THE DIFFERENT CLASSES OF FERTILIZERS.

The number of different fertilizers offered from all sources to the farmer is legion, but he who reads and studies these pages will be in a position to differentiate and to choose those which will be of most value to himself, for he will learn that a good fertilizer must be valued according to its content of nitrogen, phosphoric acid, and potash.

The cheapest fertilizer is not the one costing least per ton, but is that in which the nitrogen, phosphoric acid, or potash, in a form available to the plants. costs least. It is, therefore, necessary to know the chemical composition of a fertilizer in order to determine whether it is worth its price.

Although the organic matter present in a fertilizer is not to be considered as a plant food, it is by no means to be considered as valueless. It has a good effect on the physical character of the soil, as it augments the supply of humus. It is partly for this reason that farmyard manure is so valuable.

Farmyard manure is a complete manure containing nitrogen, phosphoric acid and potash in quantities which depend upon its origin and treatment. An average content for slightly rotted first-class dung would be about 0.4 per cent. N, 0.2 per cent. P_2O_5, and 0.5 K_2O. In tropical countries, however, we must often reckon with far lower percentages. Farmyard manure offers to the plant each of the three principal elements required for successful growth.

In consequence of its high percentage of organic matter it exercises a very beneficial effect on the structure of the soil, and also on the bacterial life. The planter should, therefore, endeavour to avail himself of all the farmyard manure at his disposal, by collecting and keeping it very carefully. A drawback of farmyard manure, however, is that, if not properly kept, it may introduce germs of diseases into the plantation.

In some districts human excrement is used in the form of night-soil and, although the composition of this is not quite so favorable as farmyard manure, it may be regarded as a good complete manure.

In order to keep down the expenditure upon fertilizers, attention should be given to the utilization of all refuse of the plantation in the form of compost. Weeds and crop refuse should be heaped together and mixed with lime, which accelerates their decomposition. The manurial value of compost is increased very materially if phosphoric fertilizers and potash salts are mixed with the heap, at the rate of ½ cwt. muriate of potash, and ½ cwt. basic slag to the cubic yard. Compost is used to the greatest advantage when applied to the seed beds. The danger of introducing weeds and pests into the plantation has also to be considered when using compost.

Owing to the comparative scarcity of farmyard manure on tropical plantations, often the only way the planter has of enriching the soil in humus is to grow green manure crops of the leguminous family and to plough them under. This practice is very beneficial on stiff clays and on light sandy soils, as the

introduction of organic matter helps to loosen the texture of the former and to bind the latter, thus improving the physical condition of both types of soil. By growing green crops between the main crops, instead of letting the land lie fallow, the planter can keep his soil free from weeds and protect it from the leaching action of the heavy rains.

Besides adding humus to the soil, green manuring also enriches the soil in nitrogen. This is a very great advantage to the planter, especially since nitrogen is the most expensive plant food, costing four or five times as much per unit as either potash or phosphoric acid. The gaseous nitrogen, which forms four-fifths of the atmosphere, is valueless as far as the nutrition of plants is concerned, since they cannot make use of it in this form. The legumes (e.g., peas, beans, clover, lucerne, &c.), however, are an exception to this general rule. On the roots of leguminous plants are nodules containing bacteria, which, while living as parasites and feeding on the carbohydrates provided for them by the plant, fix the nitrogen of the atmosphere and convert it into suitable plant food for their host. It has been calculated that a good green crop brings more nitrogen into the soil than a good dressing of nitrogen fertilizer. As a source of nitrogen, green manure has the further advantage, that it yields a steady supply of nitrogen, at the rate at which the latter is required by the main crop, because the time during which the crop grows most vigorously and requires large supplies of plant food, coincides more or less with the period when the soil bacteria are most active in converting the organic matter of the decaying green crop into available plant food. It is therefore evident that green manuring is not only the best way of improving soils which are lacking in humus, but is also an economical and efficient means of enriching the soil in nitrogen.

To the class of organic fertilizers also belong pressed cakes made from oil seeds during the oil extraction. The quantity of organic matter brought into the soil by applications of cake is not very high, nor are cakes a complete manure. They give chiefly a one-sided manufing of nitrogen, which although in a form not immediately available to the crop, is transformed by bacteria into nitrate. Its absorption by the plant is dependent upon the velocity with which the cake is decomposed by the bacteria of the soil.

