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THE ORGANIC MATTER PROBLEM OF THE NETHERLANDS SOILS.

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(Communicated by Dr. J. N. Mukherjee, F.N.I.)

The ever increasing intensity of agricultural practice makes high demands on the supply and availability of plant nutrients in the soil, i.e., inorganic substances which in different compounds are naturally present in the soil or are added to it by manuring. Climatological conditions in the Netherlands are such that not only the intake of the various substances by the crop but also the considerable losses in the permeating water must be taken into consideration. Rainfall and the amount of drainage which were determined by J. G. Maschhaupt (1) in his lysimeter investigation are shown in Table I for the different seasons with soils under cultivation.

TABLE I

	Mean rainfall in mm.			Drainage in % rainfall.		
Mean of 15 years 717	Autumn ..	190	27·1	Autumn ..	21·3
	Winter ..	154		Winter ..	65·0
	Spring ..	142		Spring ..	31·4
	Summer ..	231		Summer ..	3·9

Soil investigation carried out throughout the country according to fixed standards enabled us to form a tentative opinion of improvements that could be made in the manuring condition of land for cultivation. The subject was reported upon on the occasion of the United Nations Conference on the conservation and utilization of resources, which was held on 17th August, 1949, at Lake Success (2). As regards the importance of organic manuring in the Netherlands and the raising of the production-level by improving the soil-structure, only some general statements could be given as the number of quantitative data then collected were insufficient. The object of this paper is to provide some information as to the progress of this research.

The connection between the intensification of agriculture and the organic matter supply of the soil is quite different from the relation to inorganic crop nutrition referred to above. The increase of production by better manuring methods generally means that the soil is enriched with organic matter through a greater root development. The cultivation of after-crops following a main crop means that the soil is covered for a longer time. Adverse climatological influences on the structure are thus prevented. In the Netherlands it is of paramount importance where the organic matter problem is concerned, whether or not sufficient attention is paid to the soil structure, as it is immediately connected with the air and water supply and the effectiveness of fertilizers added to the soil. Moreover, it is of importance to know in the case of organic manuring whether or not the way in which plant nutrients become available to the crop, may result in an increase of the quantity and quality of the crop.

The organic matter percentage of the Dutch land under cultivation varies considerably. Arable land contains from a few per cents to 30% or more. The organic matter of the turf of permanent grassland may vary from a few per cents to 60% or more. It stands to reason that water conditions in the past and at present

have had a great effect on this percentage (in the Netherlands especially the water table and drainage conditions). The temperature which affects the rate of decomposition of organic matter may, as far as this country is concerned, be characterized as follows: mean temperature in spring 9·4°, in summer 17·4°, in autumn 10·4° and in winter 2·9° C. The percentage of organic matter and the thickness of the humus layer are of course of great significance in the moisture supply of agricultural crops.

M. L. 't Hart (3) emphasizes the importance of the organic matter content of the turf for the production capacity of permanent grassland on sandy and clayey soils. In his opinion the highest yields are obtained with an organic matter content of the turf of 12–16%. With lower contents the water supply is often unsatisfactory, while higher contents point to insufficient drainage. However, the fact that satisfactory grass yields are obtained on peaty soils, proves that a high organic matter content does not necessarily prevent grassland from being highly productive. 't Hart finally points out that the formation of a humus layer is of the greatest importance for a successful creation of permanent grassland. On sandy soils an organic matter accretion of more than 2,000 kilograms per hectare annually was found after the seeding of the grassland.

It is well known that a regular supply of organic matter in its microbiological decomposition exercises a favourable influence on the soil structure. American, Russian, and British investigators have collected many details in this respect. The crops themselves to a large extent provide the soil with this organic matter by their root development. M. A. J. Goedewaagen (4) has made extensive investigations on the subject in this country. The amount of roots of cereals (there are great differences in different kinds) is nearly 2,500 kilograms per hectare with a topsoil of 20 centimetres (roots and stubbles together). The root yield of potatoes and sugar-beets is much less, i.e., no more than $\frac{1}{4}$ of the root and stubble amount in cereals. Under Dutch conditions this means that per hectare on arable land approximately 2,000 kilograms organic matter are added to the topsoil through root development and the stubbles of main crops.

P. K. Peerlkamp (5) estimated with the aid of laboratory data from abroad the amount of organic matter that is necessary for the maintenance of the soil structure under Dutch conditions and found the annual amount to be equal to that of the roots and stubbles of a cereal. Organic matter must be added in the case of the crop rotation now practised and if the existing soil structure is to be improved. Farm-yard manure is next to the roots of the crops still the most important source of organic matter in the Netherlands. On an average 700 kilograms organic matter per hectare is added to arable land in this form (there are arable districts where no farm-yard manure is employed). Green-manuring ranks after farm-yard manure in importance.

