Studies in Agricultural Improvement

WITH SPECIAL REFERENCE TO THE UNITED PROVINCES

Illustrated

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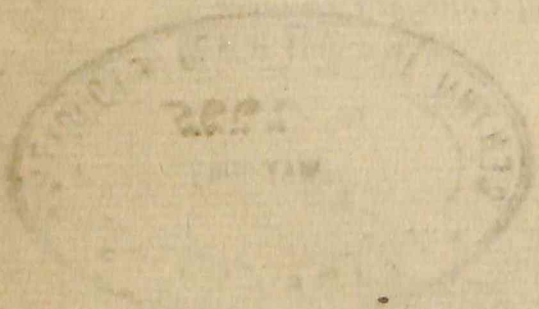

FOREWORD.

THIS publication appears as a result of a request made by the Department of Public Instruction, United Provinces, to provide a reference book for use primarily, of teachers in Vernacular Middle Schools, with the object of spreading a knowledge of the work and objects of the Department of Agriculture, United Provinces, among the tillers of the soil who attend these schools.

If in attempting to meet this purpose the book has strayed into details of the principles underlying scientific farming, it is but natural, since the Department of Agriculture owes its usefulness largely to this source.

C. MAYA DAS.

CAWNPORE :
14th *May*, 1929.

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CHAPTER I.

Introduction.

Agriculturally the largest and richest of provinces in India, the United Provinces have a total cultivated area of about 360 lakhs of acres. The province is also the most thickly populated, the rural population in the centre being as high as 712 to the square mile.

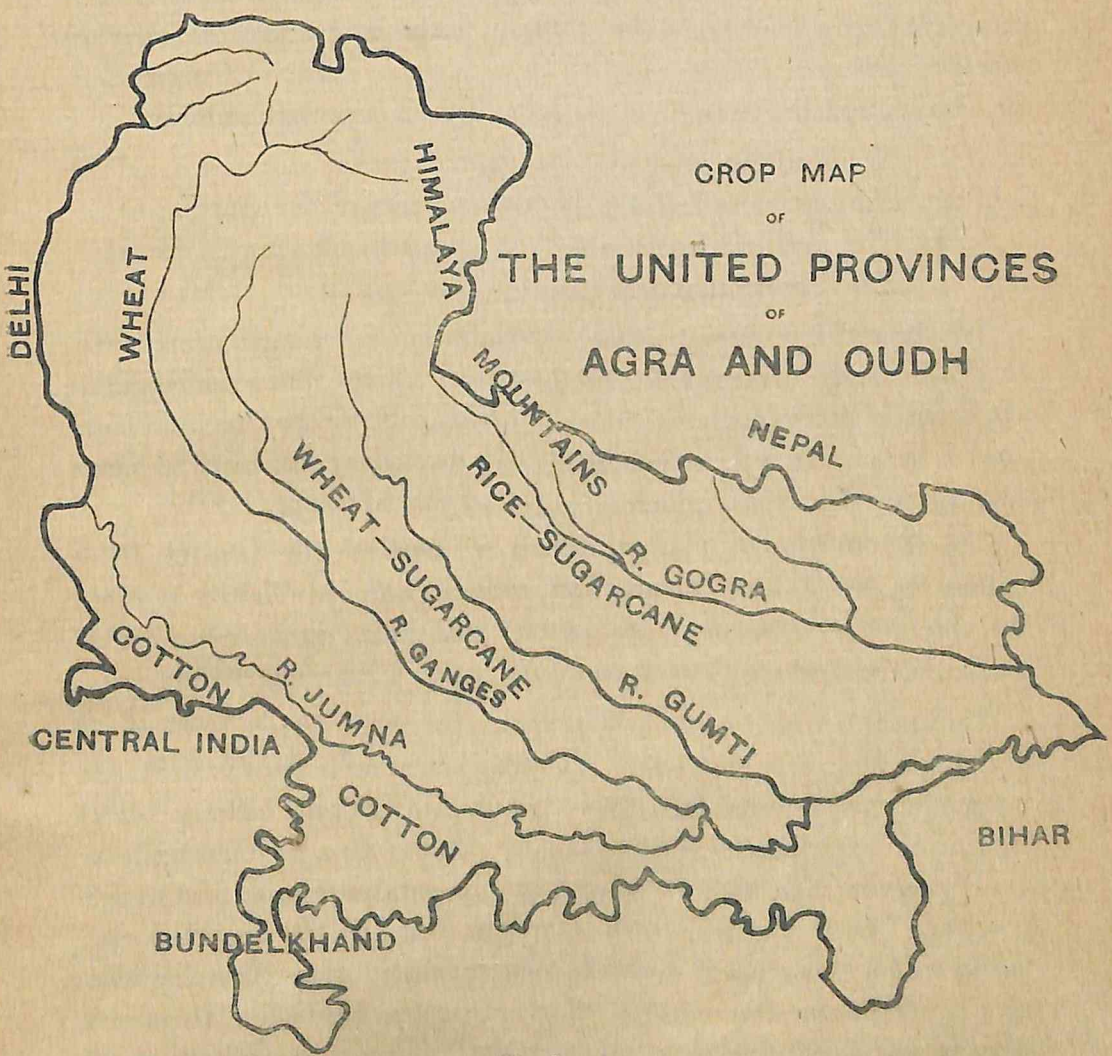


Fig. 1.

In live stock which add so much to the wealth of the land, these provinces are the richest, not counting sheep and goats which are most abundant in the Madras Presidency.

The rainfall varies from about 25 inches in the Agra Division to about 60 inches in the hills and areas immediately below the hills. In addition to rain the kisan depends a good deal on water from the four main rivers which flow through the provinces. These are the Ganges, Jumna, Gogra and Gumti with their numerous tributaries. The total area irrigated by canals is about 23 lakhs of acres, while that irrigated from all sources including canals, wells, tanks, etc., is about a crore of acres and next to the Punjab is the largest area irrigated in any province.

The United Provinces include four distinct tracts of country.—

1. Mountainous country—the Himalayas.
2. Sub-montane country including parts of the Tarai.
3. The great Gangetic plain, rich and fertile.
4. The Bundelkhand plateau.

Of these the mountains and sub-mountain tracts are mostly covered by forests or marshes and are very little under cultivation These areas are important however in as much as they include large grazing areas. They also include certain important hill fruit orchards some of the fruit from which is exported out of India.

The Bundelkhand plateau which is part of the Central India plateau is not a fertile tract and suffers from insufficient rainfall The chief crops raised here are cotton, juar, bajra, gram, some wheat and barley and where there is canal irrigation a little sugarcane.

The great Gangetic plain is perhaps the most fertile tract of its kind in India. For centuries has this tract been watered by the rivers Ganges, Jumna and their tributaries, helped latterly under British rule by a large system of canals. Rivers that flow not too rapidly deposit on their banks a great deal of vegetable, animal and mineral matter. It is a well known fact that through the countless ages during which these rivers have flowed through these provinces they have from time to time altered their course leaving behind them rich deposits for succeeding generations of kisans to utilise as fertility for their crops. Such deposits affect the fertility of the country for many

miles on either side of rivers giving rise to what are termed alluvial soils which are by far the best soils for agricultural purposes. There is no crop that cannot grow on these soils under proper care. Fodder grows luxuriantly and therefore cattle thrive well. Wherever cattle thrive there is ample cattle manure. That combined with abundant water makes these alluvial tracts extremely fertile. The alluvium of the United Provinces has this advantage over the alluvial plains of the Punjab well known as the granary of India, that the rainfall is more abundant and better distributed.

The province has been opened up by a network of railways. The agricultural markets are thus brought into easy contact not only with each other but with the great ports of Karachi, Bombay and Calcutta for export of grain, oilseeds, tobacco, cotton, jute, etc., to other countries.

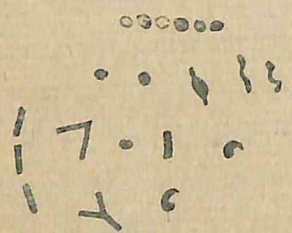
In spite of these great resources of the agriculturist in these provinces the average kisan is poor. A great deal has however been done by the Government Agricultural Department to improve his condition during the past 30 or 40 years. But as he is slow to adopt new practices, progress has not been as rapid as it might have been. From the succeeding chapters it will be evident in what manner the kisan may benefit by the work of this important Department of Government in the United Provinces.

CHAPTER II.

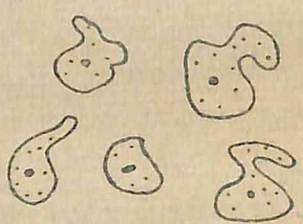
The soil, a living possession.

A study of the science of the soil shows that the soil is not a dead thing like the rock from which it took its birth. It teams with life. It behaves in many ways like a living being. For instance if you fed the soil with a large quantity of arsenic or copper sulphate it would literally die. It would never again grow any crop, not till the effect of the poison had been removed which may take a life time. Then too the character of the soil would have been so materially altered as to give weight to the assertion that it was a new soil come into existence.

In the soil are myriads of tiny living creatures of different shapes, size and habits. A very small quantity of soil from a fertile field mixed in a little water and prepared on a glass slide for examination under a microscope will reveal living and moving creatures, some known as bacteria, others as amœbae and so on. This is what they would look like :—



TYPES OF BACTERIA.
Fig. 2.



AMOEBAE.
Fig. 3.

Some of the bacteria are friends of the farmer others are not. The amœbae feed largely on bacteria and as they consume both the friendly and unfriendly bacteria their utility in the soil is doubtful.

The chief function of the useful bacteria is to make food out of crude matter for the crops which the farmer grows. Before this can take place the organic matter in the soil has to be broken down into simple substances. In this the bacteria are assisted by another type of minute organism inhabiting the soil—known as

FUNGI. Useful bacteria require certain conditions which the farmer must supply otherwise they may die and the crops for which they prepare food would suffer. The chief of these conditions are—

(1) Air.
(2) Moisture.
(3) Some vegetable or organic matter.
(4) Freedom from poisons including acids which are liable to collect in the soil unless they are properly drained and kept well cultivated.

When these conditions are present the friendly bacteria flourish and curiously enough the unfriendly bacteria greatly decrease in numbers.

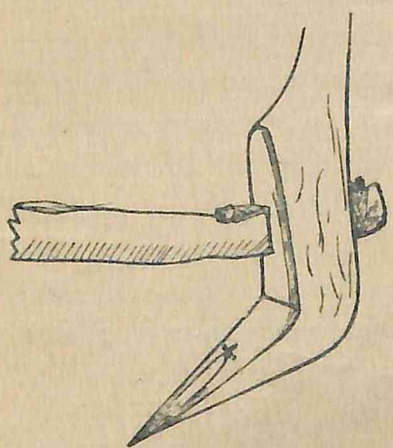
Soil Aeration :—Most of our soils are chiefly in need of two things—

(1) Organic matter that is decaying or decayed vegetable and animal substance, and
(2) Air.

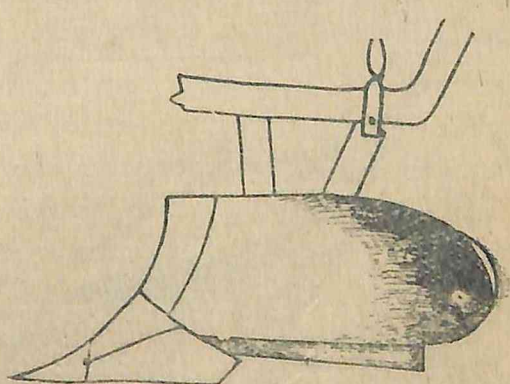
In sandy tracts there is usually enough air in the soil but not enough organic matter. In most other soils both air and organic matter are lacking.

The friendly bacteria in the soil make plant food out of vegetable and animal matter but for this purpose they *must* have plenty of air and the best way to get air into the soil is by proper cultivation. The most important implement of cultivation is the plough which serves many functions but the chief of them is to bring air into the soil.

The Desi plough compared with the improved plough.



DESI PLOUGH.
Fig. 4.



IMPROVED PLOUGH.
Fig. 5.

The illustration shows at a glance the difference in the construction of the two types. The Desi plough burrows through the soil making a simple cut and throwing the soil on either side of it. It ploughs to a depth of at most 4 inches. The improved plough not only cuts through the soil but turns it completely upside down and ploughs to a depth of from 5 to 9 inches and even more in the heavier types. Now the inversion of the soil is very important for the friendly bacteria. There are always weeds or st bble growing on the surface and when the soil is inverted these are turned down and killed so that the bacteria can easily turn them into organic matter and then into food for crops. Besides this when the soil is turned upside down the roots of crops which are left in the soil and of weeds are exposed to the air and so destroyed and after further cultivation become material for the bacteria to turn into plant food. By deep ploughing also we make an easy passage for water to pass down into the sub-soil and so carry with it any poisonous or injurious substances which may have accumulated in the soil. This is specially so in clay soils. At the Cawnpore Experimental Farm the following results were obtained by inverting the soil with a modern plough :—

Crop grain.	Yield.	
	Grain. lbs.	Straw. lbs.
Deep ploughing with inversion	1,844	2,523
Deep ploughing without inversion	1,354	2,074
Shallow ploughing with inversion	1,348	1,981
Shallow ploughing without inversion	1,147	1,442

[From Annual Report, Central Circle, year 1926-27.]

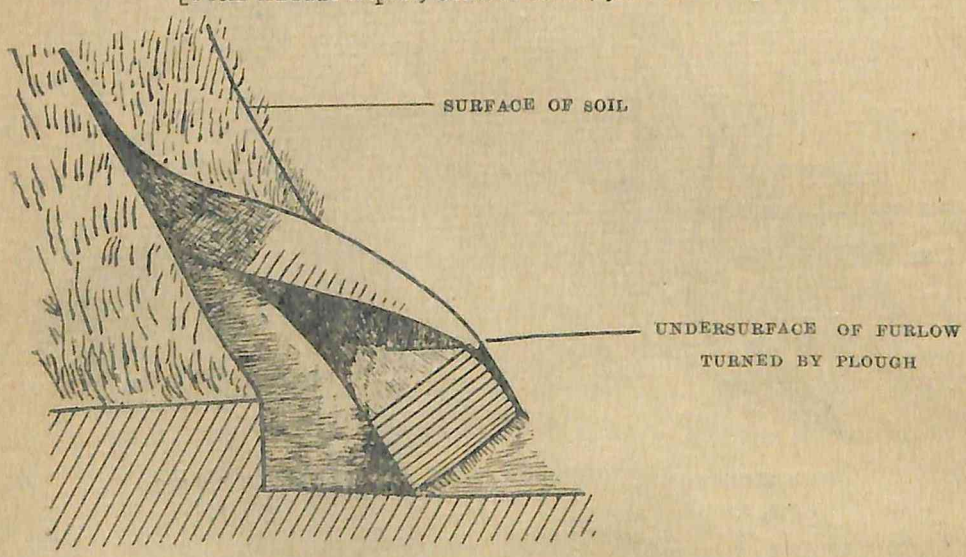


Fig. 6.

COMPLETE INVERSION OF SOIL BY IMPROVED PLOUGH.

Many types of such improved ploughs are in use in these provinces and the officers of the Agricultural Department are always available for further information as to the type, price, etc. Some of our co-operative societies now stock such ploughs and give them out on hire at nominal rates. Two such types of improved plough are—

(1) The Meston Plough costing Rs. 5-12, and

(2) The Punjab Plough costing Rs. 43-0.

Some of these ploughs require just the same amount of power to pull them and even less than that required to pull a Desi plough, and the amount of work done in a day is the same in both cases. The quality of work done by an improved plough is however worth much more than the value of the work done by a Desi plough.

Other aids to friendly bacteria.—Very often after heavy rain or irrigation the soil gets covered with a crust through which it is difficult for air to pass and so the friendly bacteria are unable to do their work properly. To break up this crust the kisan has no implement except the plank or *pata* or the Desi plough. If he uses the former he does not break the crust effectively and he cannot use it while a crop is growing in the field. If he uses the plough it means a lot of labour and perhaps it is not necessary at that time to cultivate the land with a heavy implement like a plough.

Besides breaking up the crust to admit air it is necessary also to break it up so as to prevent moisture from escaping. When a crust forms and the air inside the soil expands through the heat in the soil it pushes through the crust leaving behind tiny holes through which moisture also has an easy escape. If the crust is broken up into a layer of fine soil the moisture cannot escape so easily because these air holes in the soil are choked by a fine powdered layer of soil. So in order to preserve the moisture in the soil and to admit air into it at the same time modern agricultural science has devised certain very useful implements. Among these are the cultivator and the harrow. In the following illustration are two types commonly used in these provinces under advice of the Agricultural Department.

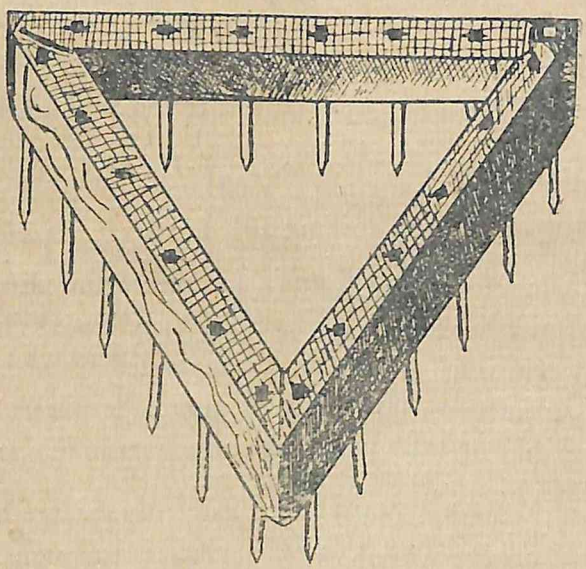


Fig. 7.

SIMPLE TRIANGULAR HARROW.

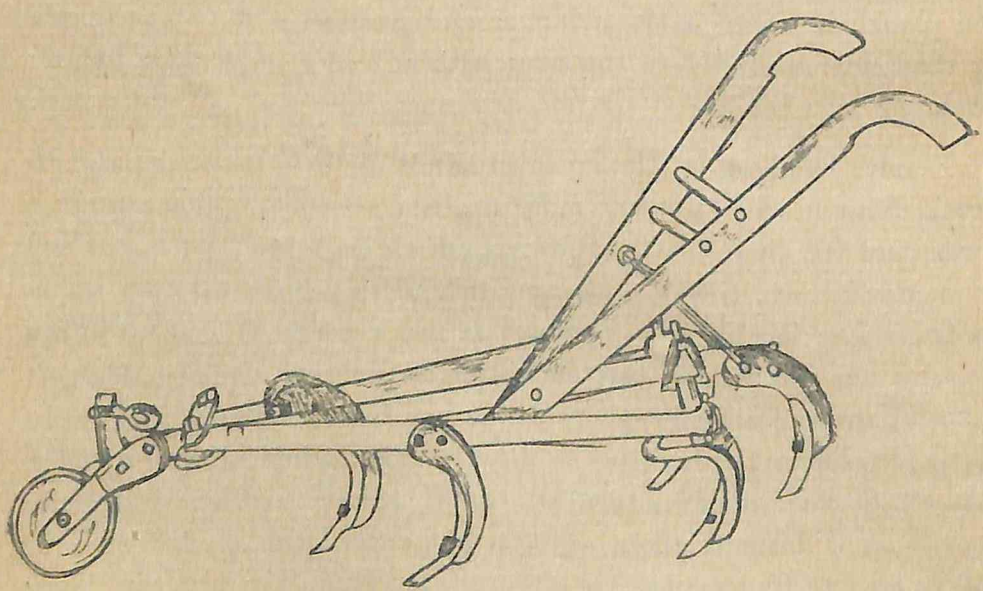


Fig. 8.

THE CAWNPORE CULTIVATOR.

The cultivator digs up the surface soil in much the same way as the Desi plough. It can be adjusted to go into the soil to a depth varying from 1½ inches to 4 inches. It requires only a light pair of bullocks to pull it and it cultivates about 3 times the area in one day. When crops are sown in lines it is very useful for interculture between the rows. The width of cultivation is adjustable to suit the variety of crop. Being a light implement it can be used when the soil is too wet for the plough.

The triangular harrow is another very useful implement for surface soil cultivation. It is so simple that any village blacksmith can make it. The number of spikes varies, but their size is important because if they are too narrow and sharp they will penetrate too deep and make narrow and deep lines in the soil opening it up too much and allowing too much moisture to escape. There are several advantages to be gained by using this implement. It is very light and with a strong pair of bullocks two can be dragged along at the same time, covering a large area during the course of the day. Soon after the first irrigation of a rabi crop like wheat when the soil has a surface crust this implement is very useful as it breaks up this crust admitting air to the young seedlings and soil bacteria and at the same time preventing excessive evaporation. It can be used in a standing crop till the latter is about 8″ high without doing any damage. It also serves to collect weeds and stubble from a ploughed field.

CHAPTER III.

Defective Soils and their improvement.

In the United Provinces there are about 103 lakhs of acres or about 30 per cent. of the total cultivated area, which can be cultivated but are lying as waste land. Zamindars all over the province find it unprofitable to cultivate and grow crops on some part of their land. Tenants will not take it on lease, and yet if properly treated this land may be made to yield good crops. Such waste land is therefore defective in some respect for agricultural purposes. Some of these defects are dealt with in this chapter.

