

## SOIL FERTILITY AND MECHANISATION\*

### INVESTIGATIONS AT ROTHAMSTED EXPERIMENTAL STATION

**T**HE systematic use of large scale machinery on the farm, called for convenience "mechanisation," is usually combined with a reduction in the number of live-stock kept, and hence causes certain modifications in the fertility relationships of the soil. Four important groups of problems are being investigated.

- (a) Can fertility be sufficiently maintained by artificial fertilizers alone, or is it necessary to return the straw to the land in the form of manure? If the straw must be returned what is the best way of doing it?
- (b) Is it possible to produce by any cultural process the same good effects on light land as are obtained by sheep folding?
- (c) Green manuring.
- (d) Fallowing.

(a) The classical experiments at Rothamsted have shown that soil fertility can be kept at a certain moderate level by the use of artificial fertilisers alone without the use of farmyard manure. In general, however, the growth of the crop has not been enough to keep down weeds, and much expense has been entailed in cleaning. A combination of artificial fertilisers with occasional fallows, however, has proved effective in maintaining yields at low expenditure in labour but with a loss of one year in four or five. Where straw is saleable at a profit this method may be adopted. Where however straw cannot be sold—and this is the usual case—it may be converted into manure, so saving some of the fertiliser bill. This is readily accomplished where many animals are kept; the straw is simply turned into farmyard manure. The experiments show that crops obtain about 25 per cent. of the nitrogen of farmyard manure, as compared with about 50 per cent. of the nitrogen of artificial fertilisers. The recovery of potash is higher, being about 60 per cent. But on many farms the numbers of animals are being reduced and the straw must be decomposed in some other way. Investigations into the decomposition of straw have long been in hand in the Bacteriological and Fermentation Departments; four different products can be obtained according to the organisms used and the conditions under which they act:—a mixture of humic substances much like farmyard manure; pentoses; hexoses; and power gas (methane and hydrogen).

The pentoses have little practical importance; the power gas is difficult to handle on the large scale; but the hexoses are the best source of power alcohol, and this particular decomposition may prove to have considerable commercial value. For the farmer, however, the production of humus is the most important of these various changes and it has been studied in considerable detail. A method for converting a heap of straw

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into artificial farmyard manure by addition of nitrogen compounds, phosphate and calcium carbonate was worked out in these laboratories by Hutchinson and Richards, and developed as a large scale process by the Adco syndicate; it has been successfully adopted by large and increasing numbers of farmers and planters in Great Britain and the Overseas Empire.

Another method is now being studied: the decomposition of straw in the soil. In practice this would have the advantage of requiring less handling of the straw and thus lowering the cost of growing cereal crops. The crop would be "stripped," i.e. the ears cut off with as little straw as convenient, then the remaining straw ploughed in and allowed to decompose in the ground. The laboratory experiments show that the decomposition of the straw requires a warm temperature and a sufficient supply of nitrate or ammonium salts; if therefore the straw is ploughed into the ground in autumn while the soil is still warm and fairly rich in nitrates, the decomposition should be fairly rapid and inexpensive, seeing that the nitrates would be largely washed out if they were not utilised in this way. If, however, the straw is not ploughed in until late winter, when the soil is cold and much of the nitrate has been leached out, then decomposition is slower and may be disadvantageous to the crop by using up nitrates that would otherwise have increased its growth. Two sets of field experiments have been started to deal with these problems.

(b) *Green Manuring*.—This affords a simple method of manuring both heavy and light soils, and it requires no live-stock; it can be practised on completely mechanised farms. Its advantage in certain conditions has long been recognised, but of late years a number of instances has been recorded where it proved ineffective. The most striking is at Woburn, where, over a series of years, green manuring with tares and with mustard has failed to increase yields of wheat. Experiments carried out a few years ago on several other farms with the help of a grant from the Royal Agricultural Society of England also yielded negative results.

There are, however, undoubted successes, and investigations have been made and are still in progress to find the conditions under which green manuring is likely to give useful results. Two of the most important factors are the composition of the plants at the time of ploughing in and the time at which the ploughing is done. If the ratio C.N in the crop exceeds a certain value (usually about 20), the organisms effecting the decomposition require more nitrogen than is supplied by the crop, and so they draw on the soil nitrates that would otherwise either be washed out or taken by the plant. If, however, the ratio is less than this value, the organisms do not need the whole of the nitrogen and they leave the excess in the soil in the form of nitrate which as before is either washed out or taken by the plant. Investigations have shown that at Woburn the tares crop failed to increase the growth of wheat because it was ploughed under in autumn, and rapidly gave rise to nitrate which the wheat plant, being insufficiently developed, could not assimilate, so it was washed out, and in the following spring the wheat suffered from nitrogen starvation. The mustard assimilated nitrate and so saved it from loss, but it liberated it too slowly to be of use to the wheat. The value of nitrogen depends on the time when it is given; when given late to barley it reduces the ear tillers and the number of fertile grains and increases the vegetative tillers. It seems clear that the process of green manuring needs to be closely adapted to the soil and the crop so as to ensure liberation of nitrate only when the plant is in a position to take it up.