Such manures will not exercise so rapid an effect as mineral manures, but this is not necessarily a disadvantage, since for perennial crops such as tea, rubber, and coco-nut, it is of great advantage to have a fertilizer which will act in a gradual and lasting way. The most important of these are soya bean cake, castor cake, rape cake, cotton cake.

Of a similar effect are some by-products of animal origin which are of importance chiefly as sources of nitrogen and phosphoric acid; among these are dried blood, tankage, bone dust, and fish meal. Guano, though of organic origin, is, in most cases, already more or less mineralized, being the fossilized excrement of birds or bats. The best of the Peruvian guanos contain nitrogen and phosphoric acid, but most of other guanos contain only phosphate in a rather insoluble form, and are to be considered more or less as rock phosphates, which require treatment with sulphuric acid to render them soluble.

The following analyses show the average percentages of the four manurial constituents contained in the principal organic manures:—

—	Nitrogen.	Phosphatic acid.	Potash.	Lime.
	Per cent.	Per cent.	Per cent.	Per cent.
Farmyard manure	0.39	0.18	0.45	0.49
Human excrements..	0.55	0.28	0.20	0.10
Ground nut cake	7.60	1.30	1.50	0.20
Soya bean cake	6.90	1.50	1.10	..
Cotton cake	6.20	3.10	1.60	0.30
Castor cake	5.50	0.75	6.50	..
Copra cake	3.33	0.50	1.12	..
Bone meal—				
Raw	4.00	20.25	0.20	31.30
Steamed	3.00	20.22	..	..
Fish meal	8.50	17.40	0.30	15.40
Tankage	5.80	17.40	0.30	22.30
Blood meal	11.80	1.20	0.70	0.80
Horn meal	10.00	9.00	..	..

The several organic manures dealt with above may locally be very cheap sources of plant food. As, however, their composition is very variable, it is advisable that the planter who wishes to buy those that are obtainable should first have them analysed, so that he may know their composition.

The planter must always remember that cakes and by-products generally are not complete manures and being one-sided, they must be supplemented by the addition of some of the following mineral fertilizers, so that the plant may be provided with all the necessary plant foods in the right proportions.

The mineral fertilizers themselves are one-sided fertilizers and may be classed as nitrogenous, phosphatic and potassic.

The undernoted are the chief nitrogenous fertilizers in present-day use:—

Sodium nitrate—containing 15.5 per cent. nitrogen.

Calcium nitrate—containing 13 per cent. nitrogen.

Leuna salpeter (ammonium sulphate-nitrate)—containing 26 per cent. nitrogen.

Ammonium sulphate—containing 20.5 per cent. nitrogen.

Nitrolim—containing 18 per cent. nitrogen.

Synthetic urea—containing 46 per cent. nitrogen.

The nitrates of soda and of lime, also in part ammonium nitrate, contain the nitrogen in the form of nitrate, the form in which it is absorbed by the plant. In temperate climates this is very much in favour of these fertilizers, because the effect is thereby quicker and surer than that of the other nitrogenous fertilizers, the nitrogen of which must first be converted to nitrate by the bacteria of the soil.

In the tropics, however, this advantage seems to be of hardly any importance, because there nitrification proceeds so rapidly, that no objection can be made to sulphate of ammonia or nitrolim. It may even be that some crops benefit more from nitrogen in the form of ammonia.

Moreover, as sulphate of ammonia is not so easily washed out as nitrate, in tropical agriculture, it is often preferred to sodium nitrate.

As sources of phosphoric acid, in addition to the more or less mineralized forms of guano, the following phosphatic fertilizers are very much used:—

1. Superphosphate—containing 14–21 per cent. water-soluble P_2O_5.
2. Double superphosphate—containing 35–46 per cent. water-soluble P_2O_5.

3. Basic slag—containing 16–20 per cent. citric-soluble P_2O_5.
4. Rhenania phosphate—containing 25–30 per cent. citrate-soluble P_2O_5.
5. Ground rock phosphate—containing 25–35 per cent. insoluble P_2O_5.