1. *Water-logged land.*—In the east of the province extending westward from the foot of the mountains is a large tract of land known as the Tarai. Some of this is fertile and capable of yielding good crops while a good deal of it has so much water in the sub-soil and soil that cultivation is impossible.

The reason why plants cannot grow in water-logged land is that their roots require air to breathe in the same way as their stems and leaves require air to keep them alive and growing. Also the useful bacteria in the soil cannot exist in the absence of air. Further, it is found that when water accumulates and remains for a long time in the soil, the vegetable and other decaying matter in the soil forms acids which dissolve in the water and make the soil poisonous to plant life. It has been found that if by drainage the water in the soil and sub-soil is made to move downwards, the roots of plants also go downwards and so have greater space wherein to develop and collect food for the plant.

From the illustration it is evident that the first concern of the zamindar in water-logged land should be to suitably drain it. It often happens that there is no convenient outlet for the drainage water. Such lands cannot be improved and eventually turn into marshes. But often there is a nulla or stream near by, the level of which is several feet below the land level and at comparatively little expense the zamindar may drain his land.

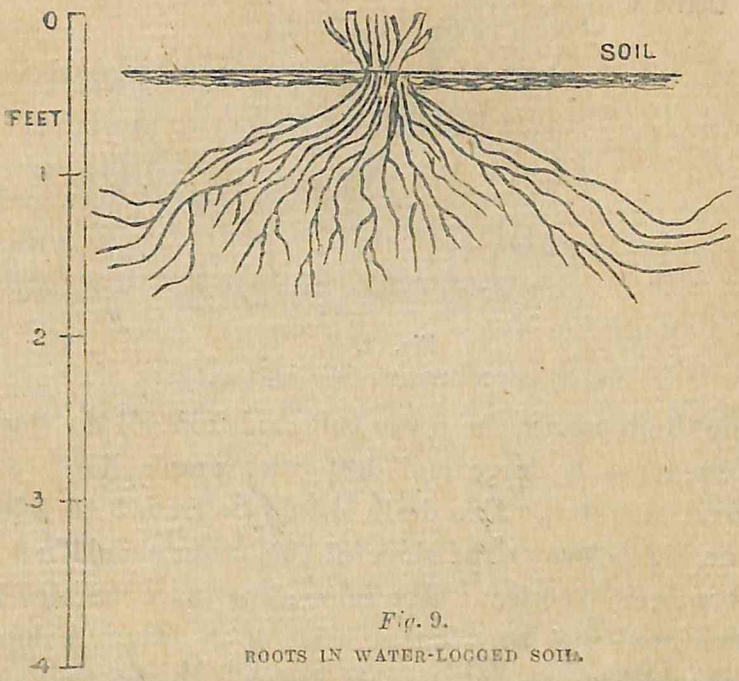


Fig. 9.

ROOTS IN WATER-LOGGED SOIL.

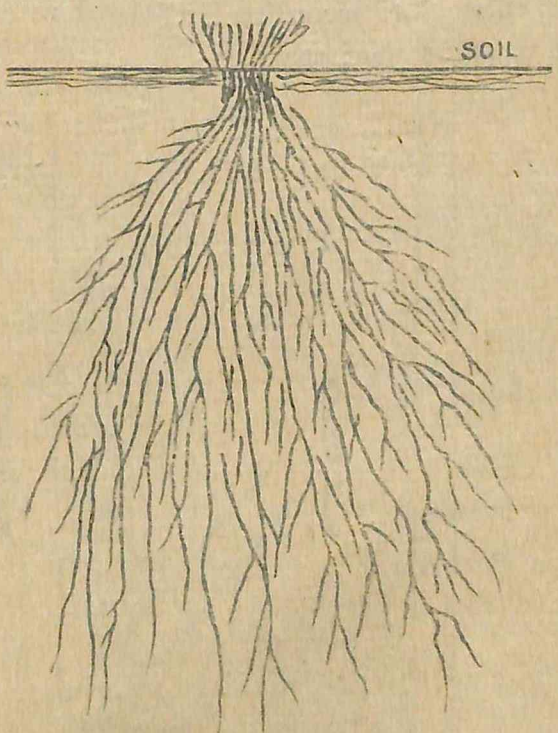


Fig. 10.

THE SAME AFTER DRAINAGE.

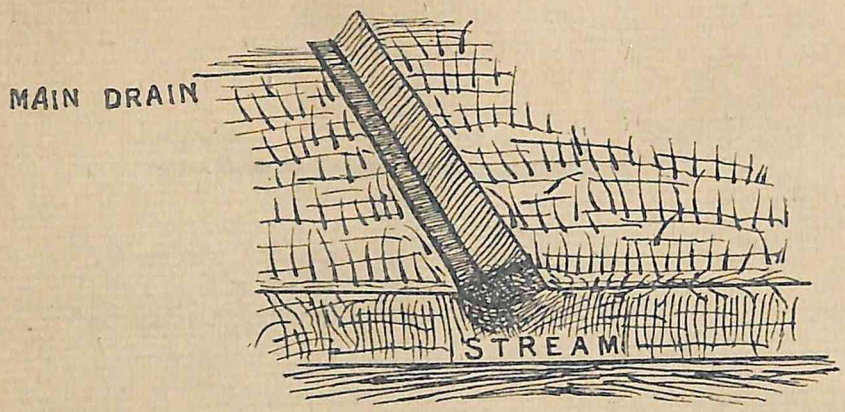


Fig. 11.

MAIN DRAIN OPENING INTO STREAM.

The main drain carries the water collected from all the side drains and therefore must be large and deep with ample slope to ensure quick removal of water. This drain should be from 3 to 4 feet deep and must be kept clean. The slope of this drain should not be less than 1 foot in every 200 feet. The same slope may be used for side drains which need not be either so wide or so deep. A depth of 2 to 2½ feet should be sufficient for side drains. In the field the side drains would be laid out according to the slope of the land but should usually be about 50 feet apart.

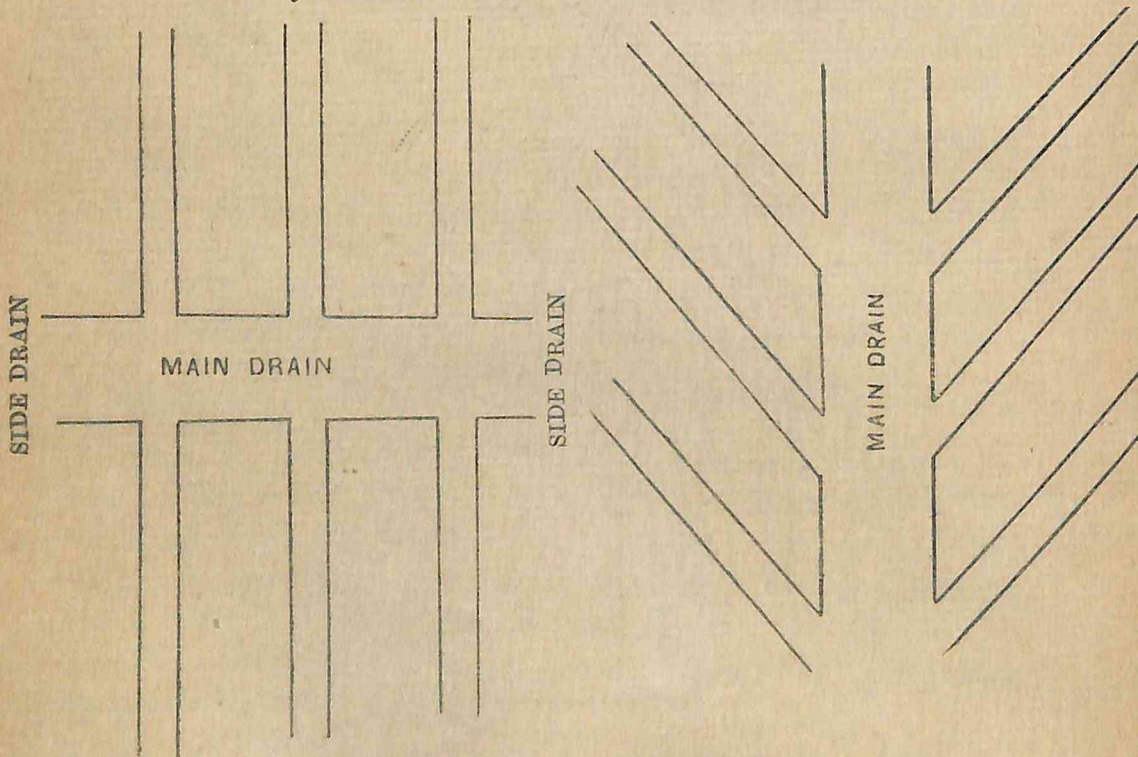


Fig. 12.

TWO TYPES OF LAY OUT FOR DRAINS.

In order that the flow of water in the drains may be regular and unchecked it is essential to keep the drains clean. The cost of construction will depend on the cheapness of labour : but the most satisfactory way to get the drains dug is to give the digging on contract at Rs. 3-8-0 to Rs. 6 per 1,000 cubic feet of earth dug, depending on local prices of labour.

There are other methods of drainage such as underground pipes ; but these methods are expensive both in construction and upkeep and do not always suit regions of heavy rainfall in the tropics.

2. *Usar land.*—Travelling along in the railway train or motor bus one very frequently sees large stretches of open plain where nothing seems to grow. The surface of the soil is in places encrusted with a white powder, commonly known as "reh." These are Usar land or lands which have been poisoned by the presence of too much alkali lands and their origin is very interesting.

We have seen that moisture escapes from the soil by evaporation. The particles of soil are very minute, sometimes so minute that they will not sink when put into a glass of water. Round these particles, the water in the soil arranges itself in the form of very minute films (see figure 13). The water clings to the particles by a force

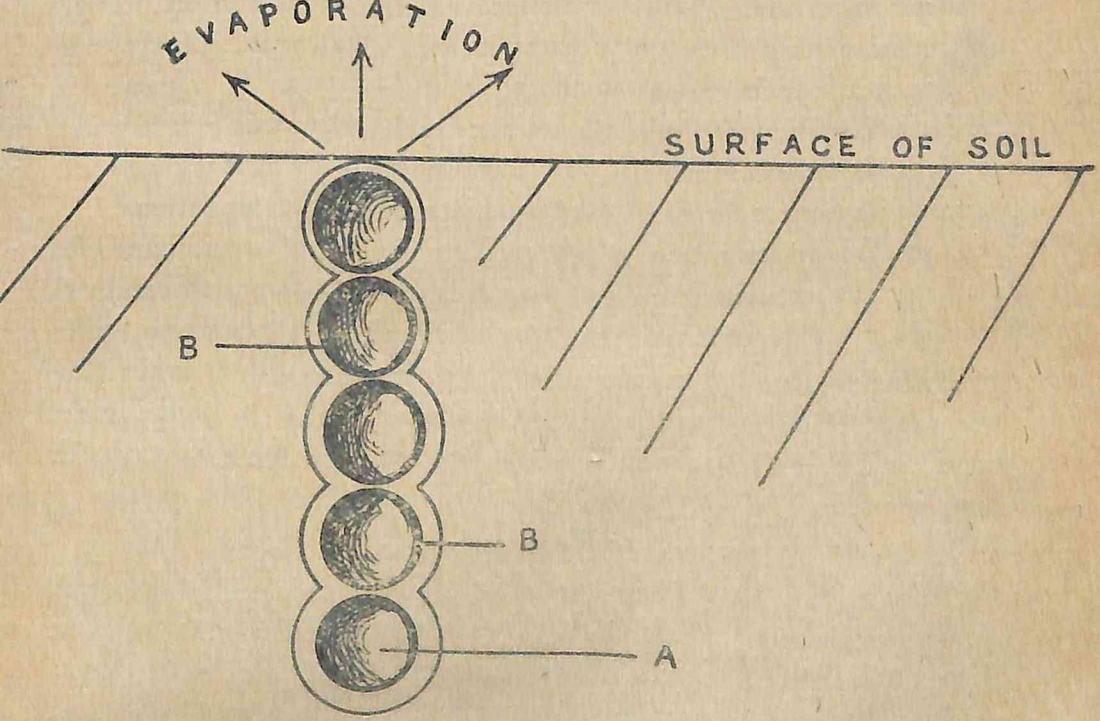


Fig. 13.

THE PASSAGE OF SOIL WATER FROM PARTICLE TO PARTICLE.

A.—The soil particle much magnified.

B.—The film of moisture held by the particle.

known as surface tension. It also moves from particle to particle by the same force. When the water surrounding the particles of soil nearest the surface of the soil, evaporates, water from the next particle near it moves forward to take its place. This leaves the latter particle with less water surrounding it than it had before. Therefore water from the next nearest particle moves to fill up the deficiency and so a regular movement upward is established.

Hence the combined effect of evaporation of moisture from the surface soil and the force known as surface tension results in the upward movement of the water in the soil and sub-soil.

With the upward movement of water are carried various substances which dissolve in water. Among these are sulphates and chlorides of alkalis which usually form white incrustations. Sodium carbonate calcium chloride and sodium nitrate generally form a black or brown incrustation.

As these substances are carried upward by water and water evaporates, they are left in the upper layers of the soil and there is no water or easy passage for water to bring them down again. So by constant repetition of these processes a large accumulation of such salts takes place giving rise to these usar or alkali soils. Favourable conditions for their formation therefore are :—

(1) Water in the sub-soil not far from the surface.
(2) Light rainfall and a dry atmosphere.
(3) Defective drainage and with it absence of irrigation.
(4) Where irrigation is practised in dry tracts without careful cultivation to check rapid evaporation from the surface.
(5) Presence of large quantities of alkali salts in the sub-soil.

These very conditions suggest some of the remedies for improving usar land. Many expensive remedies are suggested in some books but we will consider only those which are easily within reach of the small zamindar.

Treatment of Usar conditions.

Direct methods.—(*a*) These consist of deep drainage and an attempt by heavy irrigation on usar land to wash the injurious salts into the drains. The sub-soil is often impervious to an easy flow of water downwards. This may be seen by removing the soil in a small patch of usar and filling the ditch so formed with water. The water will stand

in the ditch for days. Such a case was observed by the writer at Cawnpore early in July, 1928. Drainage indeed is the key to the most successful handling of usar soils and even if irrigation is absent, the natural rainfall of the tract would help to wash down these salts.

(*b*) Removal of the surface 12 inches or so of soil and replacing it by soil free from usar combined with breaking up of the sub-soil. This is practicable only on small patches in fields as otherwise it becomes an expensive process.

(*c*) Application of substances like Gypsum which lessen the danger to plants from the presence of some of the injurious salts. This is however an expensive process.

Indirect methods.—(*a*) Careful cultivation. This process is within reach of every kisan. By constantly using any plough on his land he is liable to form a hard layer just below the depth to which his plough penetrates. This layer is called the "plough pan" and helps to create soil conditions favourable to the deposit of usar salts. To break up this layer deep ploughing is necessary and for this one of the modern ploughs as illustrated in Fig. 5 could be used with advantage. Among other things th's breaking up of the soil will make it easier for irrigation water to carry down with it the injurious salts in solution.

Apart from breaking up of the soil it is most necessary that surface evaporation be prevented as far as possible so that the soil water evaporation illustrated in Fig. 13 may be checked and the salts which otherwise would have risen with the water to the surface may be left where they need not be injurious. Surface evaporation can be prevented by cultivation of the surface soil after ploughing so that a thin layer of finely divided soil may be left on top of the soil. This finely divided layer known as a mulch acts like a blanket and so prevents evaporation. Whenever the soil is idle either before a crop is grown on it or after the crop is removed it should as far as possible be cultivated and left in such a condition. This not only prevents injurious sa'ts r'sing but also saves moisture in the soil from being lost. Sometimes when the crop is sown in lines it is necessary to make such a finely divided layer of surface soil by cultivation known as "interculture."

The implements which are recommended by the Agriculture Department and which are illustrated in Figs. 7 and 8 are both cheap and effective for this purpose. The former costs only Rs. 7-8-0 and the latter Rs. 25.

(*b*) Heavy manuring with farmyard manure. The manure acts in various ways for the benefit of these soils, firstly by diluting the poisonous effect of the usar in the soil. Secondly by opening up the soil by its decomposition during which certain changes also take place in the composition of the soil. Thirdly during decomposition of such manure an acid called humic acid is formed which to some extent neutralises the effect of alkali salts. Fourthly the manure adds plant food to these soils so that it may be possible to grow a crop on them. Once a crop has been grown, by repeated manuring, cultivation and the growing of crops the soil tends to return to a normal condition.

(*c*) Growing of certain resistant plants or trees which can stand a certain amount of these injurious salts in the soil. The planting of babul trees in deep pits has been found a successful method of reclaiming such land.

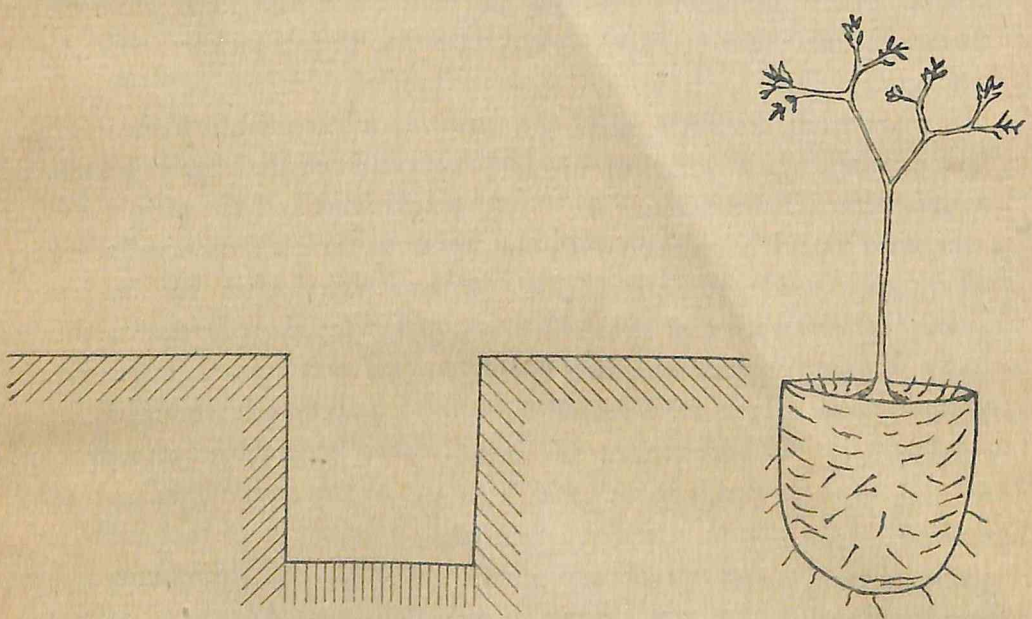


Fig. 14.

A PIT 3½ FT. DEEP AND 3 FT. WIDE DUG IN USAR SOIL AND A YOUNG BABUL TREE READY FOR PLANTING IN THE PIT.

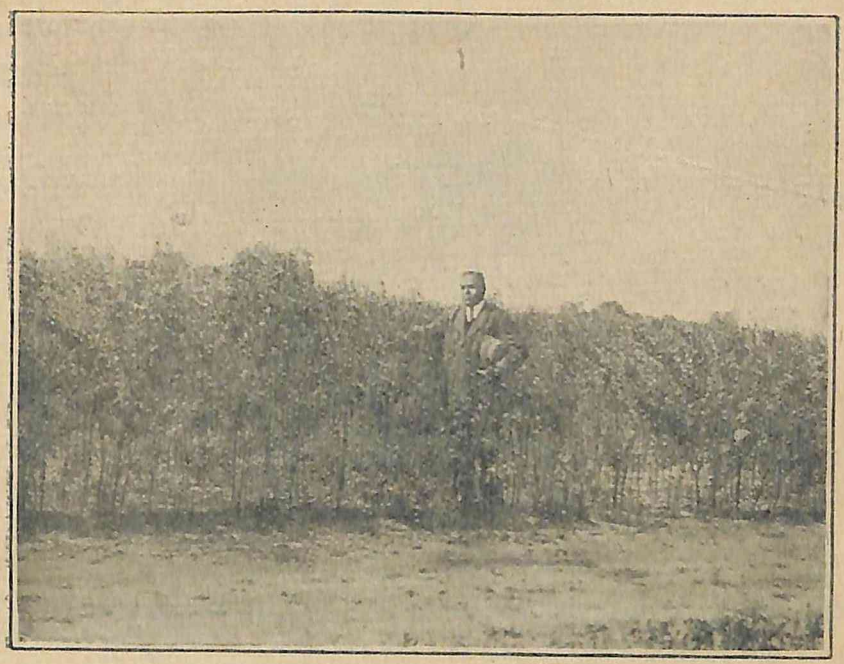


Fig. 15.

A FAIR CROP OF ARHAR GROWING ON A RECLAIMED USAR PLOT OF THE GOVERNMENT FARM, PARTABGARH.

The young tree brings with it a certain amount of healthy soil. If some cattle manure is available and is added to the pits all the better, otherwise the young trees planted in the rains will soon get a root hold and grow. This helps to open up the soil through the roots of these trees and in time grass begins to appear under the trees. By grazing cattle or sheep or goats on the land when the trees are safe from damage by them, the soil is still further improved. In time by removing the trees the land should be available for cultivation.

