FITTING ARTIFICIAL MANURING TO GREEN MANURE SUPPLIES.

W. R. THOMSON, B. Sc. (Agric.)

The importance of Green Manuring has been impressed on the planting community of Ceylon by many writers in recent years but no discussion of the modifications which might reasonably be made in the supply of artificial manure when accompanied by green manure, has been noticed.

The value of green manure as a supply of nitrogen was discussed very fully by Eden recently (*Tea Quarterly*, Feb., 1932), in which he explained that the new nitrogen supplied was possibly an extremely small amount and that the practical effects of green manuring bore this out, in that results were certainly not as striking as the earlier writings on the subject would lead the practical man to expect.

Eden (*loc. cit.*) also makes the remark that there is much to be said for the practice of forking in artificials along with green manure. It is with the further elaboration of the results arising from this practice that the writer is concerned.

The amount of green manure available for burying at any one operation is very variable but for the purposes of the following estimations some figure has to be used and a good average weight per acre after deducting the woody portions which are too coarse for burying may be taken as 4,500 lbs. This figure will vary from estate to estate and from field to field, but an estimation of the amount can always be made for particular cases without much trouble.

The dry weight of this green manure will be approximately a third of its weight when freshly cut and the dry material will on an average contain about 2·5% of nitrogen and 30-35% of carbon, both figures being dependent on the proportion of woody material to leaf.

The buried green material as explained by Eden (*loc. cit.*) ultimately becomes part of the humus fraction of the soil and as this contains about 2% of nitrogen and 20% of carbon the process involves the loss of some nitrogen and more carbon. The process is bacterial and as there is a large excess of carbon the bacteria will turn elsewhere for the nitrogen necessary for the continuance of their life-cycle. It is to this "free" carbon that the value of forking in artificials along with green manure is due.

Every 100 lbs. dry weight of green manure will contain at least five pounds and possibly more carbon which will as decomposition progresses be "freed" to combine with outside nitrogen. Under the conditions of estate practice the mixture of artificials and green

manure is probably not sufficiently intimate for the process to reach theoretical efficiency and 5 lbs. of carbon per 100 lbs. of dry weight Green Manure may be taken as a reasonable figure of available carbon.

In the case under consideration 4,500 lbs. of green manure was to be buried. The dry weight of 1,500 lbs. will supply 75 lbs. of "free" carbon. This 75 lbs. of free carbon per acre is able to combine with or absorb as the bacteria break it down, 1 lb. of nitrogen for every 10 lbs. of carbon, i.e., 7·5 lbs. of nitrogen. This 7·5 lbs. of nitrogen could be supplied by 38·5 lbs. of sulphate of ammonia and this quantity would be locked up in the humus and released slowly as the humus breaks down.

The possible errors in the above calculation are, of course, very big. Beyond the fact that free carbon can be combined with nitrogen in the way described there is very little solid information to work upon. The carbon available may vary to a large extent with the quality of the green manure buried and the efficiency of the process in practice cannot be ascertained. The estimation of the various factors is as close as possible and the interaction of green manures with artificials can be calculated in no other way.

The 7·5 lbs. of nitrogen taken into the humus could, of course, be supplied from any inorganic and some organic sources. The calculations are not affected if another inorganic supplier is used but a considerable alteration must be made if an organic manure such as groundnut cake is used. The carbon nitrogen ratio of this and similar cakes is already approximately 5 to 1 and to balance this at the humus ratio of 10-1 only requires a further five pounds of carbon for each pound of nitrogen.

The 75 lbs. of carbon supplied per acre in the example given could be combined with 15 lbs. of nitrogen supplied by groundnut cake, i.e., 215 lbs. containing 7% of nitrogen.

The combination of nitrogen from artificials with the green manure has a very definite value in Ceylon tea manuring practice. The tea bush has no resting period comparable to that undergone by perennials in temperate climates or even with the tea grown in Northern India and a steady supply of plant food is, therefore, desirable. The process outlined is a considerable assistance to efforts in this direction for the nitrogen so held is gradually released by ordinary decay in the soil. Before this release takes place the nitrogen is protected from leaching to which it would otherwise be subject.