Basic slag because of its lime content, is alkaline in reaction and is therefore preferred on acid soils, where the use of superphosphate might be dangerous. Rhenania phosphate contains about 25–30 per cent. P_2O_5 in a rather easily assimilable form.

The third important class of fertilizers is the potassic, containing potash in a form soluble in water. These are—

1. Sulphate of potash, 90–96 per cent. pure, containing about 48–52 per cent. pure potash.
2. Muriate of potash, 80–85 per cent. pure, containing about 50 per cent. pure potash.

Sulphate of potash, on account of the absence of chloride, is generally preferred for the manuring of crops rich in sugar or starch and also for tobacco—for high-class tobaccos the higher grade 96 per cent. sulphate, which has a guaranteed maximum content of 1 per cent. chlorine, is generally prescribed.

Another salt, sulphate of potash-magnesia, which contains about 26 per cent. of pure potash, is much favoured in European agriculture, because of its content of magnesia which according to modern investigation is also an important plant food. The good results obtained in Europe have led to its being tried in the tropics, but on account of its lower content of potash, and relatively high freight, it is less economic compared with, say, sulphate of potash.

The crude potash salts contain about 12–15 per cent. pure potash in the form of muriate of potash plus varying quantities of sulphate of magnesia and rock salt. Though these crude salts have been used with good results in Europe, freight makes their use in the tropics very costly. Kainit, however, is preferred by American cotton-planters and also for the manuring of coco-nuts, as the coco-nut palm is very responsive to a dressing of Kainit containing salt.

Nitrate of potash has the disadvantage that, in addition to the potash, a certain quantity of nitrogen in the form of the expensive nitrate must be bought. In experiments conducted in Java, the addition of nitrate of potash to oilcake depressed the manurial value of the cake, so that the manufacturers had to stop the practice of mixing oilcake and nitrate. Further, the negative results, which many potash experiments have given when potash was applied as nitrate, seem to indicate that nitrogen in this form reacted against the good effect of the potash.

Another potash fertilizer which seems cheap is wood ash. Its great disadvantage, however, is its varying composition and its low potash content of 2–10 per cent. potash (K_2O), which naturally means high costs of transport. It has been observed in certain experiments, that after a dressing of wood ash a strong growth of weeds was promoted, the destruction of which requires a great outlay. The check plots manured with sulphate of potash did not exhibit the same phenomenon.

As has already been pointed out, all these fertilizers are one-sided. In order, therefore, to provide a complete fertilizer, it is necessary to give them in combination as previously discussed. The mixing may be done by the planter himself, or he may buy a mixture ready made up from a reliable firm.

If the planter does the mixing himself, he will naturally save something on the cost of mixing, but he must be careful not to mix together substances which are incompatible. Such a mixture would lead to loss of nitrogenous elements or

to reactions resulting in caking. As a rule it may be stated that lime or basic slag must not be mixed with sulphate of ammonia or nitrogenous organic manures, because the caustic lime in them would lead to losses of nitrogen; furthermore, lime and basic slag should not be mixed with superphosphate, because the water soluble phosphoric acid of the latter would combine with the lime and form insoluble phosphates, which are of much less manurial value. All the other fertilizers may be mixed. It is, however, to be recommended that the mixing be done only a short time before using, in order to avoid any possibility of caking.

The mixing is done by spreading one fertilizer on a hard surface and then distributing the second evenly over the first. By working the two together with a shovel a good mixture is obtained. If three are to be mixed, it is better first to mix two and then add the third to the mixture.

Where the planter prepares his own compound fertilizer, he has the advantage of knowing exactly its composition. A great number of very reliable firms exist which sell their compound fertilizers under guaranteed analysis. Most of these firms mix by machinery and are so able to offer very uniform mixtures at little extra cost. Consequently, most planters prefer to buy their fertilizers ready mixed. Where planters are in touch with reliable firms, they are recommended to buy from these, but in every case they should ask for the analysis, and make certain that they do not get a mixture from an obsolete formula containing, say, only nitrogen and phosphoric acid, but one also containing, in accordance with the demands of theory and practice, at least 4–15 per cent. potash.—(*Rewritten from a pamphlet by Jacob and Clyle, R.C.H.*)