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Cotton Research Work and its relation to the work of the Agricultural Department.

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I have been asked to contribute one of a series of papers whose purpose is to make known the activities of the department in regard to cotton. From whatever point it is viewed, whether from that of the Agronomist, Bacteriologist, Chemist, Entomologist, Mycologist or Plant Breeder the subject is capable of treatment from four aspects.

1. The acual work being done.
2. The methods adopted in carrying out the work.
3. The results achieved.
4. The practical application of the results.

Items 1, 2 and 3 have, so far as the cotton section is concerned, received a fair share of attention at previous conferences. Moreover thoseof you who are able to take the opportunity of visiting the cotton section will find the latest information on these three items presented in a more interesting manner than is possible here. I am therefore in this paper limiting myself to item (4) not only for these reasons but also because it affords an opportunity of making clear how the work of the cotton section and research in general fits into the work of the Department as a whole.

Briefly the function of the agricultural department is the promotion of good farming. By the term "good farming" I mean all such practices as aid the cultivator to obtain good crops from his land in the most economical manner possible, not merely for a short time, but continuously.

Let me elaborate this point further, as it is important that it should be clearly understood. Our function is not merely the testing of new varieties and strains of different crops, the comparison of the immediate return given by different manures and the discovery of new methods of cultivation. Each of these is good in itself but by itself does not go far enough. We must be prepared when we commence to advertise our results to show how they should be combined with one another and worked into the local system of agriculture in order to produce a permanent improvement and not merely a temporary one. It is this aspect of the question seen from the point of view of cotton that I propose to discuss.

In an old and well established system of agriculture, such as prevails over the greater part of this presidency one of the greatest barriers to good farming that can exist is the failure to produce annually a reasonably adequate supply of good well-made cattle manure.

The salient features of well made cattle manure which are of interest to the cultivators of this presidency and which have been well tested or concerning the truth of which evidence is accumulated are:—

1. It improves the texture of the soil ie., it makes the soil easier to work and more permeable to moisture.

2. It improves the capacity of the soil for retaining the moisture and certain plant foods.

3. It improves the yield of crops.

4. It apparently improves the feeding quality of cereal crops grown on land to which it has been applied.

5. It apparently affects the seed of a crop grown on land to which it has been applied, in such a way, that this seed when sown develops into a healthier and more vigorous seedling than is the case with seed from a crop grown without the aid of cattle-manure.

6. In certain cases, it apparently must be applied to the land if satisfactory results from the application of artificial manure is to be obtained.

It is therefore clear that the correct handling of cattle-manure lies at the very foundation of good farming.

In this Presidency, speaking generally, the amount of cattlemanure available is well below requirements and its quality is of the poorest. If, therefore, the cultivators, as a body, could be persuaded to take steps to remedy these two defects in their cattlemanure supply, a long stride would have been taken towards making agriculture a more profitable industry than it is at present. I have used the word "persuaded" advisedly. There are very few cultivators who are so careful and so efficient in the preparation of their cattle-manure that they could not make some alteration in procedure with advantage and of the others there is none who possesses cattle who could not do something to improve their position. Fortunately in this case the procedure to be adopted in improving the puality of the the manure leads to an increase in quantity. This is in marked contrast to the position found in the case of crops, where efforts to improve quality usually automatically bring in their train a reduction in yield. That it does lie within the power of every cultivator who keeps cattle to improve his supply of cattle manure both in quantity and quality will become apparent from a consideration of the details of the process of manufacture of good cattle-manure.

In the manufacture of cattle-manure of good quality, three ingredients are needed, (a) dung (b) urine (c) litter. The action which takes place when these three ingredients are brought together under the right conditions may be briefly described in this way. Bacteria and fungi of which large numbers are present in the dung and in the litter draw upon the nitrogenous compounds supplied in the urine for their development. In so doing they cause the nitrogen to pass through certain changes with the result that from being present in a form in which it might readily be lost, it takes on a more stable form. Incidentally the woody matter of the dung and the litter, which goes to form humus in the soil on which the beneficial effects of cattle-manure largely depend, is brought into a mehanical condition which renders it easy of incorporation in the soil. In the presence of a sufficient quantity of litter the loss of nitrogen is small. With insufficient litter the nitrogen of

the urine escapes in the form of ammonia, as can be readily recognised by the smell. The best method of preparing cattle manure is to house the cattle in a stall with a hard floor. allowing each animal a fair amount of freedom of movement so that it does not always urinate in exactly the same spot. On the floor of this stall litter should be spread and each day the droppings should be scattered evenly over the litter and a fresh layer of litter supplied for the cattle to lie on. If the litter is very dry, a sprinkling of water should be given at intervals before the new layer of litter is spread in the stall. At longer or shorter intervals according to the size and depth of the stall the manure should be removed to a pit and covered with earth. There it should stay until required for use. Thus, granted that the cultivator possesses cattle, his supply of the two of the ingredients is assured. All he needs is a sufficient quantity of litter to aid him in the conservation of the valuable nitrogen of the urine and to supply woody matter for the formation of humus. It is precisely at this point that the root of the trouble becomes evident.

