Tea Q. 42,(4) 206-211. 1971. Printed in Ceylon.

SOIL EROSION AND CONSERVATION IN CEYLON WITH SPECIAL REFERENCE TO TEA LAND

*W. B. Manipura

In Ceylon where agriculture plays a dominant role in the economy in terms of employment and foreign exchange earnings, soil is evidently a very important natural resource. A proper system of land use and soil management should ensure not only the feasibility of growing crops under the present economic and social influences, but also in maintaining the land in a suitable condition for future use. The lack of adequate knowledge of the soil erosion problem and economic limitations in adopting suitable conservation measures have both contributed to the deterioration of much valuable land. In the past a major source of soil erosion was the large scale opening up of virgin land without adequate precautions to conserve the soil. The methods of cultivation subsequently practised paid little attention to soil conservation perhaps through a lack of knowledge on the part of the pioneering planters. Evidence of soil erosion to varying degrees can be observed on most cultivated land at present.

Principles of soil erosion

Under natural conditions soil removal termed 'geological erosion' proceeds at a very slow rate maintaining an equilibrium between the processes of soil formation and denudation. The rate of soil formation is an extremely slow process. Bennet (1939) suggested that to form 2.5 cm of soil from parent material may take from 300 to 1000 years. When the protective vegetation is removed for the cultivation of crops or for grazing the rate of soil removal or soil erosion is vastly accelerated. Estimates of soil removal (Bennet & Lowdermilk 1938) have shown that 17.8 cm of top soil may be lost between 16 to 51 years under clean cultivation compared with 3,500 to 95,800 years under a dense cover. Under various systems of cultivation, unless adequate safeguards are taken to conserve the soil, erosion would, therefore, be one of the major factors responsible for the deterioration of productive land.

When natural vegetation is removed the soil is exposed to the direct action of wind and rain. Wind erosion is most acute in dry regions devoid of vegetation and subject to strong winds. Wind erosion is of little significance in Ceylon, but water erosion takes place to varying degrees under different systems of cultivation and soil management. The beating action of rain drops on the bare soil has in itself a considerable effect on soil erosion (Ellison 1952). The falling rain drops break up the soil aggregates, displace soil particles and transport them. The finer particles of soil block the soil pores and seal and compact the soil surface. The immediate effect of rain is, therefore, to decrease the infiltration capacity of soils. When the rate of rainfall exceeds the rate of infiltration there is surface run-off on sloping land, carrying soil particles in suspension in the run-off water.

*Agronomist, Tea Research Institute of Ceylon, Talawakelle, Ceylon.

The first stage of erosion by run-off is sheet erosion where uniform layers of soil are removed. This stage is generally not very conspicuous because there is only gradual removal of uniform layers of surface soil. The next stage of soil erosion by water is rill erosion where water collects in small channels or rills. The transportation and rate of detachment of soil particles are much greater in rill erosion than in sheet erosion because of the higher run-off velocity. The next stage is gully erosion where small channels or rills join to form deep and distinctly large channels or gullys. The size and shape of gullys largely depend on soil type and degree of erosion. All these stages of erosion contribute to the loss of soil and plant nutrients from cultivated land. The results of erosion are, however, not confined only to the land where erosion is taking place. The soil carried in run-off water in streams and rivers are often deposited in the plains below resulting in the sedimentation of reservoirs, draining systems, irrigation channels and farm lands. The large quantities of run-off water discharged into rivers during heavy rains increases the incidence of floods and there is too little flow of water during dry periods adversely affecting irrigation systems, hydro-electric schemes and domestic water supplies.

