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Report 1918-20 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Organic Matter in Soil

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effects on the crops would be highly valuable. In order to study these effects a Statistical Department has been set up, in which Mr. R. A. Fisher and his assistant, Miss W. A. Mackenzie, have undertaken an analysis of the meteorological conditions at Rothamsted in conjunction with the crop records since 1852.

THE NEED OF ORGANIC MATTER IN THE SOIL.

However skilfully artificial manures are used it is essential on all ordinary farms to add organic matter to the soil. Four ways have been investigated for doing this.

1—*Farmyard Manure*.—Some 40,000,000 tons of farmyard manure are made by the farmers of the United Kingdom, but it is estimated by Hall and Voelcker that some 50% of the value is lost through avoidable causes. Thanks to the generous assistance of Viscount Elveden, it has been possible to retain an expert chemist, Mr. E. H. Richards, expressly for the purpose of studying this important question. Broadly speaking, the conditions to be secured in the making of the manure are sufficient supplies of nitrogen compounds and of air to allow the cellulose-decomposing organisms to break down the straw. For the storing of manure, however, it is necessary to have shelter from the rain and from access of air. The best methods of securing these conditions require working out for particular cases, which can be done after consideration of all the local circumstances.

Field experiments have shown that farmyard manure made and stored under these conditions is of higher fertilising value than the ordinary material—the crop being 10% or more beyond that given by manure kept in the usual way. An experiment has been begun in which one lot of bullocks is kept in a covered yard and an equal lot in an open yard, and the manure from both will be compared. During the War, when all sources of loss had to be studied, and as far as possible stopped, the necessary conditions were vigorously brought to the notice of farmers and Executive Committees by the Food Production Department and the Journal of the Ministry of Agriculture. Savings of several per cent. on old-established practice are possible, and every per cent. saved would mean in the aggregate some £200,000 at present prices.

A beginning has been made with a much more difficult problem—the handling of manure on a dairy farm. The conditions here are very different from those on an ordinary mixed farm where bullocks are fattened: it is desirable that the dung should be as little in evidence as possible and that the urine should be quickly and completely removed from the cow-sheds. So important is this that it must be done even if loss be thereby incurred. Two methods have been studied:—

(a) The solid excreta are removed and stored under cover and out of access of air; the liquid manure is collected in a tank and applied to temporary or permanent grass land and on the stubbles prior to the root crop.

This method is already in use on certain dairy farms, but when a careful examination was made a considerable deficit on the nitrogen account was revealed: the liquid contained only about one-

half of the nitrogen expected. The loss was traced to the broken straw and solid excreta which always finds its way into the liquid; these bring about an absorption of nitrogen compounds which deprives the liquid of much of its value.

Further investigation of this absorption is going on: it may be avoidable, in which case the value of the liquid manure, already marked, could be enhanced still further. In case it seems to be unavoidable, however, a second method of procedure is being studied.

(b) The solid is collected as before, but the liquid is allowed to run through straw under conditions which encourage the absorption of nitrogen compounds. By suitable arrangement the straw increases in fertiliser value while the liquid loses part of its valuable constituents, and can more easily be sacrificed.

This method is still in the initial stages, but may prove of considerable value. Mr. Richards is carrying out the laboratory experiments at Rothamsted and the large scale experiments at Woking on Viscount Elveden's Home Farm: he has applied it also to the treatment of sewage from small installations.

2—*Artificial farmyard manure made without animals.*—Few farmers are able to make sufficient farmyard manure for their needs and some difficulty arises about the best method for utilising straw. Direct experiment shows that straw is not a useful fertiliser; indeed in many cases it depresses the crop. Once it is decomposed, however, it is of great value both for its physical and chemical properties.

Laboratory work by Dr. Hutchinson and Mr. Clayton had shown that the breaking down of the material of straw—the so-called cellulose—is effected by organisms. One of these had eluded all previous investigators, but the Rothamsted workers succeeded in obtaining it in pure culture and in studying it freely (see p. 42). In order that it may decompose straw it requires two conditions — air and soluble nitrogen compounds as food. If either of these is missing it ceases to act. Moreover, it will only attack cellulose; it is unable to feed on sugar, starch, alcohol or any organic acid yet tried. Given, however, the necessary nitrogen compounds and a sufficiency of air, the micro-organisms quickly decompose straw, breaking it down to form a black, sticky material, looking very much like farmyard manure. This has been investigated in conjunction with Mr. Richards (p. 57); further quantities are now being prepared for fertiliser tests.

3—*The clover crop* is very valuable, not only on account of the hay, but also for the effect of its root residues on the next succeeding crops. It is, however, one of the most difficult of the farm crops to grow and few farmers would claim that they could grow it as frequently as they wished. The difficulty arises from the fact that the plant depends for success on the activity of certain bacteria in its roots, and the conditions, therefore, have to be favourable both to the plant and the organisms.

Experiment shows that the clover crop is improved in four ways:—

- 1—By improvements in the method of sowing so as to give the seedling a good chance of establishing itself;
- 2—By dressings of chalk;
- 3—By application of phosphates, and where necessary, potash before sowing;
- 4—By the use of farmyard manure (p. 55).

In some of our experiments the weights of the young plants at the time of cutting the barley were:—

	Weight of young Clover plants. Cwts. per Acre	Weight of Barley. Cwts. per Acre
Control	4.8	21.2
Slag and Lime	6.7	31.7
Super and Sulphate of Potash	11.2	26.1
Farmyard Manure	10.3	28.2
Super and Farmyard Manure	15.0	26.5

We are not at present able to explain altogether this action of farmyard manure, but experiments in the bacteriological laboratory by Mr. Thornton indicate a special action of some of its constituents on the nodule organism, and seem to foreshadow interesting possibilities in the culture of the leguminous crops.

4—*Green manuring*.—The difficulty of making sufficient farmyard manure brings into prominence the need for green manuring. A field experiment has been started and the necessary laboratory work is being initiated by Mr. H. J. Page.

Although the beneficial action of a plentiful supply of organic matter in the soil is well known, precise knowledge of its mode of action is lacking. Laboratory work on humus, commenced in 1919 by Mr. V. A. Beckley (p. 37), is being extended by Messrs. H. J. Page and R. M. Winter. Refined methods for the determination of ammonia and nitrates in soils have been devised by Mr. D. J. Matthews, and are being used to study the changes occurring in the nitrogenous substances in the soil, especially after the application of green manures.

THE POPULATION OF THE SOIL. FAUNA AND FLORA.

Every farmer knows the importance of organic manure in the soil, but it is less generally realised that the effectiveness of the organic manure depends on the activity of the soil organisms, without which it would be quite useless, and in some cases harmful. Although the organisms cannot be seen by the naked eye, they are present in all fertile soils in vast numbers and in extraordinary variety. An extended survey is therefore being made on definite systematic lines with the view of learning as much as possible about the soil population. No less than 10 workers are engaged on this survey. Mr. D. W. Cutler, Miss L. M. Crump and Mr. H. Sandon study the protozoa; Mr. H. G. Thornton and Mr. P. H. H. Gray