In addition to trees certain crops are found to be more resistant to usar conditions than others e.g. coarse paddies, field peas, barley, certain types of beetroot and some fodder grasses. In every case it is advisable to attempt a gradual reclamation of usar soil as any labour spent on methods claiming immediate reclamation is likely to yield disappointing results.

3. *Sloping soils scoured by rain.*

The next time you see a deep ditch or pit freshly dug look at it carefully and you may see a resemblance to the sketch in Fig. 16 (below).

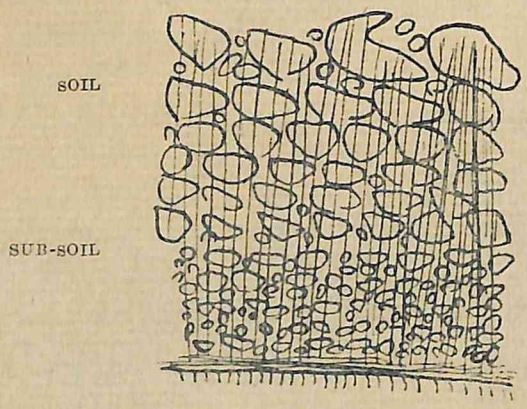


Fig. 16.
SECTION OF FIELD.

The top layer just below the surface is exposed to many agencies such as the wind, rain, frost, the burrowing of worms, the penetration of roots and so on. It is this top layer which has been described in Chapter 2 as the kisans "living possession." Its depth varies from a few inches to many feet. Immediately below it is a layer which is slowly being weathered by these same agencies and formed into soil, living soil, where the roots of plants may find food. The sub-soil however is the layer just below the soil where such food is not readily available and where there is much too much unavailable food material for plant life to be able to exist. In fact many sub-soils, because of very large quantities of raw materials of plant food being present in a form in which they are injurious to plants, are inimical to plant and bacterial life.

A very common mistake made by kisans is to leave their fields unprotected against the scouring or washing action of water as it flows over them during the rains. This is so particularly in fields which are markedly sloping.

The result of this mistake is that a large quantity of useful plant food is washed away every year and the crops grown on these fields are of a very poor grade.

Methods of improving scoured fields.

The remedy for such a condition is fairly simple. In the first place it is necessary that uneven fields should be levelled each year with the help of ordinary implements of tillage. Very little extra labour need be spent on levelling. The kisan has to prepare his fields for sowing. When the field has been ploughed the soil is in a loose condition and it is comparatively easy to move it from one side field to the other. This is effected gradually by carefully using the *pata* or plank. If the kisan can afford it a little extra labour used with a " karha " or scraper to convey the soil from high ground to low ground will bring about a level condition of the field in a short time.

Great care has to be exercised when levelling to see that the depth of the top soil remains more or less the same all over the field. This can be ensured by removing the soil to a depth of say six inches from the low lying portion of the field and heaping it up on one side. The same should be done with soil from the high ground. Now we have exposed the sub-soil assuming that the soil is only about six inches deep. As far as possible, only the sub-soil should be transferred from high to low ground. The soil which has been carefully stored away can then be replaced leaving the field covered with a uniform depth of soil and yet having achieved a level field by transfer of sub-soil from one spot to another. Of course where the soil is deeper than 6 to 9 inches, it is inconvenient and expensive to remove the whole of it and in that case only the top 6 inches or so, which is the most valuable portion, need be removed.

Secondly in order to check the flow of water in a sloping field, making a small earth embankment at the lower end often is a cheap and effective method. Where the slope is great and the kisan cannot afford to level the field in one season a simple way to check the rush of rain water is to build one or more barriers or *bunds* across the path of the water. On light soils there is always a possibility of these embankments and barriers being washed away during heavy rain. It is therefore useful to mix straw in clay and plaster the sides of the bunds with it. These operations are best done when the soil is wet during a shower of rain in the early monsoon, for the kisan is free from other work on his fields, and the wet soil gives a firmer hold to the bunds.

Finally it should be remembered that light soils are more liable to be scoured than heavy soils because the particles of soil are freer to move in the former than in the latter. It should also be noted that the presence of plant roots and organic matter in the soil helps these particles to stick closer together. Hence it is better to have a crop growing on a sloping field during the rains than to leave it fallow, assuming that it is not possible to undertake the levelling of the field before the rains commence.

Note for teacher :—The Agricultural Department is ready to help in the reclamation of defective soils by recommending the grant of taqavi loans for operations requiring outlay of capital. The advice of the local Agricultural Inspector should be sought in any individual case.

2. A good demonstration of the rise and fall of water in the soil can be shown to students by taking two glass cylinders, *A* containing sand and *B* clay and standing them in a basin filled on the *A* half with sand and on the *B* half with clay. Water may then be poured very slowly into the basin till all the earth in it

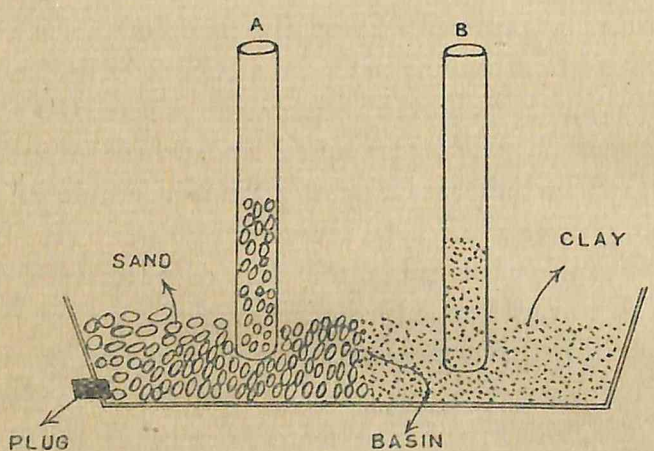


Fig. 17.

RISE AND FALL OF WATER DEMONSTRATED.

is soaking wet. It will be found that water will rise higher in the clay than in the sand by the force of surface tension. If the basin could be made fitted with an opening and plug, by draining the water the water would fall more in the sand than the clay.

The washing away of sand more easily than clay can easily be demonstrated in flowing water by holding a lump of either class of soil in one's hand in the water and letting the water wash it down through the fingers.

3. If the teacher can conveniently near the school find a patch in a field where nothing will grow he may assume it is an usar patch and he should dig a square ditch in it about 1 foot deep and say $2\frac{1}{2}$ feet square. This should be filled with water preferably after the first monsoon shower of rain. The water will remain there for days showing there is an impervious layer of soil surrounding it indicating the need for drainage in usar soils. On this very spot may be tried transplanting soil mixed with manure from a healthy field and if a crop is now sown on it it is likely to grow quite well.

CHAPTER IV.

Some crops improved by the Department of Agriculture, United Provinces.

Gram.

Next to wheat, gram is grown over the largest area in the United Provinces, namely, about 66 lakhs acres.

Local varieties.—There are three main varieties, the seed of which is (1) almost black, (2) yellow to reddish and (3) white (kabuli).

Average outturn for the province.—The outturn varies from about 9 maunds of grain to the acre in Bundelkhand to 11 maunds in the Eastern districts. When irrigated the average yield goes up to about 12½ maunds.

Improved varieties.—Pusa 25, Pusa 17, Pusa 18, Improved Partabgarh and Pusa P 6 B. These varieties have, among all improved varieties tested by the Department of Agriculture, given the best results in the United Provinces.

TABLE OF RESULTS OBTAINED.

Variety.	Where tested.	Outturn of grain in maunds per acre.	
		Mds.	srs.
P. 25	Shahjahanpur	25	24
P. 25	Cawnpore	27	10
P. 25	Gorakhpur	25	0
P. 25	Aligarh	23	0
P. 17	Shahjahanpur	23	17
P. 17	Mainpuri	17	33
P. 17	Aligarh	19	5
P. 18	Gorakhpur	23	26
Improved Partabgarh ..	Partabgarh	22	33
P. 6 B	Agra	22	10

Seed rate and cultivation.—One maund of seed per acre is the usual rate for sowing. Gram grows best on heavy soil but will grow on almost all soils. Three or four ploughings are ample. The crop is sown from the end of September to mid-October.

Diseases and pests.—When the plants are in flower frost is likely to damage them. The crop should not be sown in low-lying places which are subject to frost. Dampness also is bad for the crop when the pods are formed as it leads to attack by caterpillars which cut the leaves and bore into the pods.

Places where improved seed may be obtained.—In the above table is given the name of the place where the particular variety desired has been tested. If conditions of climate, etc., are similar in your locality, apply to the Farm Superintendent of the farm where the variety you require has been tested.

Wheat.

The area sown under wheat in the United Provinces is about 69 lakhs acres, little less than that under rice. But in importance wheat takes the first place because of the higher profit per acre resulting from it.

Local varieties.—There are two main classes of wheat in the Province the hard wheats or " Kathia " and the soft wheats or " Pissi." There are also the bearded and beardless varieties, but the distinction in quality of grain is more important.

Average outturn for the province.—For unirrigated wheat the average outturn is 10 maunds 15 seers per acre and for irrigated wheat 15 maunds 10 seers per acre.

Improved varieties.—Improvements have been made by selection and cross-breeding among mostly the soft-grained wheats which command a better market in other countries than hard wheats.

The following table shows the outturns of improved types of wheat tried at various experimental stations under the Agricultural Department, United Provinces :—

TABLE.

Variety.	Where tested.	Outturn of grain in maunds per acre.	
		Mds.	srs.
Pusa 12	Hardoi	33	0
Do.	Partabgarh	30	25
Do.	Shahjahanpur	26	27

Variety.	Where tested.	Outturn of grain in maunds per acre.	
		Mds.	srs.
Pusa	Cawnpore	25	0
Do.	Nagina (Bijnor)	22	24
Do.	Muthra	21	11

N.B.—At the Cawnpore College Farm in 1929 the best field under P12 yielded 36 maunds 5 seers per acre while the average for the whole farm for P12 was 26 maunds 16 seers.

Pusa 4	Bahraich	35	15
Do.	Gorakhpur	30	22
Do.	Cawnpore	30	0
Do.	Shahjahanpur	26	38
Do.	Nagina (Bijnor)	24	6
Do.	Jeolikote (Kumaon)	21	2
Muzzaffarnagar selected	Shahjahanpur	29	30
Ditto ..	Muttra	28	22
Ditto ..	Nagina (Bijnor)	25	8
Cawnpore 13 ..	Shahjahanpur	27	29
Ditto ..	Nagina (Bijnor)	27	5
Ditto ..	Gorakhpur	25	32
Federation	Bahraich	32	36
Do.	Gorakhpur	31	10
8A Punjab ..	Aligarh	30	23

In the above table is given the name of the place where a particular variety has been tried. The Superintendent of the Government Farm at each of these places is the person to apply to for seed of the variety tested.

Soil and cultivation requirements.—Wheat likes a loam or clay loam soil but will grow in almost any soil which has been well-manured. The wheat crop responds readily to thorough cultivation. In fallow areas cultivation should be started before the rains and continued during breaks in the rains. Where a kharif crop such as maize or juar

fodder is taken before wheat repeated ploughings followed by lighter cultivation should be given during September and October. After the first irrigation when the young plants are about 6 inches high the triangular harrow may be used and does not damage the crop. On the other hand the moisture in the soil is saved from evaporation and the young roots are aided in development.

Seed rate.—Seed rate tests have been carried out at Government farms and it has been found that 1 maund 10 seers per acre gives the best results with wheat.

Manurial requirements.—While 10 to 15 cartloads of cattle manure gives excellent results with wheat the following table of comparative results obtained on Government farms indicates the manures which are most profitable to use for this crop.

TABLE.

Place.	Variety.	Treatment.	Amount per acre applied.	Outturn of wheat per acre. Mds. srs.
Cawnpore ..	P. 4 ..	Sulphate of ammonia ..	11 mds.	30 0
Do. ..	,, ..	No sulphate of ammonia	....	23 0
Hardoi ..	P 12 ..	Sulphate of ammonia ..	Worth Rs. 6-12 ..	36 36
Do. ..	,, ..	Nitrate of soda ..	,, Rs. 6-12	37 4
Do. ..	,, ..	No manure	....	32 37
3. Altara (Banda). ..	P 54 ..	Nitrate of soda ..	1 md. 15 seers ..	14 0
Do. ..	,, ..	No manure	....	8 30
4. Gorakhpur	P 4 ..	Chilean nitrate ..	1 md. 16 seers ..	28 14
Do. ..	,, ..	No manure	....	24 12
5. Hardoi ..	P 12 ..	Green manured with sanai	....	34 5
Do. ..	,, ..	Farmyard manure ..	100 mds. ..	32 27
Do. ..	,, ..	No manure	....	28 5
6. Bulandshahr	P. 12	Neem cake	15 mds. per acre...	35 0
Do. ..	,, ..	Farmyard manure ..	150 ditto ..	33 2
Do. ..	,, ..	Mahwa cake	30 ditto ..	29 30
7. Partabgarh	P 4 ..	After fallow .. .. no manure.	....	19 16
Do. ..	,, ..	Sanai ploughed ..	....	22 13
Do. ..	,, ..	Farm yard manure ..	200 mds. per acre	23 22
Do. ..	,, ..	Castor cake	20 ,, ..	31 15
Do. ..	,, ..	Mahwa cake	50 ,, ..	25 20
Do. ..	,, ..	Neem cake	25 ,, ..	33 9

Among oil cake manures neem cake has given good results. Bone manures have been tried for wheat but have not been found satisfactory. Green manuring with Sanai is a cheap and effective way of

preparing the soil for the wheat crop and adds a great deal to the fertility of the seed bed. This method of manuring will be treated in the chapter on manures.

Diseases and pests.—Wheat is subject to losses in various ways, some of which are due to weather changes and others to causes beyond control. We will mention only such damage to the crop as can in some way directly or indirectly be prevented.

Lodging.—Frequently in irrigated areas a fine promising crop of wheat may be damaged to the extent of 10 to 15 per cent. by the plants lodging. This trouble is due partly to strong winds in February and March accompanied by rain and partly to the weakness of the straw in the plants themselves. Some wheats resist lodging better than others, *e.g.*, Pusa 12, Pusa 4 and Cawnpore 13. Resistant varieties should therefore be grown in places where this complaint is prevalent.

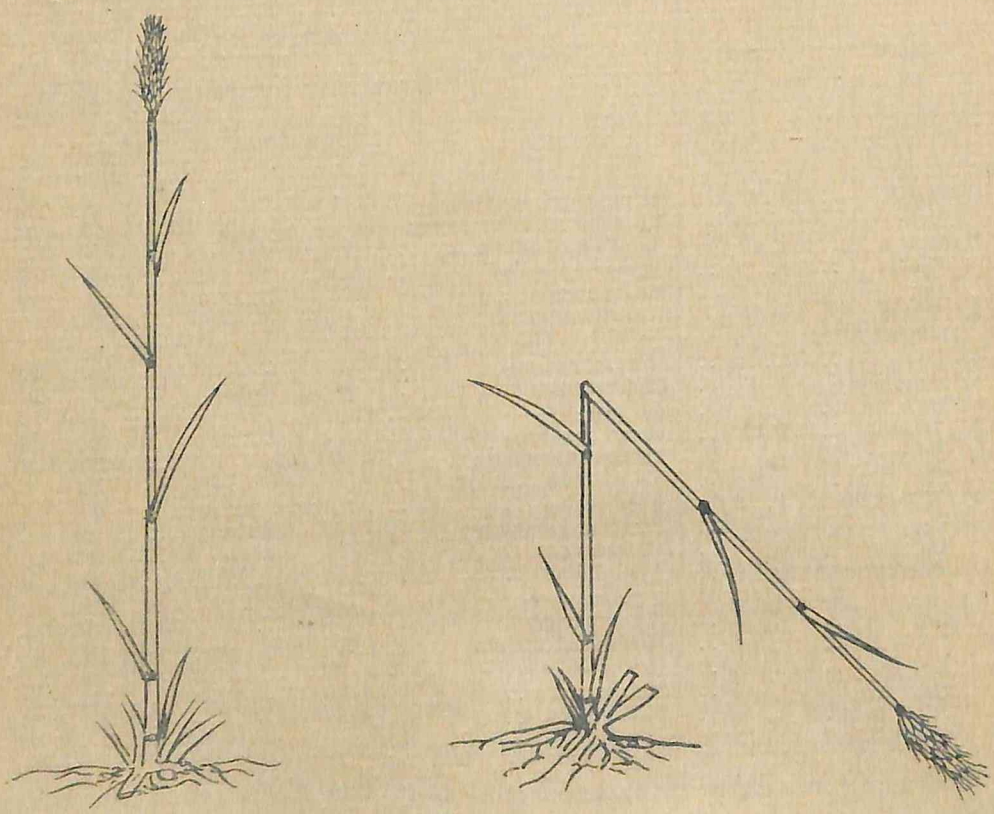


Fig. 18.

ERECT WHEAT PLANT. LODGED WHEAT PLANT.

White ants.—These pests do not require description. The best remedy is to water the crop as soon as the field shows signs of their attack. Dressings of neem cake have also been found useful and lately the writer has found that sprinkling powdered naphthaline in small quantities before irrigation in places where the attack is severe has a marked effect in removing white ants from fields of wheat and barley.

Rust.—The most common yellowish orange rust of wheat is frequently seen after the December rains. This is a disease which shows itself mostly on the leaves in the form of fine patches but which reduces the strength of the whole plant and results in shrivelled grain. There are rust resistant varieties of wheat—particularly Pusa 12 and Pusa 4, but there is no variety entirely immune from the disease. By avoiding low-lying fields for wheat and by growing resistant varieties, much of the damage from this disease can be avoided.

* *Rice.*

About a fifth of the total area under food grains in the United Provinces, i.e., over 74½ lakhs acres, are under this crop. It is the main crop grown in the divisions of Fyzabad, Gorakhpur and Benares while some of the finest varieties are found in the Dehra Dun district. It is a crop which flourishes where the rainfall is plentiful and the humidity high.

Fig. 19.

STUDENTS TRANSPLANTING RICE AT AGRICULTURAL COLLEGE FARM, CAWNPORE.

* The material for this note on rice has been gathered largely from recent publications on the subject by Mr. R. L. Sethi, M.A., B.SC. I.A.S., Economic Botanist to Government, United Provinces.

Local varieties.—There are a very large number of varieties which can be grouped as follows :—

(1) Transplanted | (2) Broadcast.

According to whether the paddy is sown in nurseries and then transplanted or broadcast like *kodon* or other similar grain.

The following are a few of the well-known varieties in the United Provinces :—

No.	Local name of variety.	Districts where grown.	Remarks,
1	Bansmati	Dehra Dun and Saharanpur.	
2	Ramjiawan	Ditto.	
3	Hansraj	Pilibhit.	
4	Gauria	Bareilly.	
5	Anjana	Ditto.	
6	Chaul	Rampur State.	
7	Parjati	Lucknow and some central districts.	Mostly transplanted from nursery.
8	Samhara	Cawnpore and some western districts.	
9	Anjee	Eastern districts.	
10	Latera	Ditto.	
11	Motichur	Ditto.	
12	Ramdhaniya	Allahabad.	
13	Kalasukhdas	Banda.	
14	Sathi	All over the province ..	Broadcast.
15	Deola	Ditto ..	Ditto.

The separate average outturns for each of these varieties has not been tested. In general the outturn of transplanted varieties is from 15 to 20 maunds per acre while that of broad cast varieties is 10 to 12 maunds per acre on cultivators fields.

Improved varieties.

No.	Variety.	Where tested.	Outturn of grain per acre. in maunds.
	Early transplanted varieties.		
1	A. 1	Cawnpore ..	20—25 maunds.
2	A. 2	,, ..	25—30 ,,
3	A. 7	,, ..	About 25 ,,
4	A. 26	,, ..	,, 30 ,,
5	A. 64	,, ..	,, 25 ,,
6	A. 89	,, ..	,, 25 ,,
7	73 F. G.	,, ..	,, 30 ,,
	Medium transplanted varieties.		
1	A. 32	,, ..	,, 35 ,,
	Late transplanted varieties.		
1	A. 21 Awned	,, ..	,, 35 ,,
2	A. 49	,, ..	35 maunds and over.
3	A. 53	,, ..	About 35 maunds.
4	A. 74	,, ..	35 maunds and over.
5	A. 74 sub-variety	,, ..	35 ,, ,, ,,
6	A. 80	,, ..	About 35 maunds.

Soil and cultivation requirements.—Transplanted varieties grow best on clayey soils. On the Cawnpore Botanical Farm, however, these have been grown with success on loam soils for the past five years, under canal irrigation. Broadcast varieties are hardy and will grow on almost any class of soil except sandy soil.

Cultivation of the field in May and June in preparation for the sowing of rice is very valuable. It is desirable to take a leguminous

crop like gram or peas during rabi on the field which is intended for rice the following kharif. The gram being harvested in March, the field should be ploughed immediately and left in a well cultivated condition after each ploughing—as many as can conveniently be given, say 4 to 6 times—until the middle of June when 10 to 15 cartloads, of cattle dung per acre should be applied and ploughed into the soil. From this time till the first week of July, whenever it rains the water should be allowed to accumulate and stand in the field. The seedlings are transplanted from the nursery to the field about the first week of July, when the monsoon has become established. Broadcast varieties require much less preparation and can be grown with about as much cultivation as any ordinary kharif crop.

