ORGANIC AND INORGANIC MANURES.*

T. EDEN.

The address which I propose to give you to-day in response to your Chairman's invitation to me to speak on organic and inorganic manures, is not quite the same as it would have been if your meeting had taken place a week earlier. In common with most of you, I expect, when I opened the daily paper the other day, I turned my attention first to the article on Manuring of Tea. As a result of the publication of this article at this particular juncture, I have decided not to traverse essentially similar ground by giving you full experimental details of our own trials on the same subject, but to broaden the basis of my remarks so as to deal with some of the fundamental questions that such experiments provoke, and to use the experiments as illustrations.

If we are to survey the whole field of organic and inorganic manuring we shall have to divide our manures into four classes:—

(1) Inorganic artificials.
(2) Organic artificials.
(3) Green Manures.
(4) Bulk manures, including composts.

and we may well start by considering some of the essential differences between these types.

There should be no ambiguity as to what is meant by an inorganic artificial. It is a material made either synthetically or derived from mined deposits which are not derived directly from animal or vegetable material. Nitrate of soda, sulphate of ammonia, cyanamide, potash salts, and rock phosphate derivatives fall naturally into this class. Organic artificials are taken to include the residues from plants or animals, such as oil cakes or animal offals, and are familiar to you in terms of groundnut cake, whale and fish guano and bloodmeal. Green manures need no definition.

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Bulk manures and composts are essentially vegetable material with or without animal excreta that have undergone a process of fermentation. I have indulged in this elementary exposition, because in what I have to say later I want there to be no confusion as to what type of material I am describing.

We can separate these types into various classes. First we can divide them roughly into soluble and insoluble manures, putting class I by itself as soluble. But even amongst inorganic artificials a distinction must be made. Suppose we consider nitrate of soda, sulphate of ammonia and muriate of potash. Ordinarily speaking, these are all highly soluble materials, but in the soil they behave differently. In nitrate of soda it is the nitrate portion that interests us, and it is correct to regard this nitrate as readily soluble and easily leached away. With sulphate of ammonia the ammonia portion is what we want, and with nitrate of potash, the potash is the important part. Now, soil has the power of removing from solution these important parts of the manure and of fixing them. An experiment to show that this is the case is very easily contrived, and I have frequently demonstrated it to visitors at St. Coombs. Sufficient to say at the moment, that a so-called soluble manure does not necessarily behave as such in the soil immediately. Let us put it as a conundrum. When is a soluble manure not soluble? The answer is when it is an ammonium or potash salt.

We can also separate these groups according to a further criterion, particularly with respect to the behaviour of their nitrogen. Which are readily available and which less so?

It is admitted on all sides that the compounds of nitrogen which a growing plant can directly use are fairly simple. The old text-book notion that every form of nitrogen must ultimately be changed to nitrate before it can be absorbed by the plant, is now known to be fallible, but the classes we have been considering do vary most markedly in the complexity of their nitrogenous compounds. The main step in arriving at this complexity is when the nitrogen is chemically combined with carbon as is the case with organic artificials, green manures and bulk manures. At first sight

therefore it looks as if organic nitrogenous manures should be classified as markedly less readily available than inorganic nitrogenous manures.

Actually it is not quite as simple as that. To a large extent the rate at which a complex compound will break down to a readily available one is determined by the proportion of carbon to nitrogen in it, and in our chemical jargon we frequently talk about the carbon nitrogen ratio. I will not mystify you with a digression on this subject, but will give you a rough working rule. Usually an organic substance containing more than two per cent of nitrogen will easily furnish available nitrogen, and the higher the percentage of nitrogen the more readily available it will become. From this it follows that inorganic artificials and organic artificials with percentages varying from four to twelve and a half, readily supply nitrogen usable by the plant, and may be classed together. Dr. Joachim's experiments confirm this classification in work he has carried out at Peradeniya.

On the other hand; green manures, bulk manures and composts may have quite a lot of nitrogen in them that is only slowly available.

We can now turn to another detail and that is the difference between green manures and bulk manures and composts. The availability of green manures will depend largely on their having a suitable carbon nitrogen ratio when dug in. The other two materials are usually made from products where the carbon nitrogen ratio is too high for immediate use, but the fermentation processes in manufacture modify the ratio in the direction of increased availability.

A further point of view is that of the effect of these manures on tilth or the physical state of the soil. In so far as the addition of organic matter is the cause, then bulk manures stand in a class apart. The few hundreds of pounds of organic material contributed by an organic artificial to the 2½ million pounds which represents the weight of soil to a depth of nine inches over an acre, is a mere drop in a bucket. It may be of interest here to say that so far as tea is concerned, sulphate of ammonia preserves tilth, but continuous use of nitrate of soda in large quantities destroys it.

Reviewing now our classification of manures, it is evident that on all counts organic artificials resemble inorganic artificials more than they do the bulk manures, composts and green manures. Without further examination, therefore, we cannot claim for organic artificials all the virtues which are known to accompany the use of bulk organic manures.

