DEPARTMENTAL NOTES

SOIL EROSION ON TEA ESTATES AND SOME SUGGESTIONS FOR ITS CONTROL*

W. C. LESTER-SMITH,
AGRICULTURAL OFFICER, SOIL CONSERVATION.

PLANTATION agriculture may be defined as the cultivation of one or more types of crop plant in large compact communities in order to economize in the production and harvesting of the crops concerned. This type of agriculture involves the establishment of large areas under one main crop, and the application of labour and capital to it in such a way that production is rendered most profitable over the whole economic life of the crop.

With a perennial crop like tea, in which the period of lag between the application of capital to the crop and the sale of the finished product is often considerably longer than is the case with other crops, one of the primary necessities is to prolong the life of the crop so that the capital expended on it is spread over an economic period of profitable returns. There are two basic requirements of all perennial crops without which their life cannot be economically prolonged, and tea is no exception. These requirements are the conservation of the soil in which the plant grows, and the maintenance of its fertility.

The economic cultivation of any crop plant necessarily involves, from time to time, some disturbance of the soil in which that plant is growing ; and this must inevitably lead to a greater or lesser degree of soil erosion. However small may be the amount of erosion which takes place, in time it will both reduce the fertility of the soil and increase the cost of production of the crop. The greater the slope of the land, the longer the length of the slope, and the more often the surface soil is cultivated or stirred, the greater will be this loss.

Owing to the varied environments in which tea is grown there are several types of erosion to which the surface soil of

* The text of an address delivered at a meeting of the Dimbula District Planters' Association on September 12, 1938. The photographs reproduced illustrate various points referred to in the text.

FIG. I.—SOIL EXPOSURE.

FIG. II.—CONTOUR STONE TERRACES.

areas under tea is subjected. I propose to describe some of these, to comment on them briefly, and to suggest various ways in which the degree of erosion can be reduced.

Direct Rainfall Erosion.—This is due to the direct beating action of the individual raindrops on exposed areas of the surface soil. It is a form of erosion which occurs on areas planted with tea which are devoid of any high shade or ground cover, and when the tea plants themselves and any other existing low shade plants do not entirely cover the soil and intercept the rain (Fig. I). This form of erosion is perhaps most severe on soils which are kept clean weeded, which are loose and dry, which contain insufficient clay or humus to render them cohesive, and on areas which are almost denuded of all high and medium shade at the same time as the tea is pruned. In my opinion this form of erosion can be reduced by maintaining a rain-intercepting high or medium cover over the tea when it is pruned, by laying the prunings and by carrying out any artificial or green manuring that is done at this time, in counter-slope lines. Close planting will also serve to reduce this form of erosion.

Sheet Erosion.—This is the widespread removal of a very thin layer of soil, mainly the loose particles, from the surface of the land. It is a form of erosion which is caused by surface run-off water. The amount of humus and soil moved is often considerable, and is increased by the steepness of the slope and by insufficient checks to the movement of this water. The greater part of the eroded soil is removed during the first hour or less of the run-off period resulting from intensive falls of rain. The most efficacious preventives of this form of erosion are an extremely absorptive surface soil, numerous sponge-pits or trenches, and a low-growing ground cover. The plant (or combination of plants) which has none of the specific characters disadvantageous in a ground cover for tea, and which is easily establishable in different areas, has yet to be found. Until this has been accomplished, and until such a plant or mixture of plants has been proved to have no detrimental effect on the crop, various makeshifts which will limit the movement of soil should be adopted. Various ground cover plants, such as *Oxalis* spp. and *Centella asiatica*, offer possibilities in this respect; but they all have one common disadvantage that they cannot be established everywhere and particularly where they are most needed. To what extent this is due to a reduction in the natural fertility of the soil resulting from past erosive action I cannot say, but I venture to think that in many cases it is primarily due to this cause. If this is so, two main ways of improving these conditions suggest themselves; firstly, by simulating at least a partial return to natural conditions by establishing an