Soil erosion in Ceylon

One of the earliest references to the problem of soil erosion in Ceylon was made by J. D. Hooker in 1873, (quoted, *Report of the Committee on soil Erosion,* 1931) who pointed out that the faulty opening up of land for the extensive cultivation of plantation crops resulted in soil erosion and irregular water supplies. A comprehensive review of the literature and investigations on soil erosion was made in the Report of the Committee on Soil Erosion (1931), following extensive studies of evidence placed before the committee by scientists, planters and others interested in agriculture. According to this report, the estate sector was held responsible for the greater part of soil erosion, particularly tea estates and to a lesser extent rubber and coconut estates. Very few attempts have been made to determine the actual quantity of silt carried in suspension by the major rivers. The only available reference to such work, based on samplings at Peradeniya, (Joachim & Panditha-sekera 1930) shows that 132,000 to 833,000 tonnes of soil per year is carried by the Mahaveli River.

Following recommendations made by the Committee on Soil Erosion marked improvements were made especially in the estate sector in adopting suitable soil conservation measures. A survey made four years later showed that new soil conservation measures had been adopted in 45,000 hectares of tea land and 3,800 hectares of rubber land, (Parker 1935). The position, however, was not entirely satisfactory in respect of all areas. In 1953, the Soil Conservation Act, was enacted and was aimed at taking suitable measures, to prevent soil erosion applicable to the entire island in general, and to adopt specific measures in certain areas declared as 'erodible areas'. Much progress has been made in adopting suitable conservation measures in certain sectors, but even the most recent references show that erosion is a problem of varying magnitude in some privately-owned estates, agricultural small holdings, village settlements on hilly slopes and lands where shifting cultivation (Chenas) is practised (Report of the Land Utilization Committee 1968).

Among the plantation crops, soil erosion is perhaps least severe on coconut land because of the terrain and the methods of soil management. The coconut plantations are situated on relatively flat or undulating land and there is normally a good cover of grass which prevent soil wash to a great extent. The problem of soil erosion in coconut land cannot, however, be completely ignored, because some degree of erosion takes place on the upper slopes and even on slightly undulating land (MaClagan Gorrie 1950, 1951). The present recommendations on soil and water conservation in coconut plantations (Coconut Research Institute Advisory Leaflet No. 16, 1968) advocates the use of contour drains, terraces and cover crops to minimize soil losses and conserve moisture. Rubber plantations are situated on moderately steep or flat land and considerable soil erosion could occur unless adequate measures are taken to conserve the soil. The use of contour platforms in new plantations, and the provision of contour drains and terraces on steep land should be useful to control erosion (Peries 1970). The use of cover crops in rubber plantations is a widely-accepted practice, which is advantageous both for soil conservation as well as for improving soil fertility.

Insufficient attention has generally been given to the problem of soil erosion in chena lands and village allotments on hilly slopes, because of inadequate planning before settlement and the economic limitation in adopting suitable conservation methods. Further, the burning of grasslands in dry weather specially on steep slopes in the Uva District, is a major contributory factor to soil erosion and loss of fertility and the steady deterioration of these lands. Reafforestation of these lands with suitable timber species, and the establishment of pasture in the lower regions should receive urgent attention.

Soil erosion in tea land

Soil erosion in tea land is generally considered to be severe compared with the two other plantation crops because of the steepness of land and the methods of cultivation and soil management practised. The older system of planting was mostly up and down the slope and where the cover of tea was poor the inter-row spaces made definite channels for surface run-off. Lateral drains were constructed at gradients varying from 1 in 7 to 1 in 30 and were designed more for carrying the water away from the land than to conserve soil. The old vigorous system of clean weeding with scrapers further aggravated the problem. This in addition to keeping the land bare, leaves behind a loose layer of surface soil to be readily carried away with the run-off water. Where the stand of tea is low and the cover is inadequate, soil erosion is, therefore, a serious problem as evident from some of the old tea plantation in the mid-country district. Where leader drains have been constructed without adequate measures to check the flow of water, they have been transformed into ravines and gullys with considerable washing away of the side walls, exposing the tea roots.

With a good cover of high-yielding VP tea soil erosion is reduced to a minimum. However during the early stages of replanting, *ie* during land preparation and until the good cover is established (this may take 2 to 3 years from planting) soil erosion could be serious. The most critical period is when the old tea is uprooted and until

Guatemala Grass or Mana Grass used for soil rehabilitation has covered the ground. Soil losses could also occur to varying degrees following the planting of young tea and until the tea has covered the ground, depending on the type of soil management. Hasselo and Sikurajapathy (1965) estimated losses amounting to 250 tonnes of top soil per hectare during the replanting period.

