THE CONSERVATION OF THE SOIL*

W. C. LESTER-SMITH, B.A. Dip. Rur. Econ. (Oxon)., A.I.C.T.A. (Trinidad),
CONTROLLER OF PLANT PESTS

I HAVE come here today to say a few words on the subject of soil erosion. That expression, in many ways, is an unfortunate one for, through common usage, it has become general to apply it somewhat loosely and inaccurately to an action we want to prevent, instead of restricting it to its sense of an action which is now taking place or has taken place in the past.

There is only one way of preventing soil erosion and that is by learning to conserve our soil and to preserve it from loss. To cultivate the soil and at the same time to attempt to stop the erosive action of rainwater on that soil once it has started, is often both a futile and an expensive process. It is rather like locking the door of the house while the thief is going out of the garden gate. The most effective action is being taken too late. The control of erosion, to be most efficient and remunerative, must be started when the land is being first cleared and should go hand in hand with its tillage and planting. If the erosion of the soil is allowed to start first, only more expensive measures can stop it and, at such a late stage, control may be either unprofitable or impossible.

The basis of both the prevention and the control of soil erosion is *the conservation of the soil*, and I have, therefore, adopted this phrase as the title of my present lecture.

With every shower of rain, drops fall on the land surface, and these fall with some force on the surface soil or on any vegetation which covers it. Sooner or later many of these rain drops run together forming little rills or rivulets which run over the surface of the ground and comprise what is termed

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surface run-off water. At a still later stage two or more of these little streams of water join up, forming the greater part of the water which finds its way into the rivers, and flows away to the sea. When the rain water falls directly on bare soil or when run-off water flows over its surface, some of the smaller soil particles are moved and knocked about causing them to break up into still smaller particles. The very smallest of these are taken up by the water, being carried with it because it is moving, and if all the water is allowed to flow away they are entirely lost. These smallest soil particles are the most valuable since they are the ones which most readily liberate the food materials which plants require for their growth. They are the main source of plant food in the soil and are therefore of special value, so that every effort should be made to prevent their loss if good crops are desired.

The loss from any soil of the greater proportion of the very smallest soil particles will render that soil infertile and increase the cost of producing crops. The conservation of soil by preventing its erosion is, therefore, one of the most important necessities in the profitable production of crops. A soil which has lost the greater part of its smallest soil particles has lost its fertility. It is harder to cultivate, will not make a good seed bed, does not retain moisture and suffers readily from drought. It is usually lacking in available plant food and this has to be made up for by the more frequent application of costly manures.

To conserve and prevent the loss of the surface soil, which is the best part of all soils, it is necessary to prevent the movement of any surface run-off water. The only effective means of doing this is to ensure that all the rain which falls is absorbed by the soil where it actually falls. In actual practice it is only possible to effect this entirely when the volume and the intensity of the rainfall are comparatively low, its duration is not too long, the slope of the land is not too great, the vegetation covering the soil is sufficiently effective and the soil itself is sufficiently absorptive. Under the existing conditions of rainfall, cultivation and soil types usual in Ceylon, it is rarely possible to prevent entirely the existence during wet weather of some surface run-off water even on almost flat land. It becomes necessary therefore on all cultivated land to take some action to preserve

the soil from loss by reducing to the greatest possible extent the quantity of run-off water and by controlling it.

The soil conservation measures which are most effective in reducing the amount of run-off water from any normal rain falling on cultivated land are as follows :

(1) Delaying the rate at which this rain reaches the soil surface and, to a limited extent, reducing it in quantity.

(2) Reducing both the rate at which it flows and the distance it travels on the soil surface ; thus giving it more time to sink into the soil.

(3) Making the soil as absorptive as possible so that it will rapidly take up as much water as will benefit both the crop and the soil.

(4) Making provision to collect and to control the removal of all surplus run-off water.

The four measures can be effected in various ways. In the case of the first, the time it takes for the rain to reach the surface soil will depend upon the density of the vegetation which covers it, and, in the case of annual crops, like tobacco, etc., the number of days on which it rains while the soil surface is almost bare while being cultivated and prepared for the crop and during the early stages of its growth. In the case of permanent crops, such as rubber and coconuts, the crop itself will largely break the force of the rain and to some extent delay the rate at which it reaches the soil, though rubber will not be so effective in this during its wintering period. Again, with tea and cacao, high shade trees in the form of albizzia, grevillea and dadap, which are most desirable in the cultivation of these crops, will have a similar action in retarding the rate at which the rain reaches the earth. Low shade and green manure plants, such as gliricidia, crotalarias and tephrosias will most usefully augment and assist both the shade trees and the crop itself, and still further delay the rain in its progress to the soil.