Seed rate per acre.—For transplanted varieties 10 to 15 seers of seed sown in a nursery gives sufficient seedlings for one acre. The rate for broadcast varieties varies, but as a rule 25 to 30 seers per acre will suffice.

Manurial requirements.—Kisans seldom manure their rice-fields. Manure in the shape of well rotted cattle dung is applied to the nurseries for transplanted rice. The practice of taking a leguminous crop before and after paddy is recommended as a cheap method of renewing fertility for the subsequent crop. Experiments at Cawnpore have shown that green manuring with sanai was enough and gave the maximum yield. Further addition of manure brought about lodging which resulted in loss caused by the shedding of grain. Green manuring was also found very useful in places like Doiwala near Dehra Dun and at Tulsipur in the Tarai. In the absence of means of irrigation green manuring is not possible. Castor cake and neem cake and some chemical fertiliser are very useful as manure for rice, but for general application their cost is prohibitive.

Pests.—The most serious pest of the rice crop in these provinces is an evil smelling slender rice bug called *gundhi*. It sucks the sap from the flowers. It often occurs in epidemic form. It generally attacks early ripening varieties, mostly in September and disappears in the beginning of the cold weather about the middle of October. No method has been found so far of eradicating the pest, except catching it in bags and destroying it.

Sugarcane.

Area.—In the whole of India the total area under sugarcane is about 30 lakhs acres. Of this no less than 13½ lakhs acres are grown in the United Provinces. The Punjab comes next with an area of about 5 lakhs acres under sugarcane. The importance of the United Provinces as a cane growing area is therefore evident, its relative position as regards area under cane in respect to other provinces is illustrated graphically below :—

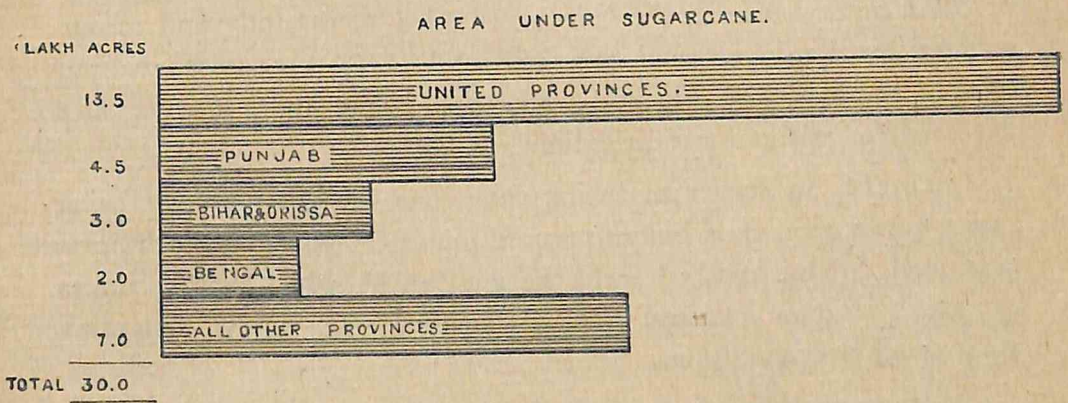


Fig. 20.

GRAPHIC ILLUSTRATION OF AREAS UNDER SUGARCANE.

Local varieties.—There are numerous indigenous varieties of cane grown in the United Provinces. These may be grouped as (1) thin canes or "Ookh" and (2) Thick canes or "Poundha". The first of this group are used mostly for the manufacture of gur, rab, etc., the second for chewing purposes as a fruit, and are grown near large markets where plenty of manure and irrigation is available.

Average outturn for the province.—The average outturn of gur from thin and medium canes in the province is from 30 to 35 maunds per acre. The following figures of outturns obtained from local thin canes on the Partabgarh Government Farm indicates results obtained under proper treatment :—

Variety.	Outturn of gur per acre. Mds.	srs.
Reora of Benares	43	14
Saretha of Muzaffarnagar	48	32
Matna	38	0
Kuswar	38	15

Improved varieties.—By far the most important work on sugarcane in the United Provinces has been carried out at the Shahjahanpur Experimental Farm where not only have the most profitable varieties been tested, but important results on manurial treatment and cost of cultivation been recorded. Improved machinery for the extraction of gur and rab has also given valuable results.

The following varieties of cane are recommended by the Department of Agriculture, United Provinces :—

Thin canes.—Among the thin canes tried successfully and recommended by the department are A42 and A47, two Shahjahanpur selected strains which do best when sown 2 feet apart in rows on a flat seed-bed without any irrigation.

C. O. 214, an earlier maturing cane, has the advantage of being harvested in good time before preparation of the land for kharif crops is started. Being crushed early the gur can be sold when the prices are high. Unlike A42 and A47, it grows better under irrigation than under dry conditions.

Reora is another selected indigenous variety which does well under dry conditions.

Medium canes.—S48 and S39, two Shahjahanpur canes, have been in great demand by cane growers for many years. The former is a heavy yielder suitable both for chewing and making gur. The latter is a good yielder but the juice is not so rich in sugar as that of S48.

Co.213, a hard skinned variety, suitable for growing in places liable to damage by rats and jackals.

It is a heavy yielder, but ripens late.

Co.290, Co. 237, Co.234 and Co.281 are other medium varieties which have established their superiority after trials at various farms. Of these Co.290 seems to be gaining greater favour now than even Co.213.

Thick canes.—The following varieties of thick cane have been tried on the Muzzaffarnagar Farm and have given good results better than local canes :—

M. 16. | B. 6308.

The local thick canes were badly attacked by mosaic and they had to be discarded. The price obtained per acre for B. 6308 for seed or chewing purposes was from Rs. 600 to Rs. 700.

The following thick canes were tried on the Shahjahanpur Farm and found suitable for the Bareilly district :—

M. 16, B. 1529 and Assam white.

Soil and cultivation requirements.—Sugarcane will grow best on clay loam soils but given ample cattle manure and irrigation it will grow on almost any grade of soil from a sandy loam to a clay. It is a crop which responds read ly to thorough cultivation. The planting season commences in January and goes on in the western districts to March and in the eastern districts in March or April. The number of ploughings which can be conveniently given to the soil will depend on the local circumstances and soil conditions. As a general rule as soon as the previous crop is lifted cultivation for sugarcane should commence. The system of growing canes in trenches has been proved to be more profitable than growing them on flat fields. The method of trenching followed at Shahjahanpur Farm is the one most widely adopted as improved practice.

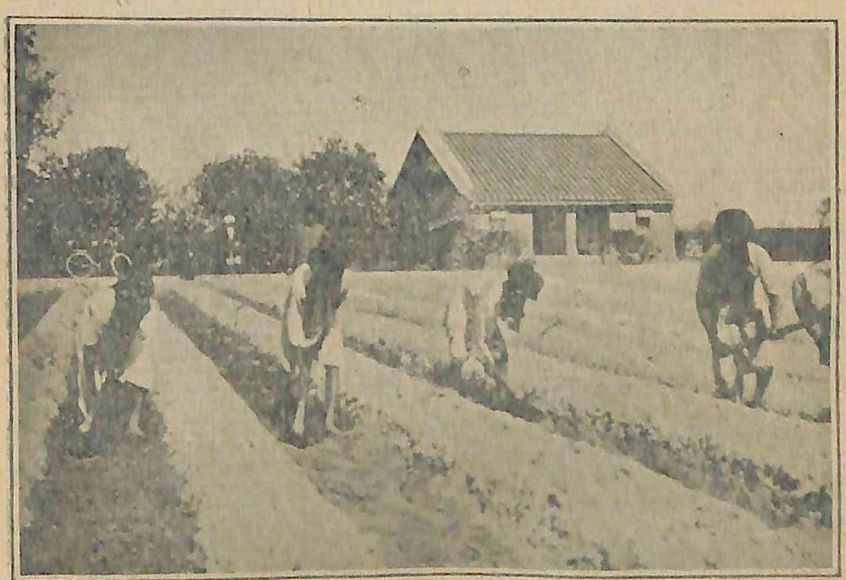


Fig. 21.

PREPARING TRENCHES FOR SUGARCANE ON THE SHAHJAHANPUR FARM.

Trenches are dug four feet apart about 3 months before planting. The soil is removed to a depth of about 6 inches and ridged up on either side of the trenches. After this to a further depth of 12 inches the soil is dug up with the *kudali* or *phaora*. Half the cattle manure to be applied to the crop is applied before the trenches are made and half is dug into the trench with the phaora. During breaks in the rains the crop is earthed up using the soil on the ridges.

Manurial requirements.—Sugarcane requires heavy dressings of cattle manure. Depending on the condition of the soil and the type of cane grown from 10 to 50 cartloads per acre supplemented if the cultivator can afford it with 20 to 30 maunds of castor cake is a suitable dressing. Castor cake should be powdered fine and applied either with the final hoeing before planting or when the plants are about a foot high. Heavy manuring should not be resorted to when the crop depends mostly on rain for its growth. Ample irrigation and heavy manuring go well together for this and other valuable crops.

The following figures of cost of cultivation per acre for the improved varieties Shahjahanpur 48, and Co.213, have been worked out on the Shahjahanpur Government Farm. It will be seen that in both cases manure is the most costly item in the production of the crop.

Operation.	Cost per acre. S. 48.	Cost per acre Co. 213
	Rs. a. p.	Rs. a. p.
Ploughing and preparation of land	37 2 8	39 10 3
Manure and cost of application	84 15 0	86 3 0
Seed and sowing expenses	47 4 6	36 5 6
Irrigation	57 6 3	40 7 6
Making trenches	16 1 10	14 5 3
Weeding and hoeing	27 12 0	30 12 0
Earthing	7 9 9	5 1 0
Watching	0 13 9	0 2 6
Harvesting	11 8 6	1 2 3
Making miscellaneous	7 0 0	7 0 0
Total ..	297 10 3	261 1 3

That so large an expenditure per acre is justified is borne out by the following figures for the above two cases showing cost of making rab and profits per acre :—

Variety.	Cost of cultivation.	Cost of making sugar and rab.	Sale per acre.	Profit per acre.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
S.48	297 10 3	31 8 6	746 13 6	417 10 9
Co.213	261 1 3	32 6 3	714 11 6	421 3 6

In most places harvesting is an inexpensive item as the labour employed will take the leaves and tops of the canes in payment. Watching charges on a private farm are likely to be slightly higher than the above unless suitable pig and jackal-proof fencing is used. Such fencing may be obtained through the Department of Agriculture.

Fig. 22.

A GOOD CROP OF Co. 213 SHAHJAHANPUR FARM.

Fig. 23.

INEXPENSIVE HARVESTING OF CANE, SHAHJAHANPUR FARM.

Seed rate per acre for improved varieties.—The seed rate will depend on (1) the variety of cane and (2) the distance apart of the rows. Seed is planted in the form of sets. Each set should have three nodes. They should be planted in the row leaving 6 inches to 9 inches between the end of each set. For improved varieties like Co.213 and S.48 the distance 4 feet apart between the rows has given excellent results on Government farms. Local varieties and even improved varieties are often planted by Kisans at 2½ to 3 feet apart. This involves unnecessary waste of seed with results that are not so good as when the distance between the rows is 3½ to 4 feet.

Diseases and pests.—(1) *Mosaic.*—This disease shows readily on the leaves of growing sugarcane in the form of fine yellow streaks. It spreads very rapidly and considerably lowers the yield of the crop. Work on the mosaic disease of sugarcane in the Rohilkhand Circle,

United Provinces, has resulted in the following conclusions which are valuable:—

(1) Varieties differ widely in their tolerance to mosaic.

(2) Sugarcane sown from sets infested result in the whole crop being completely infected.

(3) Cane sets sown from selected canes free from mosaic from a field where the infection is heavy, yield a crop with only 5 per cent. infection.

(4) Cane sets sown from canes selected as free from mosaic for two years yield a crop which shows less than ·1 per cent. infection. The above conclusions indicate that by careful selection of seed from year to year the disease may be practically exterminated.

Obtaining seed of improved varieties.—Improved seed of sugarcane is available on almost every Government Farm. The Shahjahanpur Farm is the centre of work on sugarcane in the United Provinces and valuable information about the crop may be obtained on application to the Deputy Director of Agriculture, Rohilkhand Circle, Shahjahanpur.

Gur, rab and sugar making-machinery.

The Department of Agriculture have made various improvements in (*a*) cane crushing machinery, (*b*) juice boiling and (*c*) making of gur, rab and sugar. These modern devices are in some cases expensive, but could be purchased on a joint co-operative basis by cane-growing zamindars. Modern methods may be seen at the Clarke Sugar Factory at Hardoi and the Shahjahanpur Experimental Farm.

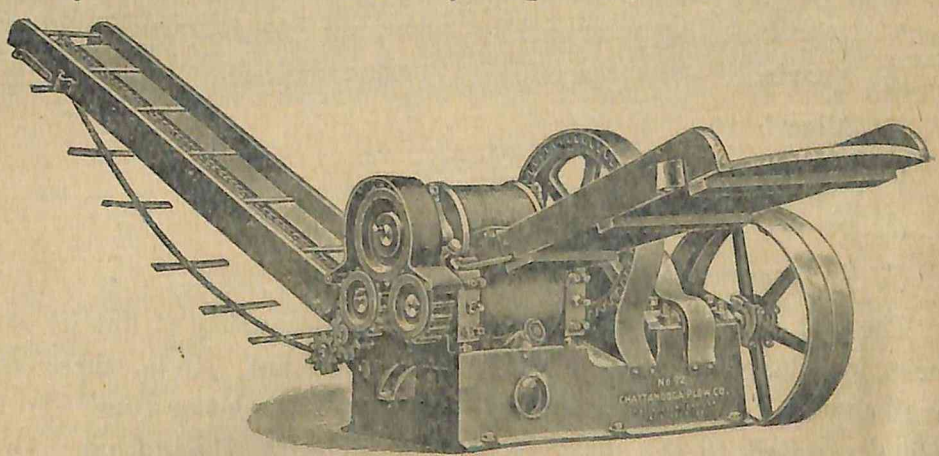


Fig. 24.

AN IMPROVED CANE-CRUSHING MILL DRIVEN BY OIL ENGINE.

Cotton.

Area.—The total area under the cultivation of cotton in the United Provinces is about 12½ lakhs acres or about 3·5 per cent. of the total area under cultivation in the province. Most of this area is under either the mixed *desi* cottons or varieties improved by the Agricultural Department by selection from Desi cottons. The area under irrigated cottons is on an average about 4½ lakhs acres.

Local varieties.—The local cotton is generally a mixture of many cottons. This results in many inferior cottons getting mixed up with *desi* cottons and so the quality of the marketable kapas is usually very poor. Desi cottons can be divided into two main classes, (1) white-flowered and (2) yellow-flowered. The former are more susceptible to the damaging effect of heavy rainfall than the latter. During the wet seasons of 1916 and 1917, therefore the proportion of yellow flowered varieties in the *desi* mixture increased.

Average outturn for the province.—The average outturns of *desi* cottons of the province are as follows :—

(1) unirrigated, 130 lbs. per acre of lint.

(2) irrigated, 170 ,, ,, ,, ,,

Varieties introduced by the Department of Agriculture.

Improvements in cotton consist of obtaining (*a*) a longer staple, (*b*) whiter and finer lint and (*c*) heavier yielding varieties than *desi* cotton.

After many years of careful work the Agricultural Department has evolved the following four cottons which are now extensively grown in the province :—

(1) Aligarh 19.

(2) Jalaun 1.

(3) K. 22.

(4) Cawnpore American.

The first of these is a heavy yielder and the quality of lint is superior in colour and fineness to the *desi* cotton lint. It is, therefore, much more profitable to grow it than to grow the latter type. It is specially suited to the districts of Aligarh, Agra, Bulandshahr and Mutt a.

Jalaun 1 and K22 are specially favoured in the central and south-western districts of the Province. Cawnpore American will grow anywhere provided the rainfall is not heavy and irrigation can be provided. Due to its long growing season it cannot be followed immediately by a mixture of barley and peas or peas alone as is the practice with shorter-stapled cottons, but its kapas fetches a high price in

Fig. 25.

A.19 COTTON AT THE PRIVATE FARM OF THAKUR DURGASINGH, LAKHUPURA, MUTTRA.

the market which largely compensates for this. Moreover if with late cottons are sown fodders like senji and even berseem or *Lucerne* as is done in the Punjab, additional profit ought to result besides improving the fertility of the soil. The fodder may be broadcasted in the standing cotton crop in October.

Soil and cultivation requirements.

Cotton is grown almost all over the province, but it thrives best in the districts of Bulandshahr, Northern Aligarh and Agra. It likes a high temperature in both the dry and wet season and a smaller rainfall than that of the eastern districts. Early cessation of rain in August or excessive rain in September is particularly harmful to this crop.

When irrigation cannot be given, the crop has to be sown as soon after the break of the rains as possible. It is therefore not usually possible to give the land more than 2 or 3 ploughings before sowing. One weeding is necessary. The crop should be sown in lines 1½ feet apart and the plants spaced 9 inches to 12 inches apart. This will make it possible to do the weeding and interculture by machinery rather than by hand. In cotton tracts the most usual rotation is cotton followed by wheat. Irrigated cottons should be sown in the end of May. The seed rate per acre varies from 4 to 6 seers.

American cotton should always be sown in lines at 2½ feet to 3 feet apart.

The outturn of improved varieties of cotton varies with soil, climatic and cultivation conditions from 9 maunds to 14 or 15 maunds of dry kapas per acre. (1 maund =100 lbs. of kapas in the Cawnpore market.)

For seed and further information about cottons, the cultivator should apply to the Assistant Economic Botanist, Cawnpore, or the Deputy Director of Agriculture, Western Circle, Aligarh.

Fodder crops.

Lucerne.—In the chapter on cattle improvement mention has been made of the appallingly small area under fodder crops in the United Provinces and its inadequate supply of fodder to the large number of cattle in the province. To increase the area under fodder crops is possible but the economic condition of kisans generally does

not permit of this. What is possible is the growing of such fodders as yield heavily compared with those grown at present.

The following results obtained by fodder trials at Atarra indicate the vast improvement which is possible by growing a fodder crop like Lucerne.

Variety.	Yield in lbs. per acre of green fodder.
1. Juar	4,379 lbs.
2. Juar-mung mixture	4,496 „
3. Lucerne	16,243 „

Nearly four times as much green fodder may be obtained by growing Lucerne as by growing juar. Besides this Lucerne has a much more superior feeding value than juar. In fact it must not be fed to cattle except when mixed with bhusa or other dry fodder in the proportion of about one part Lucerne to three of dry fodder.

Lucerne seed may be obtained from the Agricultural College Farm at Cawnpore or by application to the Deputy Director of Agriculture of any circle. It can be grown under both well and canal irrigation. Several cuttings may be obtained during the year. The crop should be cut just before it flowers and should be irrigated after each cutting in addition to irrigation given in preparing the seed bed.

The above example of the quantity of fodder obtained does not indicate the possibilities of outturn from this fodder. On the Mainpuri Government District Farm 52,960 lbs. per acre of green Lucerne fodder have been obtained.

The Howard system of growing Lucerne.—Lucerne is grown on flat beds two feet wide with irrigation channels one foot wide between the beds. The seed at 15 to 18 seers per acre is sown broadcast both on the beds and in the irrigation channels. The irrigation channels serve also as drainage channels during the rains. By this method less water for irrigation is required and weeding is reduced. The ordinary method of sowing Lucerne is to sow it on ridges 1½ to 2 feet

apart. The furrows are watered and kept clear of weeds. The seed required per acre in this case will be from 4 to 6 seers.

Lucerne cannot compete with weeds. The field which is intended for this crop must receive deep and thorough cultivation and the best soil is a rich loam.

On the Cawnpore Experimental Farm by this method 41,051 lbs. of green fodder were obtained in 6 cuttings.

The following table shows results obtained at Cawnpore with seven different types of fodder under different treatments :—

Variety.	Manure.	Date of sowing.	Number of waterings.	Date of harvesting.	Yield in lbs. per acre.
		Cawnpore farm.			
Maize ..	Mustard cake at 8 mds. per acre.	July 8, 1924 ..	..	August 17, 1924.	9,836
Do. ..	Oil cake at 9 mds. per acre.	February 21, 1924	6	May 4, 1924	19,157
Do. ..	Oil cake at 10 mds. per acre.	Ditto ..	6	May 2, 1924	12,523
Juar ..	Oil cake at 8 mds. per acre.	July 4, 1924 ..	..	September 3, 1924.	16,847*
Do. ..	Oil cake at 10 mds. per acre.	July 7, 1924 ..	..	October 22, 1924.	18,166*
Do. ..	Nil ..	June 11, 1924 ..	2	July 18, 1924	18,445
Bajra ..	Nil ..	August 19, 1924	..	October 1, 1924.	10,719
Lucerne ..	Oil cake at 10 mds. per acre.	December 16, 1923	12	9 cuttings ..	62,292
Do. ..	Ditto ..	December 7, 1923	11	8 do. ..	37,768
		Kalyanpur farm.			
Juar and guar mixed.	Cattle dung at 200 mds. per acre.	June, 1924 ..	..	July 11, to November 23.	21,134

* Damaged by heavy rain.