Methods of soil conservation in tea land

Soil erosion in tea land is due to surface run-off. Rainfall in tea-growing districts may vary from 1500 to 5000 mm per year and storms of high intensity are experienced in all districts. Soil conservation measures should primarily aim at absorbing as much of the incident rainfall as is possible. The excess water that cannot be absorbed by the soil surface during storms of high intensity or which cannot be accepted when the profile is completely saturated should be led out of the land at non-erosive velocities to prevent the loss of soil. In old tea land where the cover of tea is poor and where regular clean weeding is practised, soil erosion is a serious hazard. Soil covers either in the form of mulches, cover crops, or selective weeding where certain desirable weed species are encouraged, are useful in reducing soil losses. The importance of cover crops in reducing erosion was demonstrated by Holland and Joachim (1933). Ground covers, in addition to protecting the soil from direct impact of rain drops, serves as a useful barrier against soil movement. Further, the fine roots of the cover crops increase the porosity of the soil. Though the use of cover crops has been advocated in the past (Eden 1930, 1931) this practice has not been popular in tea estates. Selective weeding where the growth of certain indigenous weed species which are not likely to compete with the tea are encouraged, serve as useful ground covers. Weed species commonly used for this purpose are *Drymaria cordata, Oxalis corymbosa, O. latifolia* and *O. corniculata.* The disadvantages of clean weeding using mechanical implements has already been mentioned. The increasing use of chemicals for weed control in tea estates would be clearly desirable with regard to minimizing soil erosion.

Mulching with grass loppings or with other crop residues in the early stages of growth of replanted tea has been shown to be very effective in preventing soil erosion (Manipura 1971a). Cover crops grown in between tea rows are also useful in soil conservation but in areas where dry seasons are experienced, competition for soil moisture may result in the retardation of growth or even death of young tea plants (Manipura 1971b). For the purpose of soil conservation cover crops with a low creeping habit such as *Desmodium ovalifolum* or *Stylosanthus gracilis* are more useful than tall bushy types such as *Crotalaria anagyroides,* or *Tephrosia vogellii.* Certain cultural practices such as addition of organic matter, and deep cultivation of soils to break up any compact layers, generally help maintain the soil in a porous condition, thereby increasing the water-absorbing capacity of soils.

The maintenance of the soil surface in a condition suitable for maximum infiltration is the first and most important aspect of soil conservation. The construction of contour drains with silt pits are useful in collecting run-off and conserving the soil. The gradient of the lateral drains presently recommended is about 1 in 120 and they are constructed to slope gently towards the leader drains, which are designed to carry away the excess water. The construction of stone terraces where stones are available further conserve the soil. The leader drains unless properly constructed

may turn into gullys where considerable washing away of the side walls occurs. This could be largely avoided by the construction of step-wise drains and by building the sides and the bottom of the drains with stone. The system of soil conservation measures presently recommended for new clearings are fully described in the Tea Replanting Subsidy Scheme Leaflet (1971). With contour planting now adopted, and the use of efficient soil conservation measures, erosion could be greatly minimized in replanted tea, particularly because of the good cover of tea obtained in the later stages. The adoption of sound conservation methods and the maintenance of a healthy stand of tea by the use of fertilizer and proper pest and disease control, a marked improvement in the fertility of these soils could be ensured.

Conclusions

The marked decline in the cultivated acreage per head of population due to increasing population pressure clearly necessitates improving the productivity of land by adopting sound principles of land use and soil conservation. Inadequate knowledge of the erosion hazards accompanying faulty methods of cultivation, and the economic limitations in adopting suitable soil conservation techniques have often resulted in the deterioration of much valuable agricultural land.

