

## SOIL CONSERVING CONTOUR WORKS\*

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**T**HE chief cause of soil erosion in the Ratnapura District is surface run-off water. This water is derived from rain which has fallen, either continuously and gently for a long period, or intensively for a short time, so that it has not been possible for it all to be held up by the soil and the vegetative cover on it. As a result, there is a surplus quantity of water which remains on the land surface, over and above the amount the soil absorbs and the vegetation retains. This water will not remain motionless unless it is supported below and on all sides. Thus, on land with the slightest degree of slope this water joins up with any other water which it can, and then moves down the slope along the easiest possible route until it can go no further.

It is the actual movement of this water over the soil surface which causes soil erosion, and the amount of erosion which takes place is intensified by any increase in the degree of slope, the quantity of water, and the rate at which this water moves. Irrespective of the distance it moves and the degree of slope, in order to reduce the erosive power of this water to a minimum, it is necessary to prevent it combining with too much other water and also to check its rate of flow.

The quantity of surface run-off in any area depends primarily upon the rainfall, so that within certain limits, it is a quantity which is variable and cannot be regulated. This run-off has to be dealt with as it comes, and there is no time to make provision for it once it has arrived. The only safe way of controlling it and preventing erosion is to make provision for the maximum which can normally be expected.

The various parts of the Ratnapura District receive an average of between 100 and 200 inches of rain per year, 5 to 8 inches of which may fall in a period of twenty-four hours or less. It is these by no means infrequent intensive falls of rain which cause the greatest amount of erosion, and they must be provided for if serious loss of soil is to be prevented.

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Fortunately, it is only on areas of rock or hard ground which have almost no vegetative cover that nearly the whole of such falls of rain becomes surface run-off water. On a well-cultivated soil with a sufficient density of vegetative cover, only about half of the rain which actually falls becomes surface run-off. The remainder is accounted for by evaporation, soil absorption, and a certain amount which the vegetation retains. We may assume, therefore, when the soil is maintained in a high state of fertility and has the protection of a well-grown crop and other necessary vegetative cover, that a surface run-off equivalent to about four inches of rain has to be dealt with in order to prevent damage by erosion and permanent soil loss.

Even this quantity is a considerable amount since it requires a storage space of 14,520 cubic feet per acre if it has all to be held up. To make these figures simpler, it would require level trenches, 2 feet wide, 2 feet deep and only 6 feet apart, to hold this quantity of water on any area of land: obviously neither an economic nor a practical proposition, since about a quarter of the total area could not be cultivated and water-logged conditions would probably prevail. The only solution, therefore, for dealing with such a quantity of run-off water is to hold up on the land as much as is desirable and to provide for the removal of the surplus under proper control.

To do this and prevent erosion, it is necessary to make provision for collecting this surplus water as it moves over the surface of land, at distances which will enable its volume to be conveniently handled and controlled, and before its rate of flow has become excessive. In addition, since any water, however slowly it is moving over the soil surface, will inevitably carry with it some soil particles, it is also necessary to rid the run-off of most of the soil it carries before the water is collected and removed. The rate of flow of surface run-off water is governed largely by the slope of the land down which it moves, being more rapid as the gradient increases. It is therefore necessary to arrest its downward movement and to collect and remove it at much shorter distances on a steep slope than on a gentle one.

The most effective lines on which to site soil conserving and run-off collecting works are along contour lines, since the steeper the slope the more closely contour lines of the same vertical interval approach each other, and the flatter the land the farther apart they move. As the exact distance on the ground surface between two contour works with a defined interval varies according to the slope of the land, it is of little value to state the spacing which should be adopted for soil conservation works unless the exact degree of slope for which these are recommended is also given. It is necessary, therefore,

for this purpose, to take some more constant basis from which the required ground surface distance can be calculated once the actual slope is known. The general method adopted in mapping and surveying is to select a vertical contour interval which is suited to the work in hand and to adhere to this throughout. For areas having a more or less uniform type of soil, it is suggested a somewhat similar practice might be adopted, and for such contour works, a vertical interval selected which is considered suitable or has already been found suited to the degree of erodibility of the soil concerned. It is suggested, purely tentatively, for those parts of the Ratnapura District which do not experience a long dry season, that on the less friable and more compact soils, a vertical interval of about 15 feet may prove suitable, while on the more friable and looser types of soil, a vertical interval of 10 feet may be necessary. The exact interval to be adopted may be influenced to some extent by other factors, such as the type of soil conserving contour work decided on, the crops concerned, &c.

Soil conserving and run-off collecting contour works do not necessarily imply that contour planting of the crop has been or should be done. All that they mean is that each such work should follow a definite contour line, *the position of which is the uppermost junction of the particular work and the ground surface level.* The more exactly on the contour this work can be constructed, the greater will be its stability and efficacy, and the less likelihood will there be of the work breaking down. It is, therefore, worth going to a considerable amount of trouble to ensure, not only that each contour line is accurately pegged out, but also that it is in the most suitable position nearest this contour line for the work concerned. Sometimes serious difficulties arise along a certain contour line, such as the impossibility of excavating a drain along a certain section of the contour which is rocky. It is always advisable, therefore, to peg out and study the whole contour strip along which each line of work runs before commencing any work on that line, since such difficulties may often be overcome by moving the whole of the pegged out contour line (on which the work will be based) a short distance up or down the slope. There is very little objection to the adoption of a slightly different vertical interval for an occasional case of this type when it will obviate such difficulties.

Contour planting is extremely desirable in the case of certain wide-spaced crops such as rubber, coconuts, arecanuts, citrus and even coffee, since it facilitates other work being done in contour strips. It does not, however, appear to be suited to close-spaced row crops such as tea, cotton, chillies, &c., as it tends to complicate the cultivation, harvesting and manuring of the crops. In the case of crops already planted, especially

permanent crops such as tea, the slight temporary loss of crop that is occasioned by the adoption of proper contour works, should not prejudice either owners or cultivators of land against initiating such measures. These, in a few years, will more than pay for the loss and expenditure they involve.

The most effective type of soil conserving and run-off collecting contour work is considered to be the contour lock-and-spill (or as it is sometimes termed, lock-and-block) drain with a low bund, planted with some permanent cover crop, *on the upper side of the drain*. The reason for constructing the bund on the upper side of the drain is because it leads to terrace formation, through the gradual movement of soil down the slope across each contour strip towards the bund which forms its lower edge. In this way the unavoidable sheet erosion, which any form of cultivation necessarily engenders, is made use of to reduce erosion by reducing the slope of the land on each contour strip. Thus, in the course of time, provided the bunds are properly maintained and the causes of any breaks in them are traced and remedied, the contour strips can be converted into almost level cultivated terraces from which practically no soil loss takes place.

The primary object of these contour bunds is to prevent and limit the movement of soil down the slope by checking the velocity of the surface run-off water which carries or moves this soil with it. The check to the movement of this run-off causes the larger soil particles, carried in suspension by the water, to be deposited on the upper side of the bund, since the transporting power of water decreases with the reduction in its velocity. The run-off water, when small in quantity, will percolate through the bund into the drain on its lower side. If this water is excessive in quantity it will spill slowly and evenly over the top of the bund into the drain, the greater part of the soil it carries being filtered out by the vegetation established on the bund. To permit this it is essential that these bunds should be low, not more than 18 inches high; that they should always be properly maintained at an even height; and that they should be covered by some type of permanent and close growing vegetation, the base and roots of which are never disturbed. These bunds should always have a wide base to make them stable, at least 3 to 3½ feet wide, and their sides should have a gentle slope and not be steep. Whenever possible, and specially when the land is steep, a space or berm, 1 to 1½ feet wide should be left between the lower base of the bund and the upper edge of the drain and planted with some perennial plant, primarily to strengthen and hold up the bund, but also to shade the drain. On a tea estate there seems no reason why a closely planted hedge of tea could not be used for this purpose.

The contour drains themselves should be wide and shallow with sloping sides; a suitable size being  $3\frac{1}{2}$  feet wide at the top,  $1\frac{1}{2}$  feet wide at the bottom and  $1\frac{1}{2}$  feet deep. As these drains should be of the lock and spill type, blocks about 15 inches high, to provide a 3-inch spill from one lock to the next, should be left uncut in the drain every 20 or 25 feet.

The reason for giving the drains this more or less half hexagon shape is because it makes the best provision for the controlled disposal of the greatest quantity of water per foot of depth. The wide surface and sloping sides reduce both the cost of excavation and the depth of the contained water, while it also provides a larger surface for evaporation. It increases capacity, facilitates the escape of air displaced by moisture absorbed, reduces the erosion of the sides of the drains to a minimum and encourages the growth of protective vegetation on them. Some of the excavated soil may be utilized, if desired, for the construction of low bunds, about 6 to 9 inches high on the lower edge of the drains. If these consolidate and bind well they will increase the capacity of the drains and tend to prevent water spilling out of them when their capacity is taxed by periods of abnormal run-off.

On land where a sufficient amount of stone is available, the lower sides of the bunds may be built up or revetted with stone to form a low retaining wall the same height as the bund, which latter they will then strengthen and support. Such walls should never be built up straight but always inclined in the same direction as the slope of the land.

On areas where there is an exceptional amount of rock and stone, the excavation of contour drains may not be possible. In such cases, contour stone embankments about 18 inches high must be constructed. According to the slope of the land, these should be erected somewhat closer together than would ordinarily be the case with contour drains having bunds on their upper sides. Contour stone embankments of this type are liable to be of more danger than utility as regards soil conservation unless they are built with a wide base and narrower top. Their lower faces should be built with a good slope towards the hillside, and the steeper the land the greater should be this slope.

Perhaps the most important point to be attended to in the construction of such stone embankments, apart from ensuring that their upper sides are on a perfect contour line, is the correct laying of the stones which form the base of the embankment. These require to be laid evenly and close together, not level but with a reverse slope to the slope of the land. The stones that form the edge of the base which is lowest down the slope must not be laid on the surface of the land, but must have

beds cut out for them on a slope into the hillside. All the stones which form the middle and upper side of the base must have deeper beds excavated for them in a similar way, so that the reverse slope of the base is maintained throughout, as it is only in this way that the stability of the structure can be ensured and the correct slope maintained.

When their erection is completed, the upper sides should be protected from the direct impact of run-off water by a thick, closely planted belt of Napier grass (*Pennisetum purpureum*) or some similar type of vegetation. This will collect and hold up the soil brought down in the run-off and assist in consolidating the embankment. Provision must be made for the collection and lateral removal of the accumulated run-off water, along a wide and shallow contour drain above the line of vegetation which protects the upper side of the embankment.

On very steep slopes across which bunds have to be constructed, difficulty is often experienced in getting the soil or stones to remain stable at the required height, because the slope of the lower side of the bund is greater than the natural angle of repose of the soil, &c., concerned. In such cases, the first thing to be done is to establish thick and closely planted contour hedges of some strong growing plant suitable to the area concerned. When these are properly established and have grown sufficiently, the bunds are constructed on the upper side of these contour hedges, which then serve to retain and support them till they have been consolidated and established in a permanent vegetative cover.

When such bunds are being made of earth obtained by cutting contour drains, drains with sloping sides should be cut on the lower side of the contour hedges, the upper edges of the drains not being nearer the hedge than one foot.

This is the only effective method of constructing drains with bunds on their upper sides on certain friable types of soil on steep slopes.

The simplest type of soil conserving contour work of a permanent nature consists in the establishment of thick closely planted, contour hedges of some perennial plant, such as Napier grass, *Leucaena glauca*, or the Sword plant (*Sansevieria guineensis*). The last of these appears to be particularly suitable for establishment in areas under tea, and has distinct possibilities for use in areas of old rubber where root exposure has taken place or where difficulties are experienced in establishing ground covers.

Such contour hedges, however, make no provision for either the collection or the removal of run-off water. They therefore

require to be established at a considerably shorter vertical interval than more elaborate works; probably a vertical interval of about 8 feet might prove suitable.

There are other simple contour works which should be widely adopted. They offer considerable scope for introduction into existing estate routine, and they have a definite, though more ephemeral soil conserving value than those previously mentioned. These include the growing and utilization of green manures in rotational contour lines, and rotational strip cover cropping. Of still greater value would be the weeding, cultivation and manuring of all crops, even on land with the slightest gradient, in alternate contour strips across the slope rather than adopting the usual and easier practice of performing these operations straight up and down the entire slope to the accompaniment of much soil loss.

Sheet erosion is an insidious and almost unperceivable form of erosion, and the only certain method of preventing it lies in the adoption of soil conserving contour works. When sloping land is cultivated under the climatic and soil conditions which occur in Ceylon, soil erosion is inevitable. The fact that this loss of soil is not always seen or appreciated is no proof that it does not take place. It is taking place steadily, and unless measures to prevent it are adopted it will continue until all the soil is gone. Then, as Chamberlin (1) stated some years ago, "When our soil is gone, we too must go, unless we find some means of feeding on bare rock or its equivalent".

#### REFERENCE

(1) Chamberlin, T. C., Soil Wastage, White House Conference of Governors, Proc., Washington, D. C., U. S. Congress 60th, 2nd Sess., House Doc. 1425, pp. 75-83, 1908.