The average cultivator, the man with a pair of working bullocks a cow or two and a she beffalo is usually insufficiently provided with fodder to feed all his animals properly. Further he is usually of the opinion that he cannot afford to purchase fuel. The procedure he follows is therefore this. He feeds his fodder first to his work cattle. What they leave he passes on to his cows or buffaloes and what they refuse he uses as fuel. In addition he usnally makes no attempt to collect the urine his animals excrete. He is however usually more careful of the dung, which he collectes daily and consigns to the heap in which he puts his ashes and sweepings. Fortunately the dung dries quickly and therefore suffers little change before it finds its way to the land.

This procedure suffers from three grave defects.

(a) The number of stock kept is greater than the supply of fodder warrants.

(b) The refuse fodder is burnt.

(c) The liquid portion of the excreta is allowed to run to waste.

Consider these three points in turn.

(a) The usual argument offered in support of this position is that the animals which are in excess of the number required for work are kept for their manure. Were it the case that the liquid and solid excreta of these animals were used in rotting down quantities of litter this argument would carry some weight. As this is not the case the practice is indefensible. In the first place the quantity of manure obtained does not depend soely on the number of cattle kept. It depends also on the quantity of fodder fed. For example, suppose the amount of fodder on hand is sufficient to allow of four animals being fed at the rate of 15 lb. of fodder per head per day. If six animals are kept the quantity of fodder fed daily to each animal will have to be reduced to 10 lb. if the supply is to last an equal length of time. The amount of manure produced in each case is the same.

Secondly animals which are kept in a continuous state of semi-starvation are (a) of low value, (b) produce progeny which are of low value (c) do not breed regularly. (d) when in milk do not produce sufficient milk to feed the calf and supply a reasonable surplus for household use. (e) are more liable to succumb to disease if attacked than animals properly fed. They are therefore less profitable to keep than animals which can be fed properly. Here it may be remarked in passing that as in the case of cattle manure the quantity of good cow's milk produced is a long way below requirements. Fortunately the steps taken to remove the one defect can be made to serve in removing the other.

(b) Here we come into contact with the fuel question. Fuel is an absolute necessity. When the inability to purchase fuel is not real, it is false economy to burn refuse fodder. Weight for weight refuse fodder used as litter is more valuable than wood purchased for use as fuel. Where the inability to purchase fuel is real, the only real cure is to remove the disability. A way round the difficulty is for the cultivator to collect green leaf from waste lands for use as litter, or to grow some green leaf himself.

(c) There is no justification for this practice. Under the worst conditions it is possible to use earth as absorbant of

the urine. This is not as good as using litter but it is better than using nothing.

It is clear then that if the cultivator is to improve his supply of cattle manure in quality he must make some adjustment of his fodder cattle ratio, by increasing his supply of fodder or reducing the number of animals he keeps or by doing both. He must also adopt the practice of bedding down his cattle with litter and must arrange for an adequate supply of litter for this purpose. The position at which he should aim is the production of as much fodder as will allow him to feed properly his working animals and a few breeding stock and to provide sufficient litter for bedding. If he can eke out his supply of litter by collecting green leaf from waste lands or by producing it himself he will arrive at this position so much the sooner.

This problem, the problem of determining the best means of helping the cultivator to arrive at this position is by far the most important of the problems which confront the agricultural department. It is capable of being attacked directly and indirectly. The lines of direct attack may be classified as follows :—

1. Those concerned with the manure itself, e. g., proper methods of manufacture, use of green leaf as litter and earth as an absorbant etc.

2. Those concerned with the cattle themselves e. g., grading up of poor stock by using a bull of good strain and gradually replacing unprofitable animals by profitable ones.

3. Those concerned with the fodder crop e. g., use of better strains or varieties, better methods of cultivation including correct methods of dealing with pests and diseases, better methods of manuring and so on.

The lines of indirect attack are numerous. Every crop specialist who deals with a crop which is rotated with a fodder crop is a potential source of a means of indirectly solving the problem. Taking Cotton as an example, the lines of work being carried on are :—

1. The testing of varieties.

2. The production and testing of new varieties.

3. Investigation of better methods of cultivation, time of sowing, spacing, devising and trial of implements to reduce cost of cultivation etc.

4. Investigation of the best method of manuring.

5. Investigation of the best method of irrigating and of the optimum amount of water to be given.

All these lines of work are directed to one end and to one end only, viz., the improvement of the return per acre which the cultivator can obtain from his cotton crop. The uses to whtch this improvement, when obtained, may be put are of course various. But as an aid to the solution of the problem we have outlined this improvement would be most properly used as a lever to induce the cultivator (1) to purchase fuel and so set free litter and dung for the manufacture of good cattle manure or (2) to reduce his area under cotton and replace it by a fodder producing crop with the object of improving his fodder supply or (3) both.

