

GREEN MANURING AND SOIL CONSERVATION.*

T. EDEN,

Ceylon is passing through a stage of agricultural development which confronts every country where intensive agricultural enterprise is, relatively speaking, in its infancy, the stage at which the primary concern is less with soil exploitation than with soil conservation.

No matter where we turn, in long established systems of agriculture we shall find that provision for soil conservation and recuperation is part of the accepted routine. The Mosaic law, for instance, prescribed one year in seven for a field to be left fallow, and in Mediæval England one field in three was yearly left without crop. More recently in the wheat growing prairie lands of North America the continuous growth of grain and the extravagant waste of burnt straw, which characterised early efforts, have been replaced by logical systems of crop rotation. These examples suffice to illustrate the methods which sheer necessity has forced on the agriculturist for the preservation of his soil as a medium for plant growth.

The use of green manures is an ancient practice for the furtherance of this end which fell into disuse and has been revived during the last century. I propose to discuss the principles and possibilities of this feature of cultivation as it affects tea growing in Ceylon.

For convenience I shall deal with the plant as it grows first, then with the effect of its incorporation in the ground, reserving till the last a short discussion of general principles of management.

EFFECT OF GREEN MANURES WHILE GROWING.

Whilst growing, the green manure acts as a soil conserver in two ways. It offers protection from the direct impact of rain on the soil, and it makes for ease in soil drainage. The first point needs no elaboration; the second is perhaps not so obvious. The greatest losses of soil are brought about not by the beating action of the rain, but by the fact that the soil cannot normally absorb water at the rate at which it is precipitated. Consequently, there is a surface run-off of serious dimensions which carries with it surface soil, particularly the finer fractions. Nothing short of the reduction of surface run-off is going to make a striking impression on soil conservation, and anything which helps this reduction is a valuable factor. An increased porosity is a fundamental necessity. Consider what happens as the rain falls. At first a rapid uptake occurs owing to capillary forces at work in the

* The following article reproduces that portion of a lecture delivered before the Pussallawa Planters' Association on October 23rd, 1929, which dealt with green manuring in relationship to soil erosion. The remaining portion describing the effect of green manures on the nutritional cycle in the soil followed the lines of the article in this Journal, 1929, Vol. 2, page 96.

fine channels between the soil particles. This process receives a check as soon as these small channels are filled, because for free movement not only must the rain enter but air also must escape. If absorption is to continue rapidly, there must be some other channels besides capillaries. Consequently, it is to the larger fissures that one looks for the escape of air. Such channels are readily provided by the decay of rootlets and the excavations produced by the growths of new ones. In this way the growing green manure helps to keep the soil porous. Another effect that is beneficial is the prevention of rapid drying of the soil surface by baking sun after rain. Nothing so contributes to impermeability as that does.

These two effects immediately raise the question of ground cover *versus* high shade. Ground cover, regarded as a growing crop, has certain distinct advantages over high shade. The latter, efficient as it is in lessening the impact of rain, contributes little to the diminution of surface run-off, for the underlying ground is bare. On the other hand, ground cover, besides affording protection against beating rain, interposes a useful barrier against soil movement, and because its root system is finer and more thoroughly ramified, it maintains the soil porosity at a higher degree than high shade can hope to do. The aversion to its use, apart from a scarcity of acceptable species, appears to be the result of fear that competition or toxic properties will interfere with the growth of tea. The toxic properties of plants have never been generally confirmed by experiment. There is, of course, bound to be competition for air, light and moisture, but not necessarily to a greater degree than in the case of shade. Inasmuch as ground cover is shallow rooting, and practises not a directly competing but a complementary economy in root action, it may be said to have the advantage over high shade. Anything, however, in the nature of a turf-like or peaty mat, such as may be formed on the surface, is to be avoided. This will be discussed under cultivation. In assessing the evidence for and against a cover crop, due attention has not always been paid to the fact that, even if it offers to tea sufficient competition to produce a temporary decline in yield, its ultimate effect is to conserve both soil and soil fertility. On the other hand, a bare soil subjected to erosion is fated to reach a dead level of unproductiveness. The Peradeniya work with *Indigofera* has not as yet detected even the initial set-back which might be expected.

EFFECT OF GREEN MANURES IN THE SOIL.

All the benefits which a green manure crop confers on the soil whilst growing are enhanced when the green stuff is incorporated in the soil. The decay of large quantities of green stuff, acting on the self-same principles as the decay in roots, continually makes and remakes those very channels which help drainage. Moreover, as humus is formed the fine particles of soil are coated by a jelly-like film

which cements them together. Instead therefore of a compact mass there is produced a more granular structure of soil crumbs. Nor does the effect stop at a simple amelioration of drainage and porosity.