In the past, soil erosion was most prevalent in tea and rubber estates situated on hilly slopes. Much progress has been made in the estates in adopting proper soil conservation methods but erosion still continues to be a serious problem on some tea estates, tea small holdings, village settlements and chena lands. Where soil erosion has affected large extents, soil conservation requires a readjustment of land use methods with due consideration for climatic conditions, soil types, degree of slope and extent of erosion. In the diversification programme now envisaged for uneconomic tea and rubber land, and in the demarcation of existing tea land for future replanting, a scheme of allocating some of the steep land for planting of trees for fuel and timber is clearly desirable. A scheme for reafforestation of the steep hill slopes of dry patna land, and the maintenance of the existing forest reserves at high-elevations has been suggested in the Report of the Land Utilization Committee (1968). The maintenance of a proportion of the land in forest is considered essential for the provision of fuel and timber, in the preservation of wild life, for soil and water conservation and to ensure favourable hydrological conditions. In cultivated land the main principles of erosion control are the use of vegetative and mechanical procedures to retard the flow of run-off water such as the use of mulch, cover crops, contour planting, and the construction of contour drains and terraces. They should primarily aim at retaining as much of the incident rainfall as possible on the land and leading away the excess water in a controlled manner. A co-ordinated programme of soil conservation is an essential requirement of good land management. Such a scheme should include research into methods of soil conservation, and a programme for the implementation of these findings through education and other suitable action to ensure the adoption of proper methods of conservation.

REFERENCES

BENNET, H.H. & LOWDERMILK, W.C. (1938). *Soils & men.* Year Book of Agriculture, United States Department of Agriculture. 1232 pp.

BENNET, H.H. (1939). *Soil conservation.* McGraw-Hill, New York. 993 pp.

COCONUT RESEARCH INSTITUTE. Advisory Leaflet No. 16. (1968). Soil and moisture conservation measures on coconut land. *Coconut Research Institute, Ceylon.* 3 pp.

EDEN, T. (1930). Green manuring and soil conservation. *Tea Q.* **3,** 17-20.

EDEN, T. (1931). Soil erosion—The present position. *Tea Q.* **4,** 113-116.

ELLISON, W.D. (1952). Rain drop energy and soil erosion, *Emp. J. Exp. Agric.* **20,** 81-97.

HASSELO, H. N. & SIKURAJAPATHY, M. (1965). Estimation of losses and erodibility of tea soils during the replanting period. *J. Nat. Agric. Soc. Ceylon.* **2,** 13-21.

HOLLAND, T.H. & JOACHIM, A.W.R. (1933). A soil erosion experiment. *Trop. Agriculturist.* **80,** 199-207.

JOACHIM, A.W.R. & PANDITHASEKARA, D.G. (1930). A soil erosion investigation. *Trop. Agriculturist.* **74,** 200-203.

MacLAGAN GORRIE, R. (1950). Soil and water conservation in coconut growing. *Ceylon Coconut Quart.* **1,** (2) 17-18.

MacLAGAN GORRIE, R. (1951). Soil erosion on gentle slopes and flat land. *Ceylon Coconut Quart.* **2,** 165-167.

MANIPURA, W.B. (1971a). Report of the Agronomy Division. *Rep. Tea Res. Inst. Ceylon* 1969. **2,** 42-59.

MANIPURA, W.B. (1971b). Report of the Agronomy Division. *Rep. Tea Res. Inst. Ceylon* 1970. (In the press).

PARKER, M. (1935). Soil erosion questionnaire—1935. *Trop. Agriculturist.* **85,** 369-380.

PERIES, O.S. (1970). A handbook of rubber culture and processing. *Rubber Research Institute of Ceylon.* 188 pp.

REPORT OF THE COMMITTEE ON SOIL EROSION (1931). Sessional Paper No. 3—1931. Ceylon Government Press, Colombo. 54 pp.

REPORT OF THE LAND UTILIZATION COMMITTEE (1968). Sessional Paper No. 11—1968. *Ceylon Government Press. Colombo.* 121 pp.

TEA REPLANTING SUBSIDY SCHEME LEAFLET (1971). Tea replanting subsidy scheme—Replanting with Vegetative Propagated Tea. (In the press).