At first then a reduction in the area under cotton as a result of an improvement in the return obtained from the crop, provided that it were accompanied by an increase in the area under fodder crops, in the appearance of the cattle and an increased production of cattle manure would be viewed with satisfaction. The increased production of cattle manure would if rightly used result in an increased return from all crops and in the end were it found the most profitable course to take a return to the original area under cotton would be possible.

As a concrete case take a holding of 20 acres in the black soils area af Tinnevelly, cropped with cotton and cereals in rotation, the cereals consisting of cumbu and fodder cholam in equal proportion alternating with one another. For such a holding one pair of bullocks is all that is necessary for cultivation purposes.

Fodder cholum will yield one ton of hay per acre i.e., 5 tons in all. Cumbu, apart from grain will yield ¾ ton of straw per acre or say 4 tons in all. 5 tons of hay will give 4½ tons of consumable fodder and ½ ton of waste useful as litter. The whole of the cumbu is best used as litter. This amount of hay, 4½ tons, is just sufficient to feed one pair of animals properly. The same amount of straw will provide litter for two pairs of animals. 2½ tons of litter plus 4½ tons of fodder consumed will give under loose box conditions 20 cartloads of good cattle-manure. A cart load is taken as 800 lb. This is sufficient for an application of 4 cart loads per acre to one quarter of the holding. If all the litter is used 28 cartloads of manure will be obtained, sufficient for 7 acres at the same rate of application. If another 4½ tons of fodder could be produced another pair of animals could be kept and the amount of cattle manure produced could be raised to 40 cartloads, and one half of the holding could be manured every year. Under the climatic conditions which prevail over the greater part of this presidency an application of 5 cart loads of well made organic manure per acre every other year is reasonably adequate and is better than double the quantity applied once in four years. How is this extra 4½ tons of hay to be produced.

The procedure to be followed may be varied to suit the temperament and financial position of the cultivator concerned.

The first step is to persuade him to convert all his straw and waste fodder into good manure by using it as litter. He will thus produce 28 cart loads of good manure. He must in addition be persuaded to compost all his cotton stalks. This will give him a further 12 cartloads of good organic manure. He is now in a position to manure the whole of his cereal crop at the rate of 4 cart loads of manure per acre.

At the end of the first cropping season in which this quantity of manure is used, the yields of the cereal crops will have risen, cumbu grain by 10 per cent straw by 15 per cent and cholum hay by 25 per cent. He will thus obtain Rs. 4 per acre more from his cumbu grain, 4½ tons of

cumbu straw and 6¼ tons of cholum hay. Of this he will consume all of the straw and 5 tons of hay, leaving 1¼ tons of hay in reserve.

For the second season the same manuring will be given to the other half of the holding and a like result will be obtained. But as this cotton is now growing on an area which we manured throughout for the previous crop he will get a 10 per cent increase from this crop, equivalent to about Rs. 50 for the whole cotton area. He is now Rs. 20 plus Rs. 50 plus Rs. 20 plus (1¼ plus 1¼) tons of hay to the good and if he so desires is in a position to add one more animal to his stock of cattle.

For the 3rd season he is now manuring land which has been manurned once already. He may therefore expect a further increase of 5 per cent of cumbu grain, 5 per cent cumbu straw and 10 per cent cholum hay. Also as his cotton is growing on land manured in the previous season he may expect a similar increase of 10 per cent in yield as in the last year. On this basis his return from his cereal crops will be Rs. 30 on his cumbu grain, a total of 5 tons of cumbu straw and 6½ tons of cumbu hay. If now, by reason of the fact that his use of departmental cotton seed has given him an increased return from his cotton crop and in view of the increase in yield from this crop he is obtaining from a regular systematic application of good cattle manure the cultivator can be persuaded to reduce his cotton area by two acres and increase his fodder cholum area by the same amount he will obtain a further supply of 2½ tons of cholum hay. This with 2½ tons surplus from the previous year will give him at the end of 3 years a supply of 11 tons of hay. He is now definitely in a position to feed more stock and can add a pair of cows to his number to provide with milk and young stock for sale. At the end of another year with his extra stock his supply of manure will have risen to 50 cart-loads, a reasonably adequate quantity.

After three cycles of rotation from the seventh year say he may expect that his yield of cumbu grain and straw will have increased by 25 per cent his yield of cholum hay by 50per cent and his cotton by 25 per cent. He will now be in a position to use artificial manures to advantage. An

application of 2 cwt. of calcium cyanamide plus 1 cwt. of Super per acre increases the yield of cumbu by 50 per cent both grain and straw and costs about Rs. 20. The cost of the manure is recovered in the increase of grain. The increase of straw costs nothing. It can be used to supplement the supply of litter and so increase the quantity of manure obtained, or alternatively the cumbu crop can be reduced to 3 acres and manured in this way. The cholum crop can be kept at the same area and the cotton crop can be restored to its original area.

Variations on the procedure I have outlined can easily be thought out. I have I think said sufficient to indicate how I think that the work of the cotton section can be used to raise the general level of agricultural practice and to further the work of the department as a whole viz., to promote good farming.