Soil erosion can only occur when the particles of top soil are bathed in sufficient fluid to allow them to slip easily over each other. If we take soil devoid of organic matter, we find that this "flowing point" is reached at a much lower moisture content than soil well provided with humus, so that in this way the adverse effect is postponed.

Finally, there is a complicated chemical effect taking place. The ease with which fine soil particles remain suspended in water is greatly influenced by the presence of other substances. Some of these help to sustain the suspension, and are said to deflocculate the soil; others have the opposite effect and cause a rapid aggregation of fine particles which then sink, leaving the liquid clear. Conversely, the first class of substances makes it easy for the fine particles to be taken up; the second relatively more difficult. Humus belongs to the second class in that particles of humus and clay mutually flocculate each other under certain circumstances, and thus loss of fine soil is hindered. It must be a sight common to your experience to see the difference in turbidity between, say, the discharge of heavy rainfall from bare tea land, and adjoining patna or scrub jungle. To sum up then, in the soil the green manure counters erosion by increasing porosity, increasing the water-holding capacity of soil, and by encouraging the aggregation of the fine particles.

GENERAL PRINCIPLES OF CULTIVATION.

There remains the consideration of how the effects spoken of can best be brought about. In the first place, is it better to allow loppings to accumulate as mulch, or to bury them, and if so, fresh or dry? A mulch has certain beneficial properties peculiar to itself, the foremost of which is its capacity for reducing loss of soil moisture from the ground, but there are disadvantages too. A mulch to be effective must be general. Lesser quantities of organic matter left on the top are easily carried off by the surface rain and wind, and only serve to choke drains. The organic matter has little or no opportunity of exerting all those beneficent properties on the soil, which have been detailed. Furthermore there is a definite loss in manurial value. The alternate drying and thorough wetting of the leaf provides just the right conditions for loss of nitrogen in another form, *i.e.*, as gaseous nitrogen discharged into the air. The work done in the Department of Agriculture on tea prunings, which demonstrates this, applies equally to green manures. Despite labour and cost difficulties, forking in is advisable. It gives the green stuff an anchorage and uses it to the full advantage. Where this is impossible, a system of thatching the rows with leaves downwards is advisable as a useful

preventative of both actual loss of organic matter and potential loss of nutritive value. There does not appear to be much difference between forking in the dry leaves beaten off the branches and forking in green, provided that the operation is not long delayed.

The policy of forking in with artificials is a sound one. Mixtures containing readily available nitrogen and some lime, such as are constantly used, aid the breaking down of the green stuff, but where this involves a sacrifice of convenience it is not vital.

Cover crops are not so general in tea as to provide much data as yet on questions of cultivation. I hope that experiments on this subject will form part of our future work at St. Coombs. From all points of view it seems to me that periodical cultivation and digging in will have to be practised not only to check any smothering tendencies that may be manifest, but in order to derive the full benefit from the accumulated organic matter, and to promote new and healthy growth. Moreover, green manure crops need cultivation and aeration as much as any other crop. Presuming that they are leguminous, they have a special need for soil aeration. In saying that they fix atmospheric nitrogen, it must be remembered that it is the soil atmosphere that is meant. Unlike tea, green manures offer possibilities for rotation with all its attendant advantages. A cover, mixed both in matter of species and of age, is preferable to a uniform cover, and the total crop is likely to be larger. Here again it is a question of different species practising rather different economies in the matter of nutrition and light.

One hears of the difficulty of establishing cover crops. It is inadvisable to dogmatise, but there are two suggestions which may be worth considering. Where altitude is the difficulty, it is worth while acclimatising the tree by advancing up the slope gradually, and not supplying from altitudes very much lower. A great measure of success has been experienced by treating dadaps in this way. There is also the possibility that the "something lacking" in the soil is not chemical but microbial. The leguminous crops do not produce nodules on their roots from sheer altruism; without them they themselves languish. But the production of nodules depends upon the specific bacterium being present in the soil in the first place. Where the crop has been grown for some time, the organism is already there to perform its useful function on new plants, but it is by no means ubiquitous. A basket of earth from land already carrying the crop put in each hole is a rough and ready method of inoculation, but it is usually satisfactory. These are some of the many points which present themselves for consideration. In covering ground rapidly, I have tried rather to bring up points which merit discussion than to deal in matters of detail.