In village gardens a similarly useful action will be performed by the careful cultivation of many plants which have a distinct value in the economy of the home. Of the taller growing types, such plants as arecanut, jak, mango, cashew nut, papaw, clove,

nutmeg, kapok and plantains may be mentioned, while of the lower growing forms such plants as dhall, Robusta coffee, sugar-cane, Napier grass, yam, betel and pepper vines, brinjals, bandakkas, and even chillies all have a place and a use, not to mention the various kinds of valuable green manure plants that can be grown, such as gliricidia, *Leucaena glauca* and wild sunflower. A well stocked garden or plantation can be as great a blessing in the conservation of the soil as in the provisioning of the home. A varied and ample diet is of great importance in the health of the nation but no greater than the diverse and numerous plants which produce it in the guarding of the national capital—the soil.

The density of the vegetation which clothes the soil is thus an extremely important factor in its conservation and protection since it not only intercepts the rain drops and reduces the force of their impact on the soil, but also disperses and splits them up into smaller fragments. A further effect of this vegetation is that some of the rain water is directly retained by and evaporated from the foliage of the trees and shrubs on which it falls. The vegetative cover which the growth of plants gives to the land surface also performs other important functions in the conservation of the soil so that the sum total of its beneficial effects, where these can all be employed to the full, in all probability far exceeds those of all the other measures combined.

While the effects of the vegetal cover greatly reduce the amount and rate at which rain reaches the surface of the soil, it is only in areas of primary jungle that any considerable portion of the rain which falls does not eventually reach the ground. Once it does so, unless the soil is extremely absorptive, which is frequently not the case, some movement or flow of this ground surface water must inevitably take place. It is this movement or surface run-off which contributes most to the erosion of soil by water ; the greater the volume of this water, the more rapidly and the further the distance it moves over the soil surface, the greater its power of soil transport. For the adequate conservation of the soil and its effective retention, if not actually *in situ* at least close to its normal resting place, it is essential to reduce to a minimum both the rate of movement of the surface run-off water and the distance

over which it flows. Only one thing can fully effect this, and that is a perfect ground cover. The very complete clothing of the earth, which is provided by a suitable cover of low-growing plants, is the primary essential in the protection of the surface soil from the direct erosive action of rain. As in the case of tall-growing plants and those of medium height, low-growing ground cover plants intercept the rain and protect the soil from its direct beating action as well as dispersing it and causing some evaporation. They have, however, a more important and valuable function: that of giving the soil a longer time to absorb any surface run-off water. Ground covers reduce both its rate of movement and the distance it flows, since the barrier formed by their roots, their procumbent stems and leaves impede the flow and movement of this water. This is the most effective action which all suitable ground cover plants exert and which make the ideal cover for any particular crop, soil and climatic conditions a so much sought-after ally in the battle between the artificial conditions of crop production and the uncontrollable forces of nature. Low-growing ground cover plants, particularly those which have a close matted growth, such as some of the clover-like types (*Desmodium triflorum*, S. *undupiyali*, and *Alysicarpus vaginalis*, S. *aswenna*) and certain grasses, also perform a further function in that their root systems have a binding or netting action which protects the surface soil from disturbance and endow it with a sorbent, sponge-like character.

In the cultivation of permanent crops, the nature of the crop and the soil, and the conditions which these impose on the type of plant most desirable to grow as a ground cover, so restrict the choice of plants available for this purpose that sometimes no really suitable one remains. In such cases then the best has to be made of a bad job and, as almost any form of ground cover is preferable to none at all, use has to be made of grass and even certain selected weeds as a last resort. In the cultivation of shorter-aged village and garden crops, considerably greater use than usually is done could be made of various economic crops. Several plants commend themselves as having characters of value in this connection; among these may be mentioned sweet potato, *Coleus parviflorus* (S. *innala*),

ginger, turmeric, green gram, lemon grass, *Amarantus sp.* (S. *tampala*) and other types of spinach, onions, and even lettuce and mint in certain areas. All these can perform useful functions in the conservation and protection of the soil. Their most effective use lies not so much in the actual growing of the plant as in the method of planting and the rotation and positioning of the various types on the land. On land with even the slightest degree of slope, considerable advantage to the crop and protection to the soil will accrue from the planting of all crops on the contour ; across and not up and down the slope. Where there is a definite slope, more thought should be given to the distance of planting and, where the crop will permit of it, close planting in the row should be adopted. Each plant can be given exactly the same amount of root room as it receives under the customary method of spacing if it be planted close together in the row with the rows spaced wider apart. Consideration should also be given to the type of plant selected for different sections of the land which have a steeper slope, preference being given to the planting on the steeper areas of crops which have a higher vegetational density and which can be closer planted both in the row as well as between rows. Another important factor in connection with the system of strip cropping or planting in contour rows or belts is the careful selection of crops for each of the separate crop strips. Adjoining strips or contour rows should not be either tilled, planted or harvested at the same time, so that on no appreciable length of land up and down the slope is the soil disturbed, bared or otherwise exposed to erosion simultaneously. A long-aged crop should therefore alternate with a short-aged one and a closely-planted crop with a wider-spaced one so as to prevent any excessive soil loss. Where fodder grasses are being grown, a very considerable degree of soil conservation can be effected by growing the grass in double or treble contour rows spaced at intervals up and down the slope and very closely planted in the rows, instead of planting it all together in one compact block. The slight additional labour involved in the planting, harvesting, transporting, etc., of the crop, will invariably be more than compensated for by the valuable soil, the loss of which has been prevented. By the establishment of closely-planted contour rows of either some fodder grass or green manure plant, a

definite terrace formation naturally occurs in the course of time, without the expenditure on it of any special labour whatsoever. Such a terracing effect can be extremely valuable in the conservation of the soil in reducing the rate of movement of surface run-off water. The longer the time this water can be persuaded to take in flowing over the soil, or, in other words, the slower the rate at which it can be induced to move, the greater the time available for its absorption by the soil and, usually, the greater the quantity which will be absorbed.

The greater the quantity of rainwater the soil will absorb where it actually falls, the less surface run-off water will there be to flow over the soil and the less the degree of erosion which can take place. The rate at which soil can be removed by surface run-off water depends not only on the intensity of the rainfall and slope of the land, but also on the texture of the soil and the rate at which the water flows. The greater the slope of the land the greater its need of measures to conserve the soil. The most effective way of conserving it is to prevent all run-off and this can only be done if the soil is brought into and maintained in such a condition that its absorptive capacity is at its maximum. The maximum is only attained when the soil is porous, well-drained, contains plenty of humus and is moist. A soil which is moist absorbs water much more readily than one which is very dry, and a soil which has plenty of humus in it not only absorbs more water but tends to remain moist. The porosity of a soil depends largely on its texture and the size and arrangement of the individual soil particles. The penetration into the soil of plant roots, which decay and leave passages in the soil, so facilitating the movement of air and water, improve its porosity and its absorptive capacity. Shade trees, green manure plants and ground cover crops thus play a further important part in improving the absorptive capacity of the soil since they increase its porosity and by reason of their shade keep it moist. In addition, the humus they provide as a result of natural leaf-fall and through their use as green manure, improve the organic matter content of the soil, rendering it more absorptive and more productive. It facilitates the entry of air into the soil and creates a more favourable environment for the growth and activity of the beneficial soil

organisms. Within reason, and with due regard to the crops being cultivated, it is desirable to retain on the land as much as possible of the surface run-off water ; the surplus can be either stored on the land or collected and conducted off it under proper control. The too frequent tillage of the soil and the rapid percolation of run-off water through it tend to carry the smaller soil particles into the lower layers of the soil where they block up the available pore space and so reduce its porosity. In this respect the dead and decayed leaves of the crop, and of shade trees, green manures and ground cover plants, perform a further function since they protect the surface of the soil with a layer of organic debris which filters the water and prevents the downward movement of the finer soil particles. The maintenance of a high organic matter content in the soil, perhaps more than any other factor, aids in conserving it, for not only does it markedly increase its absorptive capacity but it also tends to bind the soil particles together without decreasing its porosity ; it thus serves to maintain at a high level the plant food supply of the soil and so enables it to support a better and more vigorous protective vegetative growth.

Under conditions of high or intensive rainfall, even in the case of soils with a high absorptive capacity, a certain amount of surplus surface run-off water may be unavoidable. In all such cases provision must be made for the collection and control of this water as near as possible to where it actually falls. The various ways in which this surplus water may be collected, and either stored or removed under control, open another chapter in the conservation of the soil, consideration of which must be postponed till another time.