This process combined with the fact that the growth of green manure results in the removal of available soil nitrogen from possibility of loss, to be returned in the lopping, goes a long way to making possible an even supply of plant food to the tea bush.

The supply of inorganic nitrogen for the purpose of adding it to the stock of available nitrogen in the soil is not affected by the process under discussion. What is a reasonable supply for this purpose and the rate at which it will be absorbed by the tea and green manure trees are separate problems? The amount of inorganic nitrogen supplied in excess of the quantity which can be held in the green manure is an addition to the available nitrogen of the soil. As available nitrogen it is subject to loss in the form of leaching and obviously should be an amount which can be taken up by the roots of the crop in a very short period.

In the same way resistant forms of nitrogen such as some of those derived from fish or animal sources are not affected and the total nitrogen to be supplied per acre can be made up from the wide choice available.

A fairly typical mixture would on the above lines of construction be analysed as follows:

Green Manure available 4,500 lbs.

Sulphate of Ammonia 50 lbs.—Supplying 10 lbs. nitrogen for additions to the available stock in the soil and for immediate action.

Sulphate of Ammonia 25 lbs.—Supplying 5 lbs. nitrogen for interaction with 3,000 lbs. of green manure and additions to reserve stocks.

Groundnut Cake 70 lbs.—Supplying 5 lbs. nitrogen for interaction with 1,500 lbs. of green manure and addition to the reserve stocks.

Fish Guano 150 lbs.—Supplying 10·5 lbs. nitrogen in slow acting form.

Bone Meal 100 lbs.—Supplying 3 lbs. nitrogen in slow acting form.

It is not contended that such definite segregation would occur in practice. Each category of nitrogen is present in many mixtures of the same type as that instanced above and though it is actually impossible to attribute a particular fate to any one ingredient a consideration of the possibilities on the lines indicated seems worth while when a mixture is being constructed.

A mixture such as the one taken above would, when completed with the necessary potash, be a fairly common type and would approximate to a very large class of the mixtures in every-day use.

As these mixtures have been arrived at over a period of many years' manuring practice in Ceylon it seems that their correlation with the theoretical requirements is a confirmation of the theory propounded.

In many instances the mixing of nitrogen from various sources is now being given up largely on the ground of cost. The cheapest form of organic nitrogen costs more than twice as much as the cheapest nitrogen in an inorganic form and under the present conditions of stringent finance the change-over is to some degree inevitable. Mixtures are now being used which supply up to 50 lbs. or more of nitrogen per acre from entirely inorganic sources.

It has been commonly held that a liberal green manuring programme justified this course but even with a liberal allowance of green manure the danger of losing a very large proportion of this nitrogen is considerable under Ceylon soil and rainfall conditions. If we allow the high figure of 9,000 lbs. per acre of green manure only 15 lbs. of inorganic nitrogen can be held in a form which protects it from leaching, so that 35 lbs. must be regarded as being without the slightest protection from this form of loss until it is actually absorbed by the root system of the tea and green manure trees. In low rainfall areas at the drier periods of the year absorption by the root system will probably take effect, but the position must be a gamble on the rainfall for some time after application for even the highly retentive Rothamsted soils lose both ammonia and nitrates if heavy rain (for England) falls soon after application.

The use of organic nitrogen for the balance of the nitrogen supply after the satisfaction of the amount applied for immediate action and for combination with green manure cannot completely prevent losses as a long wet period may wash out nitrates as fast as they are formed by the breaking down of the organic nitrogen. Organics do however give some protection against loss and therefore justify their use. Though in the interest of economy the largest possible amount of inorganic nitrogen should be used the supply of nitrogen to the tea may be seriously curtailed if the factors set out above are not taken into consideration. The protection offered by simultaneous burying with green manure is considerable but is definitely limited and, valuable as the practice has been shown to be, it cannot be expected to protect the whole of the nitrogen in the annual supply if this is all in an inorganic form, so that the precaution of supplying some nitrogen in fairly resistant organic forms should be taken even though it involves some extra cost.