J. Kortleven (6) studied these conclusions and other data and found that in this country too little organic manure is employed. There are several ways to supply the deficiency, e.g., existing town-refuse compost industries may be extended (at present only a small percentage of the town-refuse is used for agricultural purposes); straw may be ploughed in, and green manuring and ley farming may be more extensively practised according to the particular district concerned. The ploughing up of temporary grassland results in a considerable amount of organic matter in the topsoil. Goedewaagen found the amount of roots and stubbles in grassland to be 6-7,000 kilograms. To this is added the above-mentioned accretion of organic matter after seeding, so that in two years' leys the amount of organic matter may be fixed at more than 10,000 kilograms per hectare.

Of course, these estimates are further studied both in the field and in the laboratory. Experimental fields have been laid out where the effect of the intensity of organic matter supply on soil and silo fertility is ascertained. Experiments are also made on farms. Numerous experiments are made to determine the

significance of town-refuse and different methods are tested, e.g., addition after compost-making, addition after pounding in a fresh condition, the mixing with the topsoil, superficial dressing, etc. The conversion of town-refuse into compost is being practised to an increasing extent.

For the sake of completeness the investigation of J. Hudig and N. H. Sieuwertsz van Reesema (7) may be mentioned, who studied the possibility of preparing an artificial humus of great stability which might bring about a more permanent improvement of the soil structure. Many experiments were made, which were reported upon by J. Kortleven (8). However, owing to the Second World War a satisfactory composition of the product proved to be impossible, and field-trials were unsuccessful for the same reason. Investigations have been started again and are in full progress.

There are various signs which show that the structure of the soil leaves much to be desired in many cases. Wind erosion and water erosion also occur in the Netherlands, although water erosion is less disastrous than in some other countries. Several agricultural advisers emphasize the importance of organic manuring in order to raise the production level.

P. K. Peerlkamp (9) investigated numerous soil samples by means of a wet aggregate analysis for their aggregate formation. Fig. 1 and Fig. 2 show his results

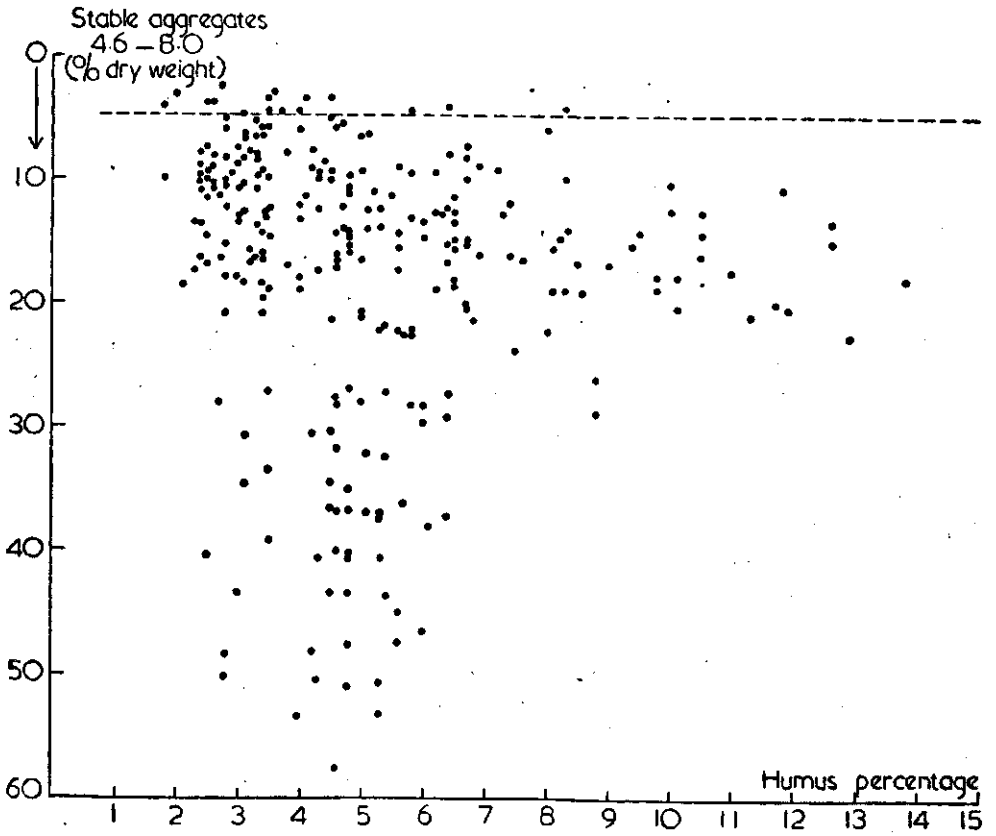

FIG. 1. Soil structure as measured by the percentage of water stable aggregates with sizes between 4·6 and 8·0 mm. (the smaller this fraction the better the structure) plotted against humus content for the top layer of 309 fields on clay soils (clay content >40% fraction <16μ). Arable land.
The hatched line parallel to the abscissa is assumed for the 'ideal' structure.