Variety.	Manure.	Date of sowing.	Number of waterings.	Date of harvesting.	Yield in lbs. per acre.
	Kalyanpur farm—(concluded).				
Lucerne ..	Oil cake at 10 mds. per acre.	November 16, 1924.	8	4 cuttings ..	26,606
Do. ..	Ditto ..	Ditto ..	9	..	21,011
Do. ..	Cattle dung at 120 mds. per acre.	Ditto ..	9	5 cuttings ..	15,721
Do. ..	Ditto ..	December 2, 1924	6	7—April 11 1924.	7,260
Oats ..	Cattle dung at 200 mds. per acre.	Novmber 16, to December 2, 1924.	9	..	16,143
Carrot ..	..	August 23, 1924	3	..	7,957

N.B.—82 lbs.=1 mauud.

Maize.—The special advantage of maize as a fodder crop lies in its maturing very quickly compared with Juar and other fodders. It can, therefore, be put into soil soon after the wheat crop is harvested provided irrigation can be given. It is then ready for harvest in about 6 to 9 weeks. After maize another kharif crop may be taken the same year if the soil is sufficiently fertile. Maize has also this advantage over other fodder crops that it is available in May, June and July before most other green fodders are ready for use.

Seed rate.—As a fodder twelve seers of seed suffices to sow one acre (6 seers per acre when sown for grain). It is desirable to grow good seed. A selected Jaunpur variety has been tried and found better than local varieties. The Deputy Director of Agriculture, Central Circle, Cawnpore, will supply seed to kisans applying for it.

Outturn.—The outturn per acre of maize fodder varies very greatly. It will depend largely on, (*a*) the fertility of the soil; (*b*) number of irrigations given, (*c*) time of the year or season when grown. From the table above it will be seen that maize grown on July 8 without irrigation yielded about half as much fodder as that grown as early as February 21 and harvested on May 4 after receiving 6 irrigations.

Maize does not generally yield such a big crop of green fodder as juar. The former after 2 or 3 ploughings will yield 120 to 250 maunds of green fodder per acre ; the latter from 200 maunds to 600 maunds and more per acre depending on the conditions of soil in which grown.

Other fodders.—For the dry months of January, February and March where irrigation is available oats will give from 150 to 250 maunds of green fodder per acre in one or two cuttings and this makes an excellent mixture with bhusa of wheat or barley.

But there is a tendency for kisans to neglect mixing legume fodders with bhusa karbi during the winter season. For the purpose of mixture the following legume fodders may be used with advantage during the rabi season :—

(*a*) Lucerne, (*b*) Green Gram, (*c*) Green field peas and just before the harvest of wheat, the bhusa of arhar which is also useful to mix with green maize fodder during the hot weather.

During the kharif season the local mixture of juar and guar or guar by itself is much to be preferred as a fodder to juar by itself because the legume crop supplies an important ingredient of diet which the pure juar fodder is poor in.

Among fodders that are under trial by the Agricultural Department are (*a*) Elephant grass, (*b*) Rhodes grass, (*c*) Guinea grass, (*d*) Berseem clover, (*e*) Shaftal (*f*) Broomcorn and Senji. Nothing definite, however, can be said about these yet.

It will be seen from the table already referred to that bajra without any manure or irrigation gave about 125 maunds per acre of fodder when sown on August 19 and harvested October 1. This means that in a little under six weeks the crop was ready as a fodder. This is, therefore, a crop the cultivation, for fodder, of which should receive greater attention.

CHAPTER V.

MANURES.

Manure from plant remains.—The soils of the United Provinces and indeed all over India are mostly in need of organic matter. This organic matter is merely the partially or wholly decayed remains of plants. The remains of animals also help to form organic matter but as their quantity is so small it may be regarded as negligible.

Chinese compost.—Plant remains, such as stubble collected from fields, weeds which have not been allowed to seed, leaves, straw and fodder removed from cattle sheds, etc., should never be burnt. Very valuable manure can be made by treating this material in the following manner.

With a chopper or by treading with bullocks or with a fodder chopping machine, reduce the plant remains to fine pieces. Then take some ordinary soil from a field and mix it with a small quantity of well rotted cattle manure and wood ashes. For a cartload of plant waste, five or six baskets full of soil, the same of cattle manure and about half a basket of wood ashes should be sufficient. Make a heap of the plant remains and mix with it thoroughly with a phaora the cattle manure and ashes. Then sprinkle water on the heap and mix again until the mixture is moist throughout. The heap should be turned occasionally. It will rot rapidly and may be applied to the crop or seed bed as soon as fermentation has practically ceased. Water should be sprinkled and the heap turned every day. This makes a very valuable manure and the Chinese use it extensively. It has, therefore, been called "Chinese Compost." At Indore, ten cartloads of this manure which costs very little to make has more than doubled the yield of cotton. The most important natural agents at work in thus converting apparently useless material into a valuable manure are the friendly bacteria referred to in Chapter II.

Human and animal excreta as manure.

Just as we have borrowed a valuable method of making manure from plant remains, from the Chinese, we have to learn a very

important lesson from the industry of the Japanese. Human excreta in that country is seldom wasted. The Japanese kisan collects all the excreta available into a large covered pot. Here this is constantly stirred so that air may get freely into it. Soon the friendly bacteria do the work of converting this offensive mass into an odourless and highly valuable manure which is applied to his crops. Suitable tanks and machinery are now being used in many countries to achieve the same purpose with human excreta and the name given to the method is the Activated Sludge Process. For further particulars on this point information may be obtained by Municipalities, Local Boards, Co-operative Societies, etc., from Dr. Gilbert. J. Fowler, Government Technological Institute, Cawnpore.*

It should be noted that the application of fresh human excreta to the field in the ordinary way is most wasteful, most of it is lost and a very small proportion is converted into plant food. It is most undesirable to apply fresh excreta of any kind to most of our soils, particularly those which are lacking in moisture.

Animal excreta.—The most commonly used manure in India is cattle manure. But the food value to plants of this manure is very easily reduced by careless handling, both in the process of preparation and when applied to the field. It is not enough to collect cattle dung in a heap daily until the time comes to apply it to the field. The heat of the sun, air and moisture while valuable in converting dung into manure are also detrimental if allowed to act on it too freely. Cattle dung is valuable but more valuable still is cattle urine and yet so much of it is lost. This can be largely saved by spreading under the cattle loose earth which costs nothing. Once a week this loose earth should be removed to a depth of say two inches and added to the stock of cattle dung. The earth absorbs the valuable ingredients of the urine and adds bulk to the kisan's stock of manure.

Cattle manure may be preserved either in pits or in heaps. The former is preferable. In pits it is most advisable to spread the daily collections evenly and to cover the layer with a thin layer of soil. In the open heap the same should be done taking care that none of the heap is exposed for long. The pits should not be more than 5 or or 6 feet deep. A convenient size is 12 feet long and 6 feet wide. It

* Now at Central Hotel, Bangalore.

is better to have three or four pits of this size than to have one large one equal to three small ones. When one pit is filled it should be covered with a layer of earth 9″ to a foot thick and the covering should be sloped down to the sides. The pits should be in a high and dry part of the village where water will not collect easily. The bottom and sides of each pit should be plastered with clay or cowdung mixed with chopped straw so that liquid matter is not easily lost by seepage. In three or four months the pit may be opened and will be in good condition to apply to the fields. It is much better for rotting of any kind of organic manure to take place in the pit or heap where it is stored than on the field where it is wanted for the crop.

Green manure.—The practice of growing a crop of sunn hemp or *sanai* and of ploughing the crop into the field to rot as manure has been advocated by the Department of Agriculture for many years. It has been adopted by many zamindars and kisans with success.

Sanai is selected (1) because it is a leguminous or pod-bearing plant and all plants of this family have the extraordinary characterstic of collecting valuable plant food in their roots and even in their stems, and (2) because of all leguminous crops tried as green manure *sanai* gives the best results. (3) It grows well on almost all types of soil and the period of its growth coincides with the rainy season and facilitates its being ploughed into the soil prior to its rotting therein and so being useful to the succeeding crops. It is ready to be ploughed in from 50 to 60

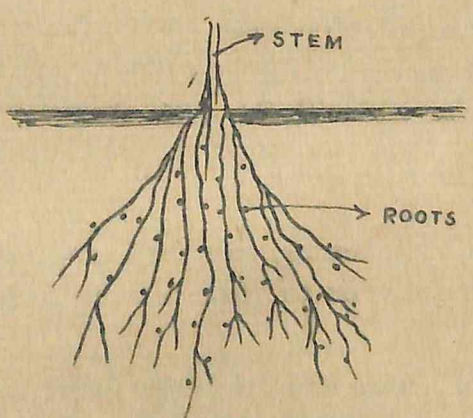


Fig. 27.

ROOTS OF SANAI SHOWING NODULES CONTAI ING POTENTIAL PLANT FOOD.

days after sowing. Now as the *roots* are left in the soil, this collection of plant food remains there also : and if the stems are ploughed in as well additional plant food is added at very little expense. One maund per acre of sanai seed sown will cost about Rs. 4. The cultivation given to the field would have been given in any case and the presence of a thick crop covering the field in the rains not only preserves moisture but prevents weeds from increasing. The succeeding crop is greatly benefitted and a cheap and effective manure is thus added to the field.

Note for teacher.—The appearance of nodules on the roots of pod-bearing plants and the absence of them on the roots of plants of other natural orders may easily be demonstrated by carefully taking out the roots with soil attached and washing them in running water till all the soil is washed away. The roots will then show very minute bead-like nodules, which contain plant food manufactured by useful bacteria which live in these roots.

The following results obtained recently on the light soils of the Hardoi Government Experimental Farm bear out the general experience gained by using sanai as a green manure :—

Pusa 12 wheat.	Yield of grain per acre. Mds.	sr.
Green manured with sanai	34	5
Farmyard manure at 100 maunds per acre	32	27
No manure	28	0

The experiment is still in progress. Seed of sanai may be obtained in almost any large market. The best time to plant the crop is late in June with irrigation and with the first shower of rain when irrigation is not available. The crop is ready to be ploughed into the soil in about six weeks.

Among other legume-bearing species, guar, cowpea dhencha, tarota, etc., have been tried as green manure, but sanai has so far been most successful.

Oil cake manures.—The seeds of castor, neem and mahua when pressed for oil leave a valuable residue in the form of oil cake. Castor and neem cake have been found useful for crops like sugarcane, tobacco, wheat and similar valuable crops but mahua cake has not

been found so useful. Dressings of from 15 maunds to 30 maunds per acre of these cakes are useful and add considerably to the value of the crop. These cakes are expensive for the ordinary kisan, prices varying from Rs. 2-8-0 to Rs. 3 per maund and as they should be applied in addition to cattle manure they appreciably increase the cost of producing the crop and except in the case of castor cake and possibly neem cake it is doubtful if this form of manuring can be generally advocated.

On the Bulandshahr District Farm neem cake, mahua cake, and farmyard manure were applied to wheat in such a way that the amount of the most valuable plant food ingredient in each was applied in equal quantities.

The outturns obtained were as follows :—

Neem cake gave 35 maunds grain per acre.

Mahua cake gave 29 maunds 30 seers grain per acre.

Farmyard manure gave 33 maunds 2 seers grain per acre.

On the Partabgarh Government Farm with the Hansraj variety of paddy 200 maunds per acre of cattle dung applied yielded 32 maunds 8 seers of paddy grain ; while 71 maunds per acre of neem cake applied to the crop yielded 29 maunds 9 seers of grain. The check plot where no manure was applied yielded only 11 maunds 34 seers of grain.

Commercial fertilisers.—There are various commercial manures available in the market which are easy to handle and in some cases have proved profitable. Among these are nitrate of soda, superphosphate, basic slag sulphate of ammonia, bone meal, sulphate of potash, guano, nitrate of potash. Use of these substances as manure must be cautiously undertaken and the reader is advised to get into touch with the nearest Agricultural Officer for advice in the case of any individual crop. The following fertilisers should not be mixed together as the results would be wasteful :—

1. Dung with lime.
2. Guano with lime.
3. Guano with basic slag.
4. Nitrate with superphosphate.
5. Sulphate of ammonia with basic slag.
6. Superphosphate with basic slag.

The following results have been obtained with nitrate of soda applied to wheat on the Atarra Farm in Bundelkhand :—

	Yield of grain. Mds. sr.
Nitrate of soda at 1 maund 15 seers per acre	15 20
No manure	8 30

These fertilisers are costly. The price varies from about Rs. 6 to Rs. 10 per maund. But small quantities serve much the same purpose as larger quantities of cheaper manures. On our soils, however, the need for organic manures such as compost, cattle dung and green manure is far greater as a rule than that for costly fertilisers. The latter, however, are valuable under certain conditions where very valuable crops are raised. It often pays to apply commercial fertilizers along with organic manures, but each case of raising a costly crop has to be considered carefully before deciding on the manure or manures to be applied.

The condition of the soil, the availability of water for irrigation, the rotation of crops practi ed and the climate are some of the factors which influence the correct use of manures.

Note for teacher.

The following object lesson should be given by the teacher on the preservation and value of manure :—

Exercise.—Take a few baskets full of ordinary cattle dung and leave it in a heap for three months preferably during the rainy season. After this apply it to any crop growing in the school garden. Take the same number of baskets of manure from the same place and bury the manure in the ground covering the pit with about 9″ of earth and sloping the top down so that rain water may run off it. After three months dig up the manure and apply it in the same way as above and to the same area of crop but in a different part of the field and note the difference in appearance of the crop in the two cases. The effect in the latter case will be much more desirable than in the former.

Note the difference between the manured and unmanured parts of the standing crop.

CHAPTER VI.

Cattle improvement.

In all matters concerning cattle improvement the most important point to keep in view is that cattle are a direct or indirect source of income. If this source of income is defective it must be improved with a view to increasing the wealth and income of the zamindar and the cultivator.

Some of the Kheri cattle in the United Provinces are excellent. They are fast, strong and being small in size do not require much food. Yet even these cattle are capable of improvement for there are large numbers of them which do not answer to the above description and the best of them though strong enough for light work with the *desi* plough are not up to the mark with heavier ploughs and other modern machinery requiring greater draft power.

Number of cattle in the United Provinces.

The total cattle population of the province, that is oxen and buffaloes, is about 310 lakhs. Of these one-third are bullocks. There are about 62 lakhs of cows and 40 lakhs of she-buffaloes. There are only 26,000 bulls and about 8 lakhs of male buffaloes including both castrated and uncastrated buffaloes. The remainder are young stock.

General causes of defective cattle in the province.

Fodder shortage.—Cattle must be well fed if they are expected to work well or to produce desirable results. The area under fodder crops in the United Provinces is only about 12 lakhs of acres while there are 310 lakhs head of cattle. This means that for every 26 head of cattle there is only one acre under a fodder crop. This is obviously insufficient even if all the grazing area in the province were taken into account.

In the Punjab the cattle are far superior to cattle in the United Provinces and we find that while the cattle population in that province is about 152 lakhs, the area under fodder crops is about 43 lakhs acres, or about one acre to between 3 and 4 head of cattle. The people there realize the importance of producing plenty of fodder in order to keep their cattle strong and efficient.

The cattle-breeding section of the Agricultural Department, United Provinces, has demonstrated the advantages of producing

and storing fodder as silage in pits at very small cost. Further information on this point may be obtained from the Deputy Director in charge, Cattle-Breeding, Muttra, United Provinces.

Insufficient and inferior bulls.—While there are 61 lakhs of cows in the province there are only 26,000 bulls, *i.e.*, about 240 cows to each bull. Now even supposing that of these 61 lakhs, 10 lakhs are old and useless cows there are still nearly 200 cows to be served by each bull. One bull should not be required to serve more than 50 or 60 cows for the best results. More than this number has a harmful effect on the bull and this is one of the chief causes why our bulls are as a rule of poor quality.

Fig. 27.
A TYPICAL VILLAGER'S BULL, COMMONLY USED FOR BREEDING.

Another reason why our bulls are inferior is that they are allowed to serve in the herd at a very early age when they are still undeveloped. The cows too, are often scarcely old enough to be served. The result is that the vitality of the young bull and cow are lowered and the progeny is of inferior stamp. A bull should as rule never be

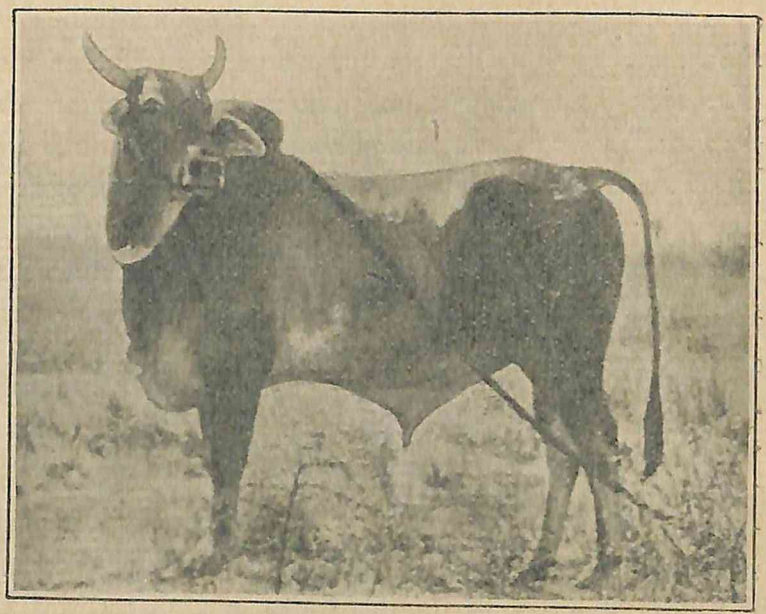


Fig. 28.

A FINE BULL OF THE HISSAR BREED ON THE GOVERNMENT FARM, MADHURIKUND.

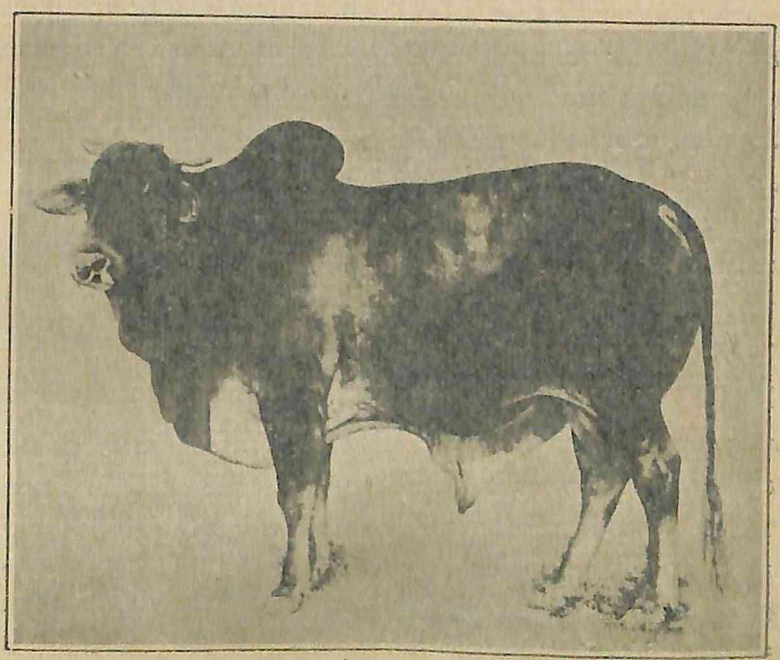


Fig. 29.

A PEDIGREED MONTGOMERY BULL (PUSA HERD).

allowed to run with the herd of cows and heifers until he is at least one and a half years old. Heifers are likely to come into first heat too early if allowed to run with the bull too soon. Heifers should so be cared for that they do not tend to come to heat before they are about $2\frac{1}{2}$ years' old.

The ration of the bull which is being prepared for service in the herd should consist of gram, bran or other grain husk and plenty of fodder. Oil cakes and starchy food should be avoided. The amount fed will depend on the size or weight of the animal, but as a rule 3 to 4 seers of the concentrate and as much fodder and grazing as the bull will take is essential. The practice of feeding Brahmni Bulls with all sorts of fattening stuff is most detrimental to them as sires for breeding purposes. A breeding bull should not indicate a tendency to fat and fleshiness.

Selection of sire and dam neglected.—It is a matter of common knowledge that like begets like. Hence a bull or sire like the Kanwaria breed of Bundelkhund with its stout squat appearance, if mated, would not yield a product like the lean long-legged Hissar or Kosi type. Neither would a bull whose dam and dam's dam never gave more than 3 seers of milk a day, if mated to a cow of like description, yield a product in the shape of a female calf that would eventually give more than 15 seers of milk a day.

According to the purpose for which the progeny of the sire and dam is required, should the sire and dam be selected. The type which would produce good work bullocks must be carefully selected for the following characteristics in the sire, (1) active and alert appearance, (2) well-formed strong bones, (3) muscular shoulders, loins, hips and back, (4) straight and well-formed limbs and hoofs and (5) deep chest and barrel.

For milk production the dam requires greater care in selection than the sire. The latter should however be the son and grandson of heavy milk-producing cows, leanness being preferable to fleshiness in both sire and dam. The following are some of the desirable characters to look for in the future mother of a milk-producing herd : —

(1) A large udder covered with soft folds of skin, with uniformly placed teats of good size.

(2) Wide hips and a large barrel showing ample capacity both for the bearing of calves and for feeding well.

(3) The body should narrow from back to front with indications of a deep chest without any tendency to heaviness or fleshiness in the shoulders, neck, head and forequarters.

(4) Thin and shapely bones are preferable to large stout bones.