So far we have been examining the properties of manures mainly from the point of view of information gathered from the chemical laboratory. Let us see how far field results tally with them. Here I shall restrict myself to the comparison of inorganic and organic artificial fertilisers. For the last four years the percentage increases or decreases in crop due to organics compared with inorganic sources of nitrogen are as follows :—

Percentage increase in yield due to organic manures compared with inorganics.

1931		1932	1933		1934		
—2·7	nil	—0·4	—4·4	—0·1	—2·8	nil	—1·2
T.B.	B.	B.	B.	T.B.	T.G.	B.	G.

T refers to tippings ; B means that the comparison is between sulphate of ammonia and bloodmeal; G between sulphate of ammonia and groundnut cake.

All these small differences are well within the experimental error and the results indicate that so far there has been no difference in yield.

The diagram* I have displayed for your attention shows how the effect of these manures has been spread over three of the years under consideration. You will notice how closely the yield curves agree whether the actual level of production is high or low. The data are based on means of 12 plots in each case, six receiving nitrogen at the rate of 20 pounds per acre and six at 40 lbs. per acre. Such agreement as is here shown is obviously not a matter of pure chance. Evidently the data do not support the contention that nitrogen losses are greater with sulphate of ammonia than with organic manures such as those mentioned, nor do they confirm

*Not reproduced.

the view that organic manures because of their slower availability give a more even distribution of crop yield. As you will probably raise in discussion the question of increased yields from inorganic nitrogen as displayed in the diagrams published in the *Times* article, I may as well comment on them now. In trial No. 1 of that article the yields from inorganics appear to have surpassed that from organics by some thirty per cent or more, whilst in the second the increase is thirty-eight per cent. I am not disposed to accept, on the strength of single plots of large size, the conclusion that these differences represent adequately the difference in yield producing capacity of the two types of nitrogen. I think the explanation lies rather in initial fertility differences between the plots chosen.

One more point regarding availability. In my Annual Report for last year, copies of which you have probably received recently, you will find that I have drawn up a tentative balance sheet for recovery of nitrogen by tea. The amount recovered from manurial applications seems very low indeed, being only some 18 per cent for flush, foliage leaf and wood. What happens to the rest I can only conjecture at the moment. The point is that there appears to be no increase in efficiency of recovery of nitrogen on the part of organic artificials.

These results are only a part of the evidence relating to the behaviour of inorganic and organic artificials. I have recently had the opportunity of discussing with Mr. H. R. Cooper of the Indian Tea Association's Research Station, Tocklai, Assam, a similar series of experiments that has been running with unchanged manuring for ten years. These experiments have been interpreted by the same statistical criteria as we employ, that is, we are both making use of the same standards of accuracy. For the range of manures we use in Ceylon, the Tocklai results during this period supplement and confirm our own experience.

The question of quality effects in made tea is naturally of great importance. All our manurial experiments are manufactured and the teas reported on by a team of tasters. As far as is possible,

subject to the departure of members of the team on furlough, the team is kept constant. During the last year of the last pruning cycle, two tasters agreed in finding no difference between organic and inorganic nitrogen teas. The third picked out the bloodmeal tea for special favour, though that improvement was not given a price value. In the present cycle four tasters are up to the present giving a slight preference to inorganics. The taster with a flair for bloodmeal was unfortunately not available at the time when tasting of second pruning cycle teas was started, but arrangements have been made for him to receive the samples as heretofore. We are naturally anxious to give all treatments the fullest possible test, and we have recently arranged to obtain London reports, as well as those from Colombo, on a similar basis. As a matter of interest the Tocklai teas tasted by teams in Calcutta and London show no difference in quality between organic and inorganic manures.

I have been asked more than once recently whether organic manures contain any accessory foodstuff analogous to vitamins, or some growth promoting substance which will impart to them special properties. This may possibly be the case. At present one of the most exciting lines of chemical and plant physiological research in relation to agriculture is the search for growth promoting substances. Such substances have been found but their properties are not yet understood. A substance which promotes growth in the above ground portions may act as a growth restricting agent as regards the roots. These substances appear to occur both in animal and vegetable tissues, and we are not in a position yet to say whether they are generally necessary as additions to ordinary plant nutrients, or whether the plant ordinarily contains sufficient for all normal growth. In fact the things we don't know about them far exceed the things we do. But current opinion is disposed to think that green manuring offers a means of supplying or preserving these little known substances. I give you this information for what it is worth, because it seems to me that it is on these lines that any attempt to distinguish "inorganic" from "organic" manures must proceed.

The position then is that field trials have failed to show any differences between organic and inorganic nitrogenous manures, and that, as far as direct nutrition is concerned, that is in keeping with what we know of the chemistry of these substances. Any special growth promoting substances that may possibly be present are evidently not required until the general level of fertility has dropped below that of the experiments that have been quoted, and are just as likely to be provided in any case by adequate green manuring