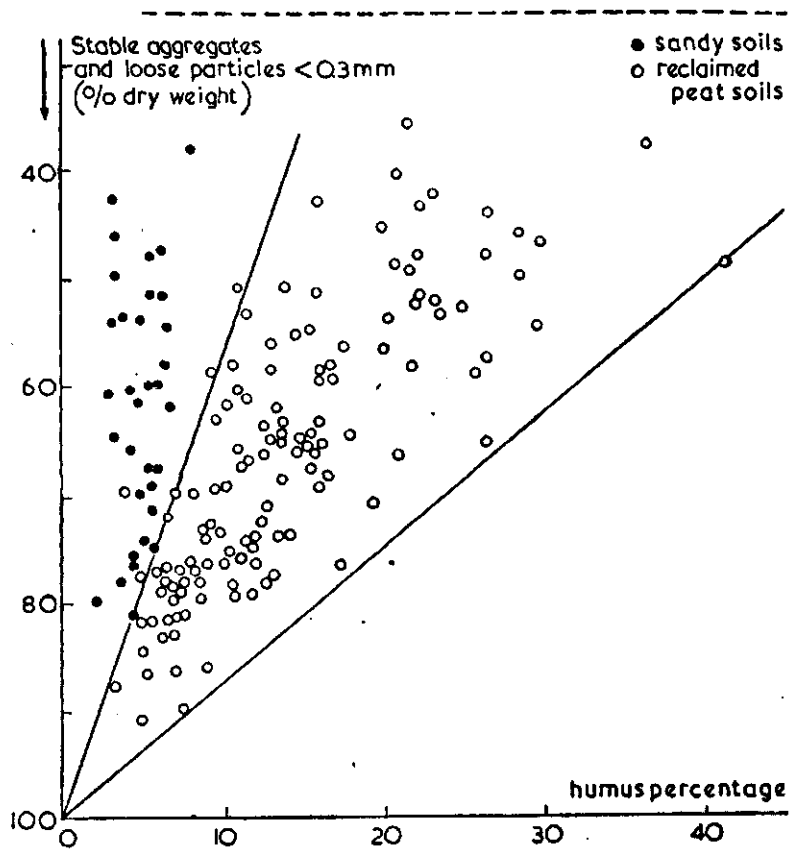

FIG. 2. Soil structure as measured by the wet sieving fraction <0·3 mm. (the smaller this fraction the better the structure) plotted against humus content for the top layer of 37 fields on sandy soils (dots) and 134 fields on reclaimed peat soils (circles). Arable land.
The hatched line parallel to the abscissa is assumed for the 'ideal' structure.

in dependence on the organic matter content of the soil. The broken line parallel to the abscissa shows the optimum structure as it was found according to provisional indications. Two conclusions have been drawn, viz., that with the same organic matter content a series of aggregations may occur and secondly that only a small percentage of the soils come up to the requirements as to high standards of soil structure.

Not only are standards for the soil structure fixed in the laboratory, but also visual methods are applied in the field. Th. J. Ferrari (10) applied the latter method to a series of experimental fields in a clayey district in the Netherlands. Fig. 3 and Fig. 4 clearly show the relation between soil structure and potato yields. It is remarkable that with an optimum nitrogen dressing the influence of the soil structure is more prominent than in plots where no nitrogen has been added. It appears that these results are very much dependent on the weather conditions in a particular year. The above results were found in 1947, whereas in 1948 in the same fields little influence of the structure was observed. This was corroborated by a soil fertility analysis carried out by Ferrari (11) in another clayey district, when the influence and interactions of many factors according to the multifactor analysis were studied.

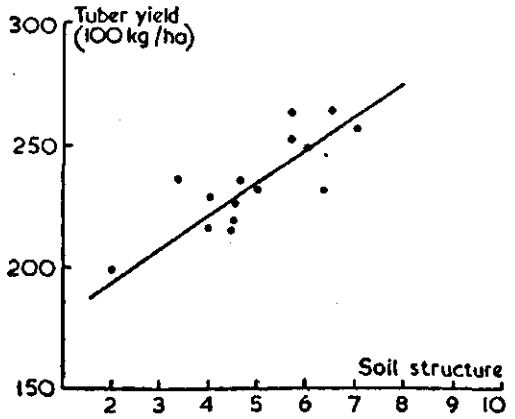

FIG. 3. The relation between the soil structure (determined by a visual method) and the yield of potatoes on plots not manured with nitrogen. Old arable land on clay.