(5) The extremities, that is, the face and the tail, should indicate good breeding, the former indicating docile temper and the latter should be long and tapering with a tidy tuft of hair at the end.

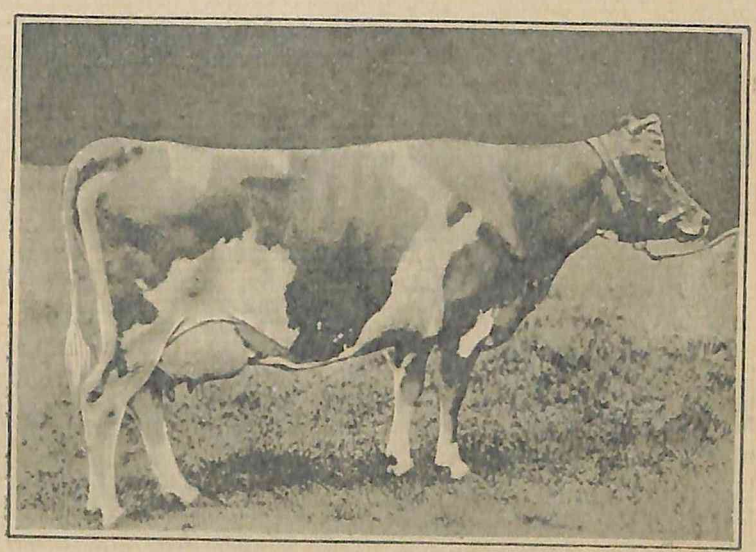


Fig. 30(*a*).

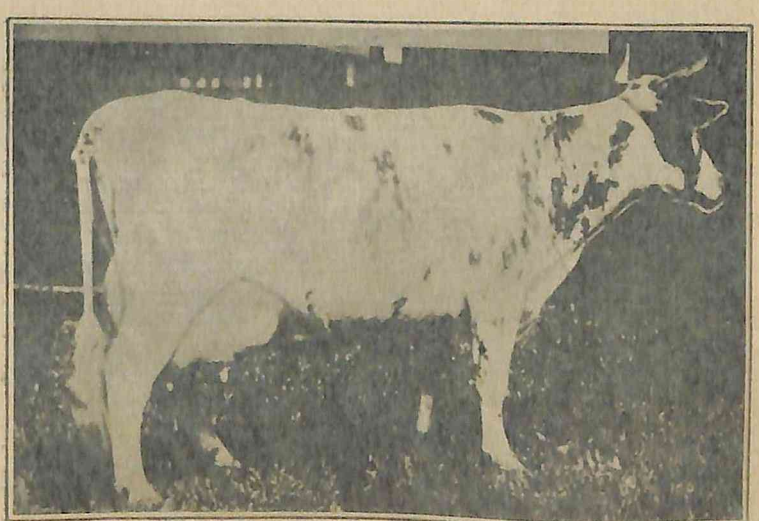


Fig. 30(*b*).

TWO GOOD TYPES OF DAIRY COW OF FOREIGN BREED.

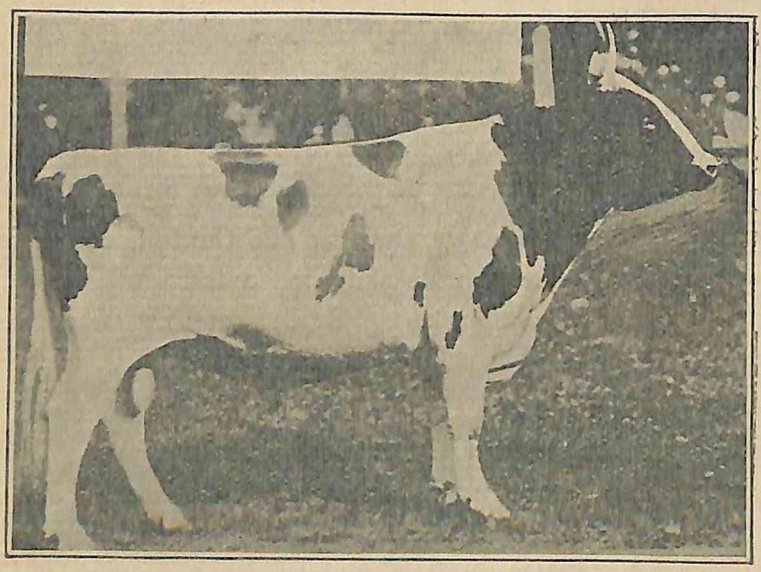


Fig. 31.

A DAIRY TYPE OF BULL OF FOREIGN BREED.

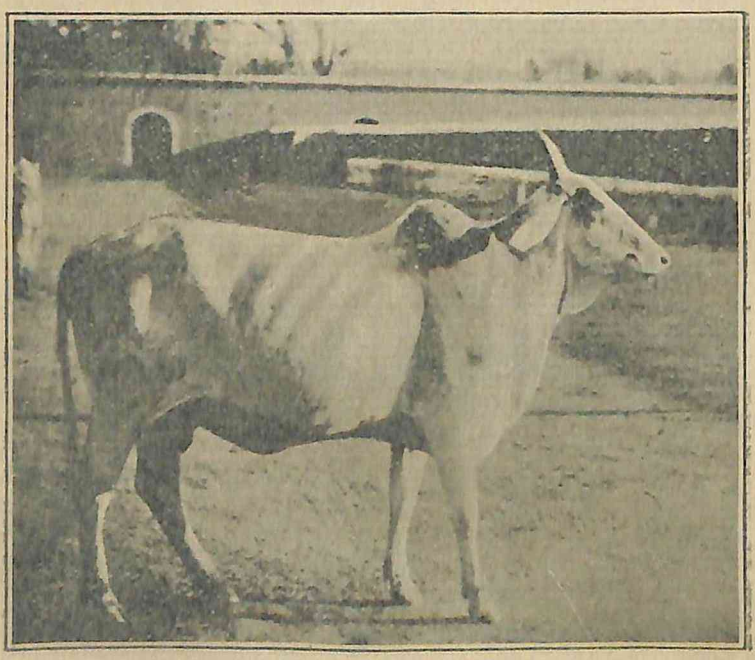


Fig. 32.

A SELECTED HISSAR COW.

(DUAL PURPOSE.)

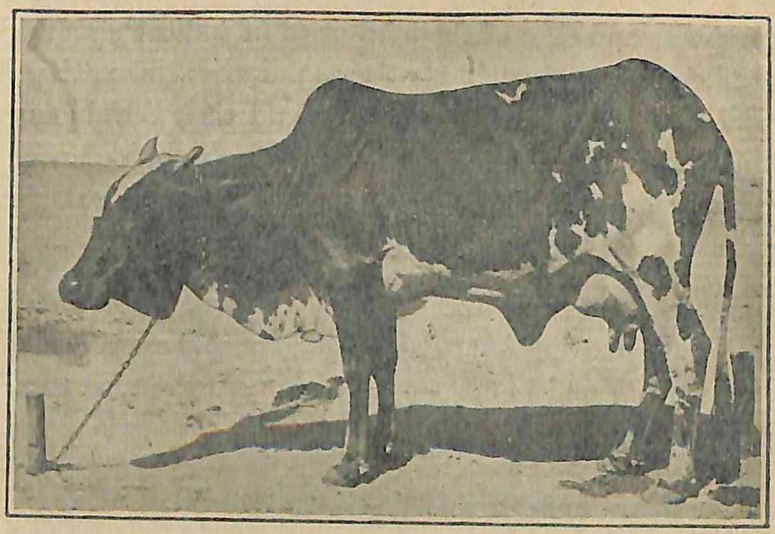


Fig. 33.
A SELECTED MONTGOMERY COW (MILK BREED).

Herding together of all classes of breeding stock.

One of the commonest causes of inferior live stock is the herding together of old and useless cows with good breeding stock. The young heifers too are allowed to run with the herd. Often the most inferior bull in the herd is allowed to serve the female stock along with the best sire. The result is that calves are produced firstly by useless cows and secondly by mothers who are too young to come into calf. Moreover the sire is not always the best bull available.

To avoid such an undesirable result the young bulls should be kept separate from the young heifers and the old and useless animals should be sent to some *gaoshala* or otherwise disposed of.

The actual breeding herd representing the dams and sire of the future stock should be carefully selected and then kept entirely apart. One bull should be allowed to run with a herd of 40 to 50 selected young cows. In large zamindari herds it should be possible to separate (1) the future dams and sire of the bullock types from (2) the future dams and sire of the milk-producing types.

The young calves should be separated as soon as they are weaned from their mothers, into (1) those which are not worth keeping either as future dams and sires of the herd or to be bullocks, and (2) those which are likely to be of value for these purposes. On the feeding and care of such selected calves will depend their development. It behoves the owner therefore to take special care of them for which advice is available through officers of the Agricultural Department.

The Department of Agriculture has a large cattle-breeding section with headquarters at Muttra. Bulls of improved strain are available for sale and distribution. Other assistance such as information concerning the care and management of the herd is also supplied on application by this Department.

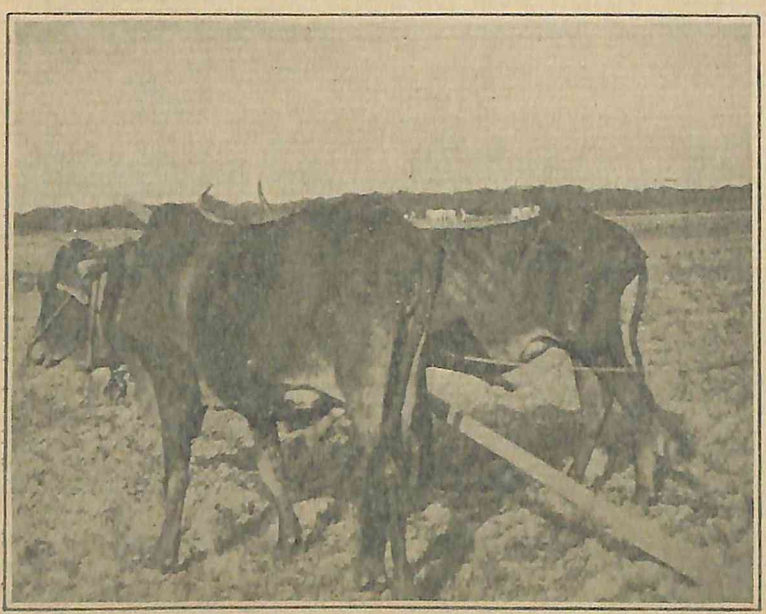


Fig. 34.

A MISERABLE PAIR OF KISAN'S BULLOCKS.

Dual purpose cattle.—The zamindar usually keeps the buffalo to supply his family with milk and butter and the cow to supply him with work bullocks where he has sufficient grazing to maintain a herd. Now this entails keeping two types of milch animal for two distinct purposes involving much expense and labour.

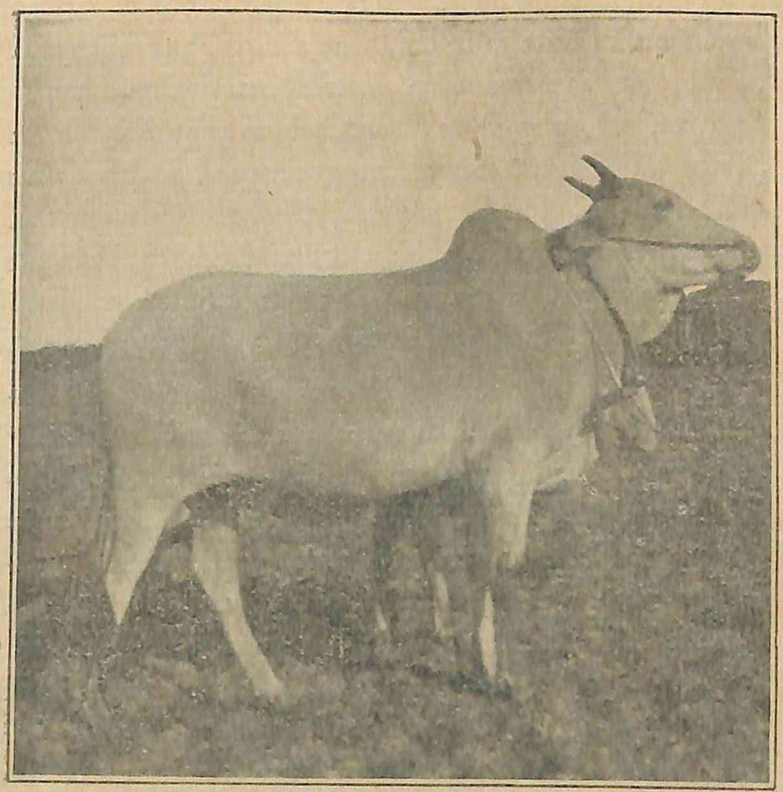


Fig. 35.

A FINE SELECTED PAIR OF KOSI BULLOCKS.

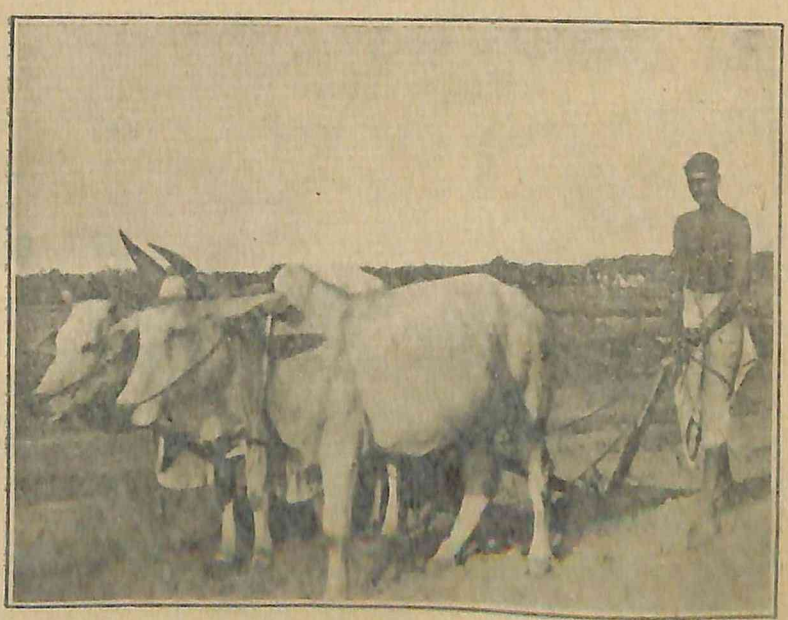


Fig. 36.

A SELECTED PAIR OF KHERI BULLOCKS.

While the buffalo is unquestionably a useful animal particularly in wet tracts and because its milk contains a larger percentage of butter fat than cow's milk, yet there are breeds of cattle which tend to combine both milk-yielding qualities with those required for draft purposes. Such breeds are known as dual-purpose breeds because they serve two purposes in the one breed. A good example of this is the Hissar breed. A good Hissar cow will give from 10 to 12 seers of milk per day and more, while she will produce bull calves which turn out to be among the finest draft cattle in India. This breed flourishes in the United Provinces particularly in the western districts and bulls of this breed can be had either direct from Hissar through the Punjab Agricultural Department or from the Government Cattle Breeding Farm at Muttra. The writer knows of at least two zamindars in the United Provinces who have purchased young cows and a bull of this breed for breeding purposes and are very pleased with them.

CHAPTER VII.

Farm management.

The secret of successful agriculture lies in sound management of the farm whether it be a small tenant's holding or a large *khudkasht* farm under the landlord's own cultivation. Sound management includes (1) selection of the most profitable cropping schemes, (2) economy in expenditure of money, (3) conservation of water and manure, (4) the correct use of the implements of tillage, (5) the proper care of cattle or other motive power on the farm, (6) keeping a careful account of the working of the farm and (7) shrewd business methods in marketing.

(1) *Cropping schemes.*

The advantage of drawing up a carefully thought-out cropping scheme for a holding or farm is mainly that the growing of unprofitable and more or less useless crops is prevented. A good cropping scheme shows the farmer what to grow and when to grow it. A good farm manager studies every field on his farm and draws up, well in advance, a programme for each field showing what crop will be grown on it (*a*) during the rabi and (*b*) during kharif. Sometimes it is necessary to give a field complete rest in which case it must be kept lightly cultivated.

Again, some fields are in need of organic matter and if sufficient farmyard manure is not available, it may be most desirable to grow a leguminous crop for green manure (*see* Chapter V).

The principles on which cropping schemes are based are very similar to those underlying scientific rotation of crops, with this difference that while a rotation of crops aims at economy of plant food, indirectly by virtue of the peculiar characteristics of each variety of crop grown, cropping schemes provide in addition an economic use for all available manures, irrigation, labour and machinery, and in fact all the material resources available, which the farmer controls.

How to draw up a cropping scheme.

The first step necessary in drawing up any cropping scheme is to make a list or inventory of all the farmer's resources which are available for crop production and marketing. The following are some of the headings under which these resources may be grouped :—

(1) *The soil.*—Its characteristics, its suitability for the growth of crops taken in order of merit, i.e., according to greatest profit per acre. Such information as is possible to obtain on these points, through expert advice or by enquiry into the past history of the fields, should be tabulated for each field. A map showing each field is most essential.

(2) *Capital available* with the farmer for such necessary expenditure as (*a*) labour on preparation of seed bed, (2) cost of seed, (*c*) manure, (*d*) irrigation, and (*e*) marketing charges.

(3) Actual quantity of manure available.

(4) Labour employed permanently and so available throughout the year.

(5) Available motive power, *i.e.*, bullocks, tractors, etc.

(6) Types of irrigation water available and the cost of each.

(7) Arrangements for storage of farm produce

(8) Arrangements for disposal of farm produce.

Along with the above should be drawn up a list of all possible crops which may be grown with reasonable hope of profit in that particular locality : and lastly the market both proximate and distant must be carefully studied with a view to determine the ultimate demand value of each type of farm produce.

Having tabulated the above valuable data the next step in drawing up a cropping scheme is to divide the farm on the map into a number of divisions of convenient size say 5 acres each. This may be done on the map, the object being to facilitate the work of drawing up a cropping scheme by breaking the farm up into small units.

Next take any one unit and jot down for each field the crop or crops which, with the information already carefully recorded, seem the most obviously profitable. By careful correlation of (*a*) the soil factor, (*b*) the other resources of the farmer, and (*c*) market demand, a programme can be arrived at which appears at first sight to be an excellent scheme for the unit we are considering.

The same method must be used for each unit until a map of the unit is obtained somewhat as follows :—

UNIT No. 1.

AREA 5 ACRES.

Cropping scheme for season 1927-28.

(Area of each plot 1 acre.)

N.B.—A convenient size of acre plot is a rectangle 180×242 feet.

Field no. 1.	*Kharif.*—Sugarcane harvested. ↓ Hot weather maize. *Rabi.*—Wheat.	*Kharif.*—Hot weather fodder (maize). ↓ Green manuring. *Rabi.*—Wheat and gram mixture.	Field no. 2.
Field no. 3.	*Kharif.*—Hot weather vegitables. ↓ Kharif fodder juar and guar. *Rabi.*—Tobacco (sown January).	*Kharif.*—Hot weather vegetables. ↓ Sann hemp for green manure. *Rabi.*—Wheat.	*Kharif.*—Sugarcane planted March. *Rabi.*—Sugarcane standing crop. Field no. 5.

Field no. 4.

1. *Typical map showing cropping scheme for unit area.*—Having drawn up such a map for one unit, the same should be done for each unit on the farm. When the map for the whole farm is ready it must be carefully scrutinized in order to make such changes as the distance of units from the manure pits the irrigation supplies and from each other, render desirable. The final map should then be faired out and kept for reference and record. Incidentally such a map will serve as an excellent method of recording the history of each field.

2. *Economy in the expenditure of money.*—Every farmer should have a convenient date for the commencement and end of his financial year. The official agricultural year commences on June 1 and ends May 31. The official financial year commences April 1 and ends March 31.

Either of these may be adopted, or even the ordinary calendar year from January 1 to December 31 will do. It is immaterial

what date the year commences, so long as the farmer sticks to the same dates throughout.

Budgets.—It is essential in the interests of good business that the farmer should draw up well in advance of his finanacil year, a budget estimating his income and expenditure during the financial year. In doing so he has to cut his coat according to his cloth. His means are of necessity limited and his income must needs limit his expenditure. The following rules will be found helpful in effecting economy :—

(1) Never exceed budgeted expenditure.

(2) Don't use any cash receipts directly as it is received. Deposit them in a bank and use only the amount which the budget allows.

(3) Keep a careful account of income and expenditure separating expenditure on such items as buildings, roads, drains, levelling of fields, repairs, implements, bullocks, fencing, etc., under the head capital or fixed account. Other recurring items such as labour, manure, seed, irrigation charges, feed and care of bullocks under the head Revenue or Recurring Account.

(4) As far as possible see that expenditure is distributed more or less evenly over each month so that at the end of the year there may be no embarrasment due to serious deficiency, or any large excess.

(5) Divide income into four main heads well before the next financial year as follows :—

(1) Proposed capital expenditure on farm.

(2) Proposed revenue expenditure on farm.

(3) Personal and family expenses.

(4) Savings in fixed deposit.

Having done so the farmer must not exceed these allotments. These headings should be further sub-divided into sub-heads, e.g.

Capital expenditure divided into—

A.—Buildings.

B.—Roads.

C.—Drains.