increased density of high and medium shade plants, and secondly, by reducing soil movement to a minimum in other ways. It appears to me that one of the cheapest and most effective methods of preventing sheet erosion on sloping land is to establish permanent hedges of some close-growing perennial plant. These hedges should be planted along contour lines at such vertical intervals as would best suit the slopes and soils concerned. If these hedges are once properly established and maintained they will reduce the length of the flow-lines of surface run-off water, check its rate of flow, and effect the deposition of eroded soil along the upper sides of the contour hedges. In this way the forces of erosion will be directed along anti-erosive lines which will automatically terrace the land, reducing its slope, conserving its soil, limiting the movement of its humus surface-litter, and so raising the natural fertility of the soil.

Contour stone terracing (Fig. II) can effect this equally well, when stone is available in sufficient quantity on the spot; but stone terraces suffer from the disability of having to be periodically heightened to prevent loss of soil from steep slopes on which soil movement continues to take place. Hedges of suitable perennial plants, however, grow up with the rising bank of arrested soil, tend to consolidate it, and cause less damage when breaches occur. The plant which I consider most useful for this purpose is the Sword plant (*Sansevieria guineensis*), while its indigenous relative, the Ceylon Bowstring Hemp (*Sansevieria zeylanica*), forms a fair substitute and is available in greater quantity.

Contour works of this type require to be co-ordinated with some system of drainage which will remove surplus run-off water and thus prevent its accumulating and breaching one or more of the contour works. Under the rainfall and other conditions which commonly prevail in Ceylon it is inevitable that a certain portion of the annual total rainfall eventually becomes surface run-off water. It is this fraction, however small it may be, resulting mainly from intensive falls of rain of short duration and restricted distribution, which causes the most severe erosion. Therefore unless contour works are provided with some means of relief in the form of drains, they may be the cause of serious damage, if not on the area itself probably on that immediately below it. Contour drains naturally work best in conjunction with contour hedges and contour terraces, but existing estate drains can generally be utilized to serve a similar purpose, until such time as more up-to-date drainage systems can be constructed.

Contour hedges of the Sword plant have a particular value, I consider, for establishment in areas of tea which it is proposed

FIG. III.—COUNTER-SLOPE PLANTING.