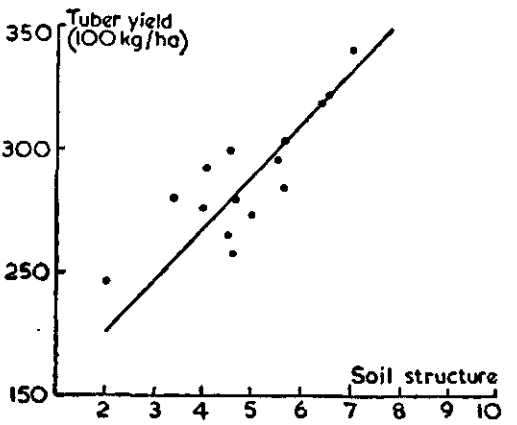

FIG. 4. The relation between the soil structure (determined by a visual method) and the maximum yield of potatoes. Old arable land on clay.

The addition of organic manures not only affects the aggregate condition, i.e., air and soil conditions in the soil, but probably also causes changes of secondary importance. Lack of space prevents us from discussing the significance of many plant nutrients which may be found in organic manures. The nitrogen conditions in the soil and nitrogen supply for crops may be drastically influenced by them. We wonder to what extent the nitrogen gradually becoming available from organic manure, besides quick-acting nitrogen from fertilizers, can have a favourable influence on production. P. G. Meyers (12) and W. A. Bosma (13) obtained data about a similar increase of the fertility level.

In his investigation in 1947, Ferrari found an important relation between the soil structure and the amount of nitrogen from fertilizers needed to obtain a maximum potato yield (Fig. 5). It should be noted that the differences in soil structure

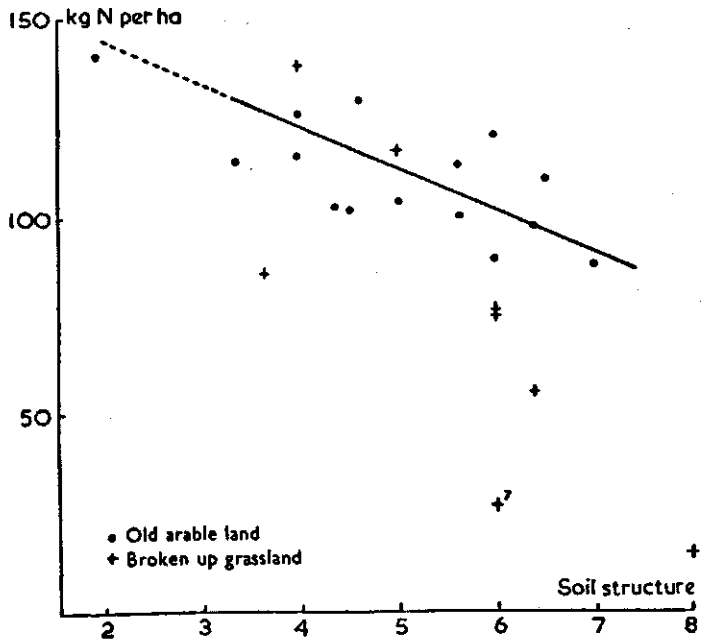

FIG. 5. The relation between the soil structure (determined by a visual method) and the quantity of nitrogen, which is needed to obtain maximal yields of potatoes.

were not deliberately obtained by changing the composition of the organic manure, but were accidentally found in the experimental fields. Ferrari was especially struck by the low amount of nitrogen needed with a good soil structure to obtain a maximum yield. On the ground of analyses of potato and potato-tops he thinks it possible that there has been a considerable nitrogen fixation from the air to the amount of 60 kilograms per hectare. This amount corresponds with the N-fixation which was found by J. G. Maschhaupt (1) in his lysimeter investigation. Several investigators who attended the Fourth International Congress of Soil Science in Amsterdam were surprised at Maschhaupt's results in view of microbiological considerations. Maschhaupt is of opinion that lysimeter investigations may contribute much to the solution of the organic matter problem.

We get the impression that the improvement of the soil structure and an increased use of organic manures will have a favourable influence on the average production level of arable land. It is as yet impossible to express this influence quantitatively. In the above report for the U.N.O. Conference 't Hart estimated for permanent grassland an increase in production of 5%, being the average for the whole area under grass (1,300,000 hectares grassland against 1,000,000 hectares arable land) if farm-yard manure and compost are more intensively employed.

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