D.—Machinery.

E.—Permanent improvements in the land such as levelling up, making drains, etc.

Revenue expenditure should similarly be divided into a number of heads according to convenience.

Savings.—Having allotted amounts to various heads and sub-heads according to estimated expenditure, the farmer should next turn his attention to possible savings under each head. The item which can usually be curtailed from day to day is the item of daily labour. Monthly paid labour can also often be curtailed under a competent manager of the business. For example it is better to pay one good man Rs. 16 per mensem when he does the work of two men on Rs. 11 each. There is here a saving of Rs. 6 per mensem. Again, the farm manager must as quick as possible get acquainted with his labourers and be able to tell the value or worth of each. He must then replace every weak or incompetent man by competent labourers even if the latter cost one or two annas more per man per day. In the long run the roll of labourers will be reduced to a small number of competent men at a much smaller cost per day than if a large team of incompetent men, women and children are employed, at bigger total cost.

Similarly under every head and sub-head there must be careful scrutiny to see whether the slightest saving is possible. This can only be done if the farm manager is keen enough in his work to go into every detail of the business of the farm from day to day with a view to saving and curtailing expenditure. Even in the matter of bullocks there can be curtailments, if for light work in the cart, light one-bullock carts are used and wherever possible the use of large and heavy feeders among bullocks is avoided. In selecting machinery great care should be exercised to get the most economical in use. and where heavy and expensive machinery is purchased the oft made mistake of loading up a farm with too much of it should be carefully avoided.

General economy.—A great deal of money is spent each year on manure. The writer has increased the output of manure on a farm by 100 per cent. by careful methods of conserving it such as are described in the chapter on manures.

Good seed of heavy yielding varieties which fetch a good price in the market is always worth the extra money it costs. In this respect therefore a little extra spent is a point of economy and not extravagance

The farmer must organize his labour in such a way that there is some productive work to do throughout the year even if it is an extra ploughing or two given to a field or labour spent on the conservation of manurial resources.

3. *Conservation of water and manure.*—Just as a scarcity of moisture in the soil is harmful so also is an excess of water. Special care must be exercised to see that excessive amounts of water do not collect in the following conditions :—

(1) In clayey soils.

(2) In any soil where the permanent water table is less than say 10 feet from the surface of the field.

Fortunately the latter conditions are not found except in the *Tarai* and tracts adjoining the *Tarai*. The former condition however is to be found more frequently. The kisan should remember that clay soils retain moisture for a long time and very often surface cultivation is all that is necessary to utilize this store of moisture. In areas where rice is grown large doses of water scarcely ever do any harm ; but rice is not the only crop grown on clayey soils. Even if water is available in plenty the kisan should not use it unless and until he is certain that the particular crop growing needs it.

Methods of conserving or saving soil moisture from wastage by evaporation have already been discussed in chapter 2. Not only should these methods be used in economically using natural sources of moisture such as rain and dew, but where artificial irrigation is practised the same care is necessary to prevent moisture evaporating from the soil.

Conserving manure.—In the chapter on manures we have dealt with the methods of collecting and preserving cattle manure as well as rubbish and everything on the farm which can add to the bulk of the manure heap and which consists of animal and plant remains which decompose without much difficulty. The kisan should remember that by burning cattle dung he is destroying valuable plant food. If

this very dung were preserved and applied to his crops at the right time the additional produce obtained would enable him to buy the necessary fuel. Zamindars and kisans should make it a rule that in every village a portion of land will be afforested for the purpose of supplying fuel and other wood to the inhabitants at cheap rates. Afforestation is very simple and any zamindar wanting advice on this matter can get it easily by applying to the Collector of his district.

4. *The correct use of implements of tillage.*—On Government farms the correct use of implements of tillage may be seen and the advantages gained thereby are many. To take one instance, the department of Agriculture has recommended the use of the Punjab plough as a type of soil inverting implement suitable for use with a good pair of bullocks. In the central circle from 1923 to 1928 the Deputy Director has carried out experiments to compare the work of this plough with that of the Desi plough, both working at a depth of 6 to 7 inches. Five to eight ploughings were given to wheat and the average increase in outturn over five years experiment, due to the more satisfactory work of the Punjab plough was as follows :—

5·5 maunds of grain per acre.

11·3 maunds of bhusa per acre.

The money value of this advantage comes to Rs. 39 per acre with wheat selling at Rs. 5 per maund and bhusa at Re. 1 per maund.

Similar experiments were carried out to compare the value of the Meston plough with the Desi plough. The Meston plough like the Punjab inverts the soil, but is meant to work at shallow depths and with the ordinary bullocks possessed by the poorest kisan. In this case both the Meston and the Desi plough were worked to a depth of 4-5 inches and the crop sown was wheat. In these experiments as well as those with the Punjab plough all other operations in the field such as preparation of seed bed, irrigation, harvesting and threshing were done by the ordinary methods of the kisan.

The advantage gained by the Meston plough over the Desi plough in the shape of increased outturn of wheat was as follows over an average of five years :—

4·2 maunds of grain per acre.

7·1 maunds of bhusa per acre.

This represents a monetary advantage of Rs. 28 per acre in favour of the Meston plough with wheat and bhusa selling at the prices quoted above.

The Punjab plough costs Rs. 43 and the Meston plough Rs. 5-12-0 so it is clear that to gain so large an advantage does not cost so very much after all. A kisan growing 5 acres of wheat would in one rabi season reap an extra profit of Rs. $39 \times 5 = 195$ if he used the Punjab instead of the Desi plough while by using a Meston plough over the same area his additional profit would be Rs. $28 \times 5 = 140$.

With other types of improved implements the zamindar or intelligent kisan should in the same way endeavour to work out the profit in cash to him by the use of those implements before be actually uses them. That is the best way to arrive at the correct use of implements of tillage in the management of a farm, for each implement has its own peculiar function and advantage.

5. *The proper care of work cattle.*—Since a kisan's bullocks supply the power required to pull his plough and other implements of tillage, to work his water lifts, to pull his carts and to thresh his grain, it follows that without good and efficient bullocks, the power supplied will be weak and the outturn of work less than it would be with strong and healthy cattle.

Moreover the bullock is a living animal and the better you care for it the longer it will live and the better it will work, within certain limits. On the contrary the life of the bullock would be shortened and its efficiency impaired were it to get less than its proper ration. This would mean that during the life-time of the kisan the quicker his bullocks became old and useless the oftener would he have to replace them by fresh purchase. In order to get the best use out of bullocks the greatest attention they need is towards their feeding. In a large number of cases the kisan has neither enough fodder nor enough money to feed his bullocks well. But even where both these commodities are present very few zamindars and cultivators take the trouble to provide the minimum food requirements of their cattle. The amount of food per bullock will vary with the size and weight of the animal ; but the quality of food must never be so poor that the bullock cannot eat it with relish. The best and simplest evidence of

the animal getting enough to eat of good quality fodder is its condition. The animal should look active, the skin and hair should never look coarse and rough, the ribs and other prominent bones should be well covered with muscle. Concentrated ration in the shape of grain or oil cake or bran is most essential when the bullock is engaged in work and even when it is idle but in smaller quantities, but few kisans can afford to give them these things. If however by harder work and greater industry the outturn of grain and fodder from his fields can be increased, he may be able to spare some grain and enough fodder for the cattle that help him to raise his crops. This extra food will act as an investment and lead to better results in the field. In other words, higher outturns will be obtained with the same amount and quality of human effort. The practice of extracting the maximum of work out of bullocks with insufficient feeding is bad economy and results in loss to the kisan in the end.

6. *Keeping a careful account of the working of the Farm.*—In the appendix to this book will be found the forms which are recommended for maintaining the necessary accounts of a Farm and a commercial Dairy. The latter will also be found useful on a Cattle Breeding Farm. The advantages of keeping records and accounts in this manner are manifold. Not only are the money transactions noted as in every business concern, but details of outgoings and incomings of produce of all kinds are recorded. The affairs of the farm can be checked at any time without difficulty if the registers are properly maintained. In this way if the zamindar has to leave his farm in charge of a *karinda* he need have no fear that he will be cheated provided he has a rough idea of the condition of his crops from time to time. Such records have the further advantage of teaching the farmer to be accurate. Vague statements are of no use in any business, far less in farming. Properly kept records and accounts remove all indefiniteness from the business of farming.

In the case of cattle these records enable the farmer to foresee his next year's requirements in fodder and concentrates. The records of produce moreover, form a correct history which in time becomes a store of useful information regarding the farm.

7. *Shrewd business methods in marketing.*—This subject will be more fully dealt with in the next chapter. Suffice it to say here that the time at which the kisan sells his produce does not generally coincide with the time when that produce can fetch the best price. For instance when wheat was harvested in 1928 the price near Cawnpore was about Rs. 5-8-0 per maund. In the month of December the same year it was over Rs. 7 per maund. But by this time it was in the hands of the grain merchant who was reaping large profits which ought to have belonged to the grower of the wheat. Now Rs. 1-8-0 per maund may appear to be a small increase ; but the merchant who buys 1,000 maunds at harvest makes Rs. 1,500 within a few months. This profit could have been shared by the kisans who grew the wheat if they had some means of storing the grain, and if they were not always so much in debt and so easily led to borrowing money.

The same holds good to a large extent with other kinds of marketable produce and it behoves the kisan to see that his own interests are not damaged by his disposing of his produce hastily and without watching the fluctuations in the market.

Nowadays with improved means of transport such as the railway and motor buses, when the latter often reach the very door of the kisan, it is comparatively easy in many cases for him to visit the market and see for himself the methods of purchase and sale practised there.

If this is not possible he should endeavour to make friends with persons residing near large markets so that they may keep him informed of prices and save him from the ever ready money-lender who tries to lure the kisan from shrewd business methods of sale by the promise of ready money. The best method of fighting this evil is by co-operation among zamindars and kisans. This will be discussed in the next chapter.

Note for teacher.

The following two exercises on the subject matter of this chapter could be usefully done by the students under the guidance of the teacher :—

Exercise 1.—Taking the sample cropping scheme on page 34 as a guide let the teacher mark out a measured square on the ground 2 yards by 2 yards. This should be divided into 5 approximately equal

rectangles to represent acre plots. Using weeds and the stems of wild grasses and trees to represent crops the teacher should make the students plant the plots with crops as they would stand at different periods such as August 1 and December 1. The teacher might tell the students simple facts about each crop in the scheme such as the sowing and harvesting seasons, the seed rate per acre and the outturn per acre. This would serve as an object lesson in drawing up simple cropping schemes. A few intelligent questions asked from neighbouring kisans by the teacher in the presence of the students would go a long way to fix in their minds the elementary principles of cropping schemes.

Exercise 2.—*Afforestation.*—The principle of planting up young trees close together at first and later on to thin out the plantation to allow room for the growing trees may be illustrated by the teacher (*a*) by growing at 2 or 3 inches apart the seed of Sann Hemp commonly called sanai and when the plants show poor development due to being planted close the plants may be thinned out leaving double the original space between the plants. The better development of the plants can now be noted. Further thinning should be continued until a space of about 2 feet is left between each plant. This will allow of fresh planting of Sann Hemp between the full grown plants and will illustrate how the gaps formed by cutting down trees may be filled up systematically by fresh plantings at regular intervals. Sann Hemp will grow any time between June 1 and July 15. (*b*) By making an actual plantation of babul or sheesham on a suitable plot near the school if available. Neighbouring zamindars could help a great deal by allowing the teacher to plant up some of their waste land under babul or sheesham. In either case according to common practice the seedlings are first planted at an equal distance of 5 feet apart. When the young trees are about 9 or 10 feet high the first thinning is done leaving them 10 feet apart. In the gaps so formed it is not possible to replant with success as the shade of the older trees prevents development. When the trees have grown tall and straight the next pruning would leave them 20 feet apart. Each tree removed can now be replaced by a seedling which will develop under the protection of the older trees.

CHAPTER VIII.

Co-operation in agriculture.

It is not our object here to describe the Co-operative Credit movement. That Co-operative Societies and banks exist all over the province is well known. These are however mostly credit societies where money may be borrowed at reasonable rates of interest.

Assuming that our reader is already a member of a Co-operative Society from which he can borrow money, let us see some of the ways in which this money may be spent with advantage. The borrower must remember that he has to pay interest, say 9 per cent. Now his money must be so invested that a return of more than 9 per cent. is assured.

Individual versus Co-operative investment.

Since the borrower cannot obtain indefinitely large supplies of money against his own or his societies securities, it follows that with the capital he borrows he cannot make any very big investment likely to yield very big results. For example, suppose that there are 50 members of a small Co-operative Credit Society and each member is able to borrow Rs. 100 from the society. One hundred rupees would scarcely buy a pair of bullocks for each member.

Now suppose this money were to be borrowed by each member at the same time then $50 \times 100 =$ Rs. 5,000 would be available for investment. This sum would purchase a motor tractor with a large plough. Now, one such tractor could plough 8 to 10 acres of land in one day against about $\frac{1}{2}$ an acre done by an average pair of bullocks. Now suppose all the members of the society have their land in one fairly flat stretch of land, the plots adjoining each other, and suppose each member has 8 acres to plough. Then in one day would be

finished the ploughing of one member and in 50 days or about $1\frac{2}{3}$ months would be finished the ploughing of 400 acres representing the sum total of land to be ploughed. The rabi harvest finishes by about April 10. The kisan's bullocks are busy threshing thereafter till about the end of May. Therefore no ploughing can be done. With the motor tractor from April 10 to the end of May all these 400 acres belonging to 50 members of the society could be ploughed and where irrigation is available a useful crop of hot weather fodder could be grown. There is always a scarcity of fodder in the hot weather before the rains commence and the kisan has to use up his valuable bhusa which would otherwise be stored away and used between December and March when fodder is again scarce. Apart from the advantage of growing a hot weather crop before the kharif season, such a ploughing by the tractor would open up fresh soil at depths which are not reached by the Desi plough. Weeds would be killed and the succeeding kharif and rabi crops would be greatly benefited. If there is an excess of fodder grown it can always be stored away as silage in pits.

So far we have described how a tractor may be purchased co-operatively and used in the hot weather. During the rains it is only if there are breaks of 10 days or more, that the tractor can be used for cultivation in fields reserved for a rabi crop. In tracts where valuable crops like potatoes and sugarcane are grown on a large scale a tractor could be specially useful for cultivation of the fields reserved for sugarcane after the potato crop is harvested from them. Light ploughs with bullocks are not able to do the work so speedily and efficaciously as the tractor, and for sugarcane deep and thorough cultivation is essential.

Preparation of a seed bed for wheat between mid September when the rains stop and early November when wheat is sown is another operation where the tractor could be used with advantage.

So far we have considered only field operations where the tractor may play an important part. There is another aspect of the utility of the tractor which calls for further purchases of machinery on a co-operative basis.

Suppose we were dealing with a larger Co-operative Society and its members were able jointly to purchase the following machinery :—

	Rs.
(1) A threshing machine costing about..	4,500
(2) An ensilage cutter for chopping fodder costing about	1,000
(3) A large seed drill costing about	700
(4) A saw mill costing about	300
(5) A reaping machine costing about	550

Now let us consider the utility of each of these articles of expensive machinery and compare this with the utility of the machines which the kisan ordinarily uses to serve similar ends.

1. *A threshing machine.*—This machine of the large type is able to turn out 150 maunds of clean grain from wheat, barley, oats, rice and similar crops, in one day. In other words the produce of about 8 to 10 acres would be threshed and winnowed in one day, producing coarse bhusa out of the straw at the same time. Under present practice of treading the wheat under the feet of bullocks and then waiting for a strong wind to winnow by hand, this same produce would take 8 to 10 days with 4 pairs of bullocks working and 2 men for threshing with 4 men for winnowing. The time saved is

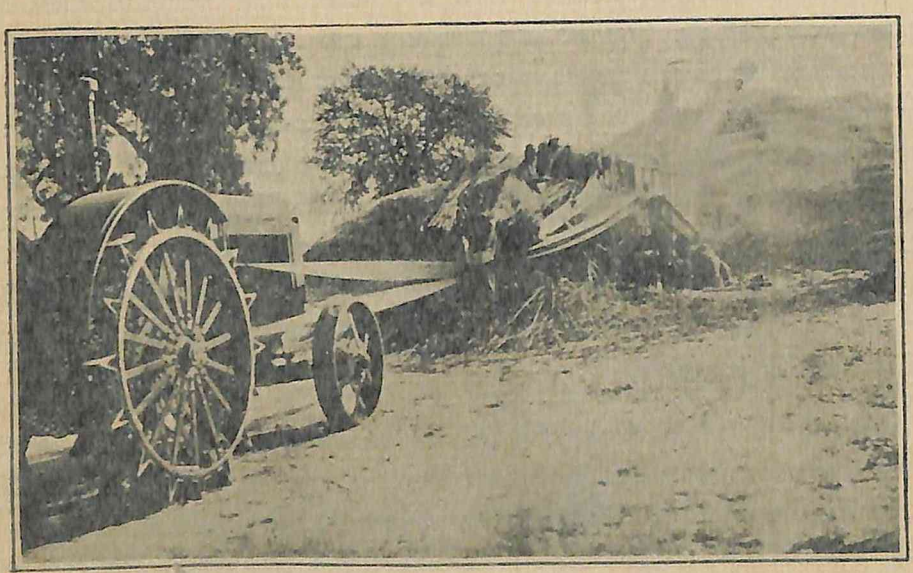


Fig. 37.

THRESHING MACHINE WITH MOTOR TRACTOR AT WORK ON THE CAWNPORE AGRICULTURAL COLLEGE FARM.

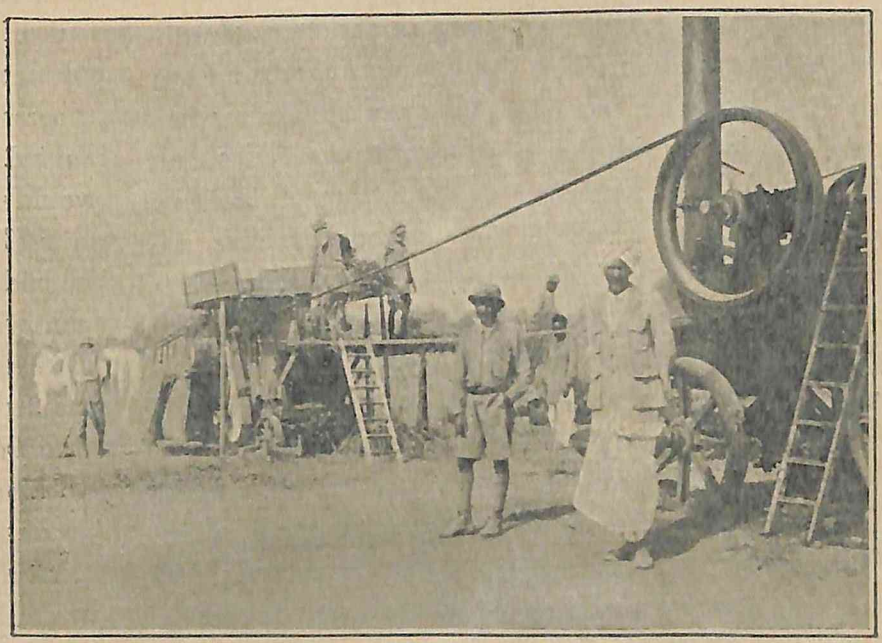


Fig 38.

THRESHING MACHINE WITH STEAM ENGINE AT WORK ON THE KALIANPUR SEED FARM, CAWNPORE.

therefore enormous and the actual cost would be much less by thresher than by manual and bullock labour. The threshing machine can be worked by a tractor such as has been described above. It may be argued that bullocks and men would be otherwise idle if not employed in threshing and winnowing at this time. But this is not so, for these very bullocks and men could be used to prepare land for hot weather and kharif crops. If however the tractor is used both for ploughing and threshing the number of bullocks kept would be greatly reduced, thus effecting a saving both in capital and recurring expenditure.

The following extract from a paper recently written by the author illustrates the above remarks:—

"It appears from results obtained so far that an outlay of Rs. 9,000 on a threshing set like the McCormic Deering Thresher combined

with a 15 to 30 h.p. motor tractor is justifiable if conditions favourable to its use exist. As a matter of fact such conditions do exist in some parts of the irrigated tracts of the United Provinces. The fact that the threshing set is portable brings it within reach of agriculturists whose holdings adjoin each other over an area of say 1,000 acres. Suppose such a set is purchased co-operatively for a thousand acres of wheat land in one block. Assuming that 75 days are occupied in threshing at 150 maunds per day, an area of 1,000 acres would represent a yield of about 11,250 maunds of grain threshed. The threshing season extends from the beginning of April until the end of June and sometimes later. The cost of threshing and winnowing by the country method has been shown to be Re. 1 to 1-8-0 per maund and that by a threshing set working 60 days at 5 annas 2 pies per maund. The net gain to the producers of wheat in the area would thus be about 11 annas per maund amounting to about Rs. 7,734 for 1,000 acres which is over 85 per cent. of the value of the threshing outfit in one single season. It should be noted that the cost of threshing per maund of wheat when the thresher works for 90 days, *i.e.*, the maximum for one season will be even smaller than that worked out for 60 days' work in the season. The advantage of the motor tractor over the portable steam engine lies in the fact that it can be used with profit to cultivate the land when not required to work the thresher."