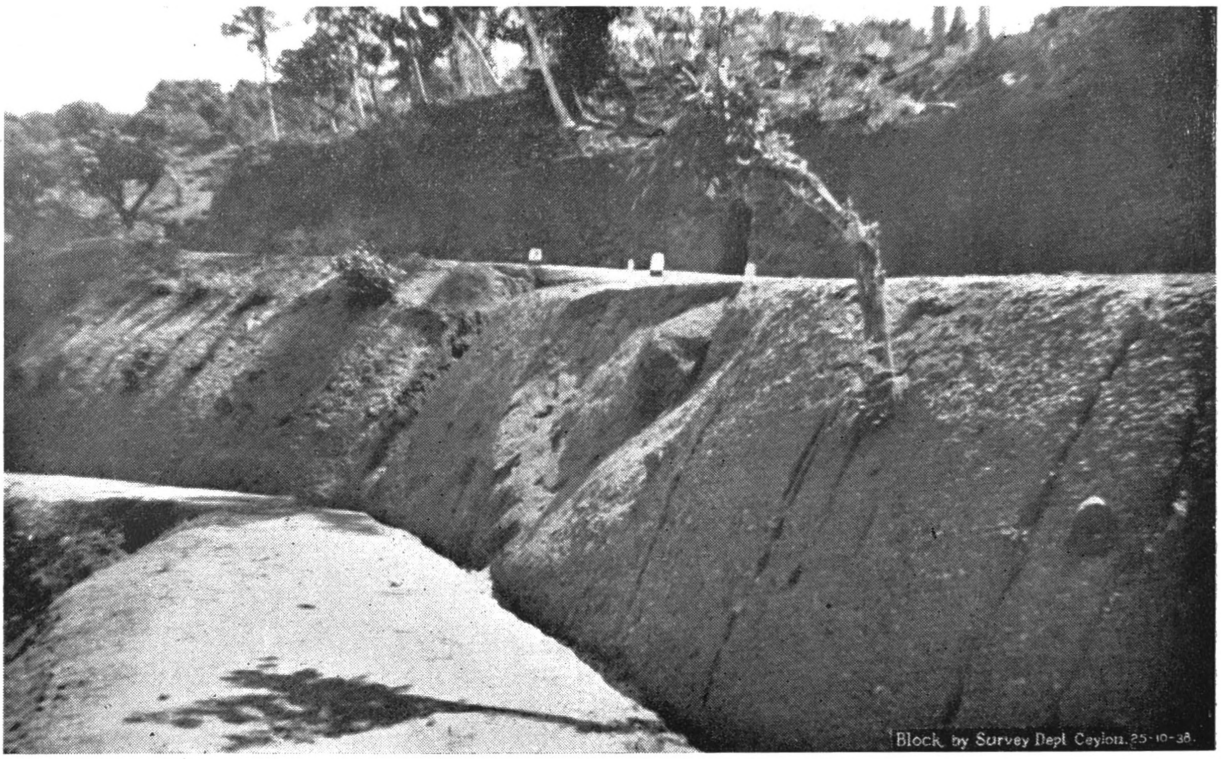

FIG. IV.—ROADSIDE BANK EROSION.

to replant. For this purpose I would suggest that the contour hedges are planted at least a year before the old tea is removed, and that, at first, only those tea bushes which interfere with the establishment of the contour hedges are removed. The soil which is subsequently displaced and loosened by the removal of the remainder of the old tea plants will then be held up and protected from loss by the contour hedges. The land will tend to terrace itself, which will facilitate replanting and the subsequent plucking and cultivation of the area, and run-off and erosion will be reduced. Once the area is cleared, except for the contour hedges, a re-orientation of the drainage system of the area is facilitated, and more or less level contour drains can be constructed without the necessity for much pegging and lining. These drains should be sited on the lower side of the contour hedges and the spoil or excavated earth may be utilized for filling in old drains and for assisting the natural terracing of the land by spreading it along the upper sides of the contour hedges.

In connection with the replanting of the contour strips, I should like to correct an erroneous impression I appear to have given in a previous lecture I gave at Ratnapura (*Tropical Agriculturist*, June, 1938, Vol. 90, No. 6, page 363, last paragraph.) I then said that contour planting did not appear to be suited to close-spaced row crops such as tea, &c., and I still hold this view. The slopes of the greater part of the undulating land of Ceylon are either so small or so uneven as to render the large-scale contour planting of close-spaced crops uneconomic, on account of the difficulties involved in their lay-out and management. To be more explicit I should say that I refer to strict contour planting, and not to those modified systems of contour planting which can be more correctly referred to as counter-slope planting (Fig. III).

Dry Wash.—This is a form of erosion which is mainly characteristic of steep stony slopes with a soil the particles of which, when dry, are lacking in cohesion. They are the cultivated counterpart of areas which, I believe, in mountaineering parlance would be termed " scree ". Dry wash, as its name implies, usually takes place in areas which are subject to pronounced spells of dry weather, which are deficient in shade and ground cover, and have been so eroded in the past that any surface material worthy of the name of soil is conspicuous by its absence. The physical nature of the so-called surface soil, the slope of the land, and the sparseness of vegetative cover, are such that in dry periods, a spontaneous or induced downward movement of soil, soil-aggregates and stones, takes place on the more exposed slopes. It is due to evaporation of soil moisture and a low humus content causing a

reduction in the cohesion between the particles which constitute the surface soil ; and also to variations in the amount and position of soil moisture causing changes in the centre of balance of stones and soil-aggregates.

This form of erosion can be greatly reduced by permanent contour terraces, grass bunds, and hedges of almost any woody plant if sufficiently closely planted. As a temporary measure, low, contour, wattle fences, made of *Gliricidia* branches, &c , can be used with effect across areas of this type. High shade, low shade and ground cover plants, combined with green manuring, can also be used in addition, in order to increase the moisture-retaining capacity of the soil and its cohesiveness. The prevention of this form of erosion must, in any case, be based upon the prevention of soil movement and the revegetating of the area.

Bank Erosion.—The banks of roadsides (Fig. IV), streams, gullies and drains (Fig. V), often suffer severely from erosion as a result of their being devegetated, cut at too steep a slope, and unprovided with an adequate check to surface run-off water before it flows over the edge of the bank. A clean cut earth bank may look neat and tidy when it is kept free of weeds and all other vegetation, but, to my mind, it cannot be considered either economic or stable unless it consists of hard rock-like material. Such banks are often cut so steep that no vegetation will grow on them, or they are periodically scraped and weeded to keep them clean. In this state they are perpetually exposed to the sun, the wind and the rain. The alternations of wet and dry conditions, cold and heat, and sometimes the percolation of sub-soil moisture, upset their stability and cause cracks and fissures to appear in them which widen and increase in size in the course of time (Fig. VI). Unchecked surface run-off water shoots over the top of the bank. If a splash-cushion or pavement is provided, the splash water wears away and undercuts the base of the bank ; if no such provision is made, waterfall erosion pits and wears away the road, pathway, drain, or soil at the foot of the bank. Where the rush of surface run-off is checked by a grass edge at the top of the bank, the water flows down the exposed face of the bank causing fall-face erosion and gradually wears back the bank. An even more pernicious form of undermining the face of devegetated banks is sometimes to be seen. This takes the form of scooping the earth or gravel out of hollows in the face of the bank, for the purpose of repairing and maintaining roads and paths.

The best method of stabilizing and preventing the erosion of the sides of banks, streams and drains is to slope them sufficiently to permit natural vegetation to grow or a desired type of vegetation to be established on them. A slope of from

FIG. V.—DRAIN-SIDE EROSION.

FIG. VI.—BANK EROSION.

45° to 60° is usually sufficient for the purpose of enabling a suitable type of vegetation to become established. Where available, Carpet grass (*Axonopus compressus*) is perhaps one of the best and tidiest bank-binding plants, while the little white-flowered Australian Daisy (*Erigeron mucronatum*), often grown on banks and rockeries in gardens, provides an attractive alternative. *Indigofera endecaphylla* can also be sometimes used with advantage for this purpose.

Drain bed-scour.—In the case of graded main drains their beds often get badly scoured and pot-holed and their sides undercut to an extent which, on steep slopes or in readily eroded soil, rapidly converts them into ravines and gullies. Alternatively, narrow drains with straight sides, when cut in cohesive or erosion-resisting soils, wear deeper and deeper as more easily eroded sub-soil strata are reached. Both these forms of erosion are not uncommon ; they may develop to such a degree that the height of the water table of the land on each side is permanently lowered, so that during short dry periods, artificial drought conditions for the crop are induced.

The remedy lies in sloping the sides of all drains, reducing their depth, and retarding the rate of flow of water by vegetating them, and constructing in them check-dams, locks and blocks, and reverse-slope steps. It has to be realized that apart from such factors as volume of water, gradient, retard effect, &c., the rate of flow of water in drains is largely governed by its depth ; thus, the deeper and narrower a drain the greater the rate of flow of water in it, and so the greater its erosive power.

A word of warning is perhaps necessary here as regards the construction in drains, of locks, pits and reverse-slope steps in areas at low-elevations where malaria is endemic. Such water-retaining compartments provide suitable breeding places, particularly when insufficiently shaded, for the malaria-carrying mosquito *Anopheles culicifacies*. In malarial areas, therefore, it should be a rigid rule that all such water-holding silt-pits, locks and step-angles should be converted into, and properly maintained as, sponge-pits, sponge-trenches, and sponge-cushions, by keeping them at least half to three-quarters full of dead weeds, cut grass and other cut vegetation which is absorbent and readily decayable humus-forming material. This will reduce the length of time water stands in these places, assist its percolation into the soil and make any such water less acceptable for breeding purposes. A good growth of suitable vegetation should be permanently maintained in, and on the sides and banks of, all such drains so as to keep them effiectively shaded.