessary that the farmers of the first category are given recognition and helped with short-term credit and other facilities, so as to enable them to raise national production. The farmers of the latter category should be eliminated as quickly as possible and provided with alternative occupations.

Mixed farming

For a long time past, agricultural improvement in India has come to mean only crop husbandry. This should not be so. Agricultural improvement should also mean animal husbandry. Louis E. Howard says, "The animal is our farming partner, and no practice and no knowledge which ignores this fact will contribute anything to human welfare, or indeed, will have any chance either of usefulness or

survival." It is, therefore, essential that mixed farming should be popularised in real earnest.

Conclusion

By adopting the suggestions made above, it would be possible for us to use the land more intelligently and thus grow enough of food and other raw materials for our growing industry, without detriment to the soil. The same has been done in China and, under similar conditions, the Chinese peasant has greatly benefited. He has not only adopted superior techniques but also put in harder work. The intensive use of green manures, night soil, human and cattle urine, cattle dung, etc., have resulted in the increased production of food-grains as well as raw materials. The use of artificial manures, both nitrogen and phosphate, sowing of crops in lines, and constant hoeing and weeding are a normal feature of their cultivation practices. To obtain larger participation of all farmers in agricultural development programmes, cooperatives have been formed. These not only help in increasing production but also in stocking and selling it, thereby ensuring reasonable price for the produce to the farmers.

There is no reason why, under democratic conditions, we cannot achieve similar or even better results in India. It is, however, necessary that the development programmes enjoy the ready and enthusiastic support of farming communities. They should be prepared in full consultation with their representatives and organizations. The farmers should feel that it is their own programme. The items included in the programme should be such as would meet their urgent needs. In the assignment of priorities to the different items of work first things should come first. In the formulation of programmes, emphasis should be laid on and preference given to such activities as are likely to produce the most outstanding monetary results in the shortest time possible. This will win their confidence. The breaking up of the programme and the fixation of targets of increased production for each village and eventually for each farmer will greatly help us in attaining the goal.

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