2. *Ensilage cutter.*—A machine costing about Rs. 800 could, with the tractor to drive it, chop up about 50 maunds per hour of green fodder. It can also be used for chopping dry fodder but in this case the quantity chopped per hour would be decreased.

Now to chop up the same quantity by manual labour, two men working with the "*gandasa*" or chopper would scarcely be able to chop two maunds per hour. The cost of doing this piece of work with the machine is about 3 pies per maund while by the other method it would cost about 8 pies per maund, taking wages at 6 annas per man per day. But the amount chopped by the machine in 10 hours, *i.e.*, 500 maunds would require such a large team of labourers that in any large dairy or cattle-breeding farm the advantage of such a machine is obvious.

Details of calculation.

(1) With machine—

	Ddaily cost. Rs. a.
Labour :—	
Four men at 6 annas per day	1 8
One man at 10 annas per day	0 10
Cost of electric power or engine power roughly ..	4 0
Depreciation and renewals	0 12
Miscellaneous	0 4
	17 2

Outturn 500 maunds—Cost per maund=about 3 pies.

(2) By hand (*gandasa*)—

Two men at 6 annas per day 0 12

Outturn per day=18 mds.—cost per maund= about 8 pies.

(3) By hand chaff-cutting machine—

	Rs. a.	
Three men at 6 annas per day	1 2	Outturn=63 maunds per day.
Depreciation, renewals, etc.	0 2	Cost per maund=4 pies.
	1 4	

3. *Seed drill.*—This machine enables the farmer to sow 5 or 7 or even 9 rows in the field in the one operation. The local method in the provinces is to sow either broadcast by hand or by following the single furrow made by the country plough. Each plough requires a pair of bullocks and a labourer, while another labourer, usually a woman, follows the plough sowing seed. By this method the work of one plough in sowing wheat is about 1½ acres sown per day. The seed drill will do five times this amount of work with one pair of bullocks to pull it and two men to work it. While doing the work in one-fifth the time taken by the same bullocks and labour the cost of doing the work is reduced in like proportion.

4. *Saw mill.*—The same tractor which in the ploughing season ploughs the land and at harvest threshes the corn, will work a saw bench on which large tree trunks may be reduced in a few minutes to planks, beams and rafters, at a small cost. The tractor need not be used for this work every day, but only when it is idle for long such as in December and January and again in July, August and September. Not only may wood be cut by this saw for members of the society which owns the tractor and mill ; but for outsiders at a profit. Planks, beams and rafters mean that cheap and useful furniture and sheds made at home are within reach, increasing the general prosperity and well being of the countryside. An ordinary country carpenter will soon be able to use the saw bench with ease.

5. *Reaping machine.*—This machine can be worked with a pair of bullocks and 10 men and will harvest 4 acres a day. Ordinarily 10 men are required to harvest one acre a day of a crop like wheat. The machine therefore does the work in quarter the time and at a quarter of the expense.

In the case of all these labour saving machines there is of course the risk of the machine going out of order and of parts breaking. But nowadays, every machine sold has supplied with it complete instructons as to its use and repairs and, provided these instructions are carefully followed, there is no danger of harm to the machine except by accident. Mechanics who can read and understand these instructions should be employed and if the assistance of the Deputy Director of Agriculture in whose circle the society is formed, is sought he will gladly render it. He may even be able to arrange for a periodic inspection of the machinery to see if it is being well cared for. Spare parts are always available in the market and should be kept in stock by the owners of the machines.

6. *Co-operative marketing.*—The demand for ready cash is responsible for a great deal of the poverty of the kisan in these provinces as elsewhere. If it were only a demand for ready money there would possibly be no harm done, but this demand coupled with the high rates of interest extorted by an unscrupulous community of moneylenders leads to the financial ruin of many a kisan or zamindar.

There are two seasons in the year during which the kisan is most liable to fall into the trap laid by money-lenders. These are (1) the sowing season and (2) harvest time. Other occasions occur such as marriages and ceremonies requiring large expenditure of money, and of course famine years. But these latter are of less frequent occurrence.

The sowing season finds many a kisan looking for the seed required to sow in his field. It may happen that at harvest he sets aside enough seed for sowing time, but necessity nearly always compels him later to consume this as food. Moreover in the case of perishable seed like potatoes, storage is difficult and seed must be purchased from the seed merchant at sowing time, *i.e.*, early September in the case of the most common variety of potatoes grown in the province. Sometimes it is desirable to purchase new seed rather than use the seed produced on the same land.

Under all these circumstances the co-operative purchase of seed would be of great advantage to the kisan, for the following reasons :—

(1) The seed being purchased in bulk there is likely to be a lower price charged than if each kisan purchased it separately.
(2) Cartage or railway freight would be saved on a large order.
(3) The middleman's profits could be eliminated by direct purchase from the suppliers.

The same principle could be applied to the purchase of manure, concentrated feeding stuff and even wearing apparel used by kisans.

Now turning to the harvesting season, the kisan has had to wait for many months for any income since he sold his last crop. He has in the interval had many demands on his slender resources. Land revenue, water rates or rent, interest to the money lender, the family clothing and other necessities, not to speak of religious festivals and ceremonies which squeeze a further few rupees out of his savings. He is therefore only too eager to sell the grain he has harvested to the first person who offers him hard cash. Indeed sometimes his eagerness is so great that the grain is sold before it is harvested.

Here is where co-operative sale may step in and result in untold relief to kisans.

In order to place these co operative methods on a business footing, the kisans must form themselves into Sabhas or societies. Each society should have its munshi to carry out correspondence for its members and to arrange sales and purchases. If members of the society can themselves read and write it is much better for one of them to undertake to work as secretary or munshi of the society even if the society has to pay him for his services.

The Government co-operative department is always willing through its Inspectors to help such societies to come into existence. Should any group of kisans require assistance in this matter, they should apply to the Registrar, Co-operative Societies, United Provinces, Lucknow.

APPENDIX I.

Outline of the minimum number of forms required for the maintenance of accounts of an arable farm.

Dr. *Cash Book.* *Cr.*

Date.	Particulars.	Amount.	Date.	Particulars.	Amount.	Remarks.

N.B.—Classified abstract can be separated at end of year.

Live Stock Book.

S. no.	Particulars for identification of the animal.	Year of purchase.	Value.			Remarks.
			Purchase price.	Sale price.	Value at end of the year.	

Stock register of Farm produce and articles purchased.

Date.	Particulars of receipts.	Quantity.	Date.	Particulars of expenditure or issues.	Quantity.	Balance.	Depreciation.	Remarks.

Register of credit sales account.

Date.	Particulars.	Amount.	Amount realized.	Amount due.	Remarks.

Attendance Register and Acquittance roll of monthly labour.

S. no.	Name and designation.	Address.	Rate of pay.	Dates. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	Amount due.	Remarks.

Register of attendance and weekly pay of temporary labour.

S. no.	Name and caste.	Address.	Rate of wage.	Days. Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total amount.	Remarks.

Register of cost of production and outturn.

F. No.————————area————————.

Date.	Particulars.	Cost of—				P. Total.	Remarks.
		Cattle.	Labour.	Seed.	Manure.		

Outturn.....transferred to Stock Register, page.....

APPENDIX II.

Outline of minimum number of forms required for the maintenance of the accounts of (*a*) *A Dairy Farm or* (*b*) *A Cattle-Breeding Farm.*

Dr. *Cash Book.* *Cr.*

Date.	Particulars.	Amount.	Date.	Particulars.	Amount.	Remarks.
		Rs. a. p.			Rs. a. p.	

Live Stock Register.

Sl. no.	Name.	Date of—		Price of purchase.	Price of sale.	Date of sale.	Valuation at end of the year.
		Birth.	Purchase.				
				Rs. a. p.	Rs. a. p.		

Godown Book.

Date.	Particulars of receipt.	Quantity.	Date.	Particulars of expenditure or issue.	Quantity.	Balance.	Depreciation.	Remarks.

Credit Sales Account.

Date.	Particulars.	Amount due.	Amount realized.	Balance.	Remarks.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	

Attendance register and acquittance roll of monthly labour at———

For the month of ———

Sl. no.	Name and designation.	Dates.																													Total number of days to be paid for—	Rate of monthly pay.	Amount due.	Receipt of the labourer.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				

Daily abstract of outturn and disposal of dairy produce.

Date.	No. in milk.	Outturn of milk.			Disposal of milk.							Outturn and disposal of cream.						
		Daily yield.	Balance.	Total.	Cash sales.	Credit sales.	Skimmed.	To Dahi.	Loss.	Balance.	Total.	Balance.	Outturn.	Total.	Cash sales.	Credit sales.	Balance.	Total.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Outturn and disposal of butter.								Outturn and disposal of separated milk.					Outturn and disposal of ghee.					
Balance.	Outturn.	Total.	Cash sales.	Credit sales.	To ghee.	Balance.	Total.	Outturn.	Cash sales.	To calves.	To Dahi.	Total.	Balance.	Outturn.	Total.	Cash sales.	Balance.	Total.
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38

Head service register.

Sl. no.	Name of animal.	Service.		Date due to calve.	Actual date of calving.	Date of fresh service.	Remarks.
		Date.	By.				

Live Stock Register.

Adult stock for the year.

No.	History-sheet no.	Name.	Date of—		Price, if purchased.	Breed.	How disposed.	Price and date, if sold.	Valuation at end of year.	Remarks.
			Birth.	Purchase.						

Young stock for the year.

Name or no.	Date of birth.	Sex.	Pedigree.		Breed.	How disposed.	Price, if sold.	Date of selling.	Valuation at end of year.
			Sex.	Dam.					

History-sheet of cows.

Name _____ Name of sire _____ Name of dam _____

Date of birth _____ Date of purchase _____

Colour and distinguishing mark _____ Place and cost _____

Breed _____ Age _____

Service.		Date calved.	Colour, sex and no. or name of calf.	Went dry on.	Lactation period in day.	Dry period in day.	Total milk yield in lactation period.		Average daily milk yield for period.		Whether calf weaned or otherwise.	Remarks.	Initial of officer in charge.
Date.	By.						lbs.	oz.	lbs.	oz.			

APPENDIX III.

List showing seed stores in operation and seed distribution during the year ending June 30, 1928.

List showing the various seed stores in operation and seed distributed during the year ending June, 30, 1928.

—	Departmental.				Others worked under the supervision of the department.	Total number of seed stores.	Amount of seed distributed.	Remarks.
	Built by the department.	Rented building.	Rent-free building.	Total.				
1. Central circle ..	12	14	1	27	8	35	32,741	
2. Western circle ..	13	31	3	47	..	47	83,315	
3. Eastern circle ..	9	4	3	16	12	28	15,497	
4. North Eastern circle	6	6	1	13	..	13	10,605	
5. Rohilkhand circle..	8	2	..	10	7	17	37,119	
6. Bundelkhand circle	5	14	2	21	..	21	18,965	
7. Hill circle ..		..	..	..	..	..	10	
Total ..	53	71	10	134	27	161	198,252	..

APPENDIX IV.

List of departmental seed stores showing circle and place where situated.

List of departmental seed stores, whether built by department or rented or rent-free, which were in operation during the year ending on June 30, 1928.

Dehra Dun ..	W. C. 2	(1) Dehra Dun, (2) Choharpur.
Saharanpur ..	W. C. 4	(1) Saharanpur, (2) Deoband, (3) Gangoli, (4) Roorkee.
Muzaffarnagar	W. C. 1	(1) Muzaffarnagar.
Meerut ..	W. C. 5	(1) Meerut, (2) Hapur, (3) Ghaziabad, (4) Begamabad, (5) Mawansi.
Bulandshahr	W. C. 3	(1) Bulandshahr, (2) Anupshahr, (3) Sikandrabad.
Total, Meerut Division.		
Aligarh ..	W. C. 8	(1) Aligarh, (2) Kalai, (3) Sasin, (4) Mursan, (5) Sikandra Rao, (6) Gomal, (7) Kahar, (8) Jarauli.
Muttra ..	W. C. 6.	(1) Chhete, (2) Jachonda, (3) Sadabad, (4) Aurangabad, (5) Jait, (16) Maut.
Agra ..	W. C. 8	(1) Firozabad, (2) Bichpuri, (3) Achnera, (4) Bhojpura, (5) Sayan, (6) Fatehabad, (7) Etmadpur, (8) Jarauli.
Mainpuri ..	C. C. 4	(1) Mainpuri, (2) Shikohabad, (3) Jasrana, (4) Bewar.
Etah ..	W. C. 10	(1) Etah, (2) Jalesar, (3) Marehra, (4) Soran, (5) Pahali, (6) Sahawar, (7) Aliganj, (8) Malawan, (9) Bagwala, (10) Bibroni.
Total, Agra Division.		
Bareilly ..	R. C. 4	(1) Boheri, (2) Nawabganj, (3) Faridpur, (4) Fatehganj.
Bijnor ..	R. C. 1	(1) Nagina.
Budaun ..	R. C. 1	(1) Kisarwa.
Moradabad ..	R. C. 1	(1) Amroha.
Shahjahanpur	R. C. 2	(1) Tilhar, (2) Shahjahanpur.
Pilibhit ..	R. C. 1	(1) Bisalpur.
Total, Rohilkhand Division.		
Farrukhabad	C. C. 3	(1) Farrukhabad, (2) Kasganj, (3) Qaimganj.
Etawah ..	C. C. 2	(1) Etawah, (2) Heoura.
Cawnpore ..	C. C. 9	(1) Cawnpore, (2) Kalianpur, (3) Maudhana, (4) Bilhaur, (5) Sheorajpur, (6) Rura, (7) Jhinjhak, (8) Pukhrayan, (9) Ghatampur.
Fatehpur ..	C. C. 3	(1) Fatehpur, (2) Khaga, (3) Jahanabad.
Allahabad ..	B. C. 4	(1) Allahabad, (2) Pali, (3) Sondhia, (4) Saidabad.
Total, Allahabad Division.		
Jhansi ..	B. C. 4	(1) Jhansi, (2) Sinori, (3) Barwa Sagar, (4) Chirgaon.
Jalaun ..	B. C. 3	(1) Orai, (2) Madhogarh, (3) Kunch.
Hamirpur ..	B. C. 3	(1) Bela Tal, (2) Ratti, (3) Gohand.
Banda ..	B. C. 1	(1) Attara.
Total, Jhansi Division.		
Benares ..	E. C. 1	(1) Benares.
Mirzapur ..	B. C. 6	(1) Bisandarpur, (2) Chil, (3) Kachwa, (4) Ahraura, (5) Tisuhi, (6) Baraudha.
Jaunpur ..	E. C. 2	(1) Jaunpur, (2) Badshahpur.
Ghazipur ..	E. C. 1	(1) Saidpur.
Ballia ..	E. C. 1	(1) Ballia.
Total, Benares Division.		
Gorakhpur ..	N. E. C.6	(1) Headquarters, (2) Deohia, (3) Couperganj, (4) Hata, (5) Padrauna, (6) Sardarnagar.
Basti ..	N. E. C.2	(1) Basti, (2) Khalilabad.
Azamgarh ..		
Total, Gorakhpur Division.		

List of departmental seed stores, whether built by department or rented or rent-free, which were in operation during the year ending on June 30, 1928—(concluded).

Naini Tal.			
Almora.			
Garhwal.			
Total, Kumaun Division.			
Total, Province of Agra.			
Lucknow ..	.. E. C. 2	(1) Mohanlalganj, (2) Lucknow.	
Unao ..	.. C. C. 2	(1) Unao, (2) Safipur.	
Rae Bareli ..	.. E. C. 1	(1) Rae Bareli.	
Sitapur ..	.. C. C. 1	(1) Sitapur.	
Hardoi ..	.. C. C. 2	(1) Hardoi, (2) Sandila.	
Kheri ..	.. C. C. 1	(1) Lakhanpur.	
Total, Lucknow Division.			
Fyzabad ..	.. E. C. 1	(1) Fyzabad.	
Gonda ..	..N. E. C.2	(1) Gonda, (2) Utraula.	
Bahraich ..	..N. E. C.3	(1) Bahraich, (2) Fakirpur, (3) Nanpara.	
Sultanpur ..	.. E. C. 4	(1) Kadepur, (2) Naugawan, (3) Amethi, (4) Gauriganj.	
Partabgarh ..	.. E. C. 2	(1) Partabgarh, (2) Handia.	
Bara Banki ..	.. E. C. 1	(1) Bara Banki.	
Total, Fyzabad Division.			
Total, Oudh ..	..		
Total, United Provinces of Agra and Oudh.			

List of the seed stores worked under the supervision of the department which were in operation during the year ending June 30, 1928.

Dehra Dun.			
Saharanpur.			
Muzaffarnagar.			
Meerut.			
Bulandshahr.			
Total, Meerut Division.			
Aligarh.			
Muttra.			
Agra.			
Mainpuri.			
Etah.			
Total, Agra Division.			
Bareilly ..	.. R. C. 1	(1) Behar Nagla.	
Bijnor ..	.. R. C. 5	(1) Dhampur, (2) Chandpur, (3) Nagina, (4) Najibabad, (5) Bijnor.	
Budaun.			
Moradabad	.. R. C. 1	(1) Sahaspur Farm.	
Shahjahanpur	..		
Pilibhit.			
Total, Rohilkhand Division.			

List of the seed stores worked under the supervison of the department which were in operation during the year ending June 30, 1928 —(concluded).

Farrukhabad.			
Etawah ..	..	C. C. 3	(1) Hardoi, (2) Jaswantnagar, (3) Bhognipur.
Cawnpore.			
Fatehpur ..	..	C. C. 1	(1) Bilanda Farm.
Allahabad ..	..	C. B. 5	(1) Pali, (2) Mission Farm, (3) Vidya Pitti, (4) Bose Farm, (5) Chaka Farm.
Total, Allahabad Division.			
Jhansi ..	..	B. C. 2	(1) Siaori, (2) Isagarh.
Jalaun ..	..	B. C. 1	(1) Imalia.
Hamirpur.			
Banda ..	..	B. C. 4	(1) Rampura, (2) Khur, (3) Newada, (4) Samri.
Total, Jhansi Division.			
Benares.			
Mirzapur.			
Jaunpur.			
Ghazipur.			
Ballia.			
Total, Benares Division.			
Gorakhpur.			
Basti.			
Azamgarh ..	..	E. C. 1	(1) Azamgarh.
Total, Gorakhpur Division.			
Naini Tal.			
Almora.			
Garhwal.			
Total, Kumaun Division.			
Total, Province of Agra.			
Lucknow ..	..	E. C. 1	(1) Lucknow.
Unao.			
Rae Bareli.			
Sitapur ..	..	C. C. 1	(1) Nibunagar.
Hardoi ..	..	C. C. 2	(1) Hardoi, (2) Hardoi.
Kheri ..	..	C. C. 1	(1) Oel estate.
Total, Lucknow Division.			
Fyzabad ..	..	E. C. 8	(1) Fyzabad, (2) Akbarpur, (3) Tanda, (4) Bhadarsa, (5) Biskhari, (6) Khajuaraghat, (7) Maima, (8) Shahganj.
Gonda.			
Bahraich.			
Sultanpur ..	..	E. C. 2	(1) Sultanpur, (2) Gauriganj.
Partabgarh.			
Bara Banki.			
Total, Fyzabad Division.			
Total, Oudh.			
Total, U. P. of Agra and Oudh.			

APPENDIX V.

Implements distributed by the Department of Agriculture, United Provinces, during the year 1927-28.

Distribution of implements during the year 1927-28.

Name of implements.	Central circle.	Western circle.	Eastern circle.	North-Eastern circle.	Rohilkhand circle.	Bundelkhand circle.	Hill circle.	Total.
Implements—								
Meston plough	1,453	579	379	80	331	..	..	2,822
Konkan plough	53	279	..	171	84	..	..	587
Watts plough..	49	94	..	13	..	..	..	156
Kirlaskor plough	..	26	..	..	..	..	..	26
Pari plough ..	..	25	..	..	..	..	..	25
Other plough ..	87	87	..	37	10	92	..	233
Shares for plough	2,427	1,201	175	508	..	..	..	4,311
Kibblers ..	..	..	1	..	..	..	..	1
Levelling karhas	10	7	2	..	..	..	..	19
Ridgemakers ..	..	..	..	..	..	..	..	53
Chaff-cutters ..	40	5	2	1	2	3	..	4
Screw pump ..	..	4	..	..	..	..	..	57
Harrows ..	18	25	4	5	2	3	..	13
Hand Hoes ..	..	..	1	12	..	..	..	..
Persian wheels	..	..	..	..	..	..	..	..
Sugarcane mills	115	..	1	7	5	20	..	148
Cultivators ..	8	20	5	..	..	..	..	33
Chain pump ..	2	1	..	..	..	..	..	3
Pans ..	2	..	..	..	..	1	..	3
Baldeo Balties	..	1	..	..	..	..	..	1
Oil engines ..	1	..	..	..	..	..	..	1
Power crusher	1	..	..	..	..	..	..	1
Bullock Gears	..	..	..	..	..	..	..	0
Screw water lift	..	..	..	..	..	2	..	2
Maize shellers	..	..	2	..	..	..	..	2
Sugar centrifugals.	2	..	..	..	..	..	..	2
Misc. implement	1,175	749	211	..	819	124	..	3,078
Reapers ..	1	..	..	..	..	..	..	11,582
Total ..	5,444	3,023	783	834	1,253	245	..	11,882