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Soil Conservation Measures Benefit the Nilgiri Farmers*

by

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Synopsis: The problem of soil erosion on the Nilgiris, the measures undertaken, the progress and the benefits accrued from soil conservation measures are discussed in this article.

Introduction: Soils are the natural bodies on which plants grow. The top few inches of soil which is called "Top Soil" is the most fertile portion containing the needed plant nutrients, organic matter and favourable physical properties. It is this layer that has to be preserved and properly managed for obtaining sustained and successful agriculture. If through man's folly of land neglect and faulty agricultural practices, this productive layer of soil is lost, the land not only loses the capacity to sustain crops but also its productivity until cultivation is rendered unprofitable, if not unsuccessful.

Of all the processes of land deterioration, erosion is the greatest destroyer of soil and thereby the land. Soil erosion which is the process by which the top layer of soil is progressively removed from its place to waste by external agency like water and wind, interferes with the very object of soil management and removes the natural fertility of the land as well as the nutrients artificially applied. The gains that should be there due to increased production by adopting advanced soil and crop management practices like improved strains, fertilizers etc., are quickly offset by the destruction caused by soil erosion, thereby necessitating application of more and more quantity of fertilizers just to maintain the normal crop yield. Therefore protection against erosion hazards is of paramount importance to ensure better quality of soils and sustained agriculture which factors determine the living standard of the farmers in particular and the Nation in general.

Due to the steepness of slope, undulating topography, friable nature of soils, heavy and erratic rainfall normally experienced in the hills, soil erosion there, is very rampant. Removal of several inches of top soil after a single heavy rainfall is not uncommon there. Realising the urgent need for soil conservation on the steep agricultural lands in the hills, the Madras State has been one of the earliest to launch the scheme for soil conservation in the hills and the scheme was first implemented in Nilgiris district as early as 1951.

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Soil Erosion Problem in the Nilgiris: Nilgiris Plateau is a hilly tract extending over an area of 989 square miles and its average elevation is 1981.2 M (6500 feet) above mean sea level. The entire region is dotted with several steep and high hills separated invariably either by a stream or a swampy valley. A net work of several rivulets have their origin in this plateau and tributary to the major rivers called Moyar in the North and Bhavani in the South which almost surround the plateau. The general slope of the land varies from below 5 per cent (1 in 20) in the valley flats and foot hills to over 100 per cent (1 in 1) on the hill sides.

The soils are lateritic in character derived from charnokite (Gneiss) as parent rock. The texture of the soil is clay to clay loam, the kind of clay being Kaolin which is very friable and highly erodible. The soils are acidic and generally deficient in all major plant nutrients, N, P and K. But the soils have high capacity to respond to heavy manuring with chemical fertilizers and recouperate rapidly, when further erosion is stopped. The depth of soil varies from 0 to 2½ feet and that of sub soil from 10 to 14 feet.

The district receives an annual average rainfall of 1891 mm. (74·50 inches) a major part of which is precipitated during both South-West (June to September) and North-East (October to December) monsoon periods. The rainfall received particularly during the North-East monsoon is intense, erratic and ill-distributed. During this period, over 60 per cent of the cultivated lands will be lying fallow after harvest of main crop of potato. As a result of high intensity rainfall beating on the bare fallow lands, soil erosion during this period is more pronounced. The severe frost experienced between November and December affects most of the vegetation and exposes the lands for further accelerated erosion.

Nearly 33,500 acres are under annual crops like potato, wheat, samai, barley, vegetables etc. Out of this, nearly 22,000 acres are mainly under potato which is raised mostly under rainfed conditions. potato which is the principal crop grown in this district is a clean-tilled row crop which permits soil erosion. Added to this, faulty practices like cultivating up and down the slope, inadequate protective measures and extensive cultivation of annual crops without consideration to the steepness of the slope have also been responsible for heavy soil erosion in the Nilgiris. Further, badly managed tea estates on hill slopes, over grazed grass lands, current and other fallows, culturable and un-culturable wastes, are also affected by one form or other of soil erosion hazards. In all, it is estimated that nearly 1,70,000 acres are affected by soil erosion in the Nilgiris.

In view of the steepness of slope, erodible soil, heavy and ill-distributed rainfall as explained above, soil erosion in the Nilgiris had already obtained alarming proportion and attracted the immediate attention of the Government. In view of sudden discharge of floods into the streams below, stream bank and bed erosion as also slip erosion are seen in many parts of the Nilgiris. A reconnaissance survey of the districts indicated that about 10 per cent of the total land area is moderately eroded (nearly half the depth of productive soil is lost) and the remaining area are all severely eroded. The lands situated on the steep slopes have already lost the entire top soil and cultivation is now being made on sub-soil only by applying heavy doses of organic and inorganic manure. Enquiries have shown that the farmers had been applying only 4 to 6 tons of cattle manure during 1910–'20 to obtain an average yield of 6,000 to 7,000 lbs. of potato. In order to maintain the same yield, 2 to 3 tons of cattle manure and 300 to 500 lbs. of chemical fertilizers were applied during 1920–'35. During 1935–'40 and later, 1 to 2 tons of cattle manure and 2,000 lbs. of chemical fertilizers had to be applied for obtaining more or less the same yield of potato. Such progressive increase in dosage of fertilizers clearly indicates the silent revolt of the land against progressive deterioration of its productive capacity due to continuous soil erosion and also the need for proper soil and water management measures to preserve and maintain the productivity of the land for economic cultivation.

Soil conservation works executed in the Nilgiris : In view of the steepness of slope experienced in the Nilgiris, slopes being over 15 per cent in the majority of the land under cultivation, the soil conservation works executed for such tract, constituted mainly Bench Terraces for cultivated lands. The front faces of bench terrace is provided with a slope of 1 in 1 for the embankment and almost vertical for the cutting portion. The sloping embankment is protected by planting grasses or other vegetation. The average width of the Bench terraces constructed, ranges from 10 ft. to about 20 ft., the width varying according to the slope of the land and the height of the benches. Bench terraces formed in this tract are provided with a slope of $2\frac{1}{2}$ per cent to 8 per cent inwards and 3/4 per cent longitudinally, so that the excess water after heavy rainfall may rapidly drain towards inner edge and safely flow towards a disposal drain. The disposal drains which run almost up and down the slopes are excavated at a distance of about 800 ft. so that the length of bench terraces in one direction will only be 400 ft. maximum. The

FIG. 1

Extensive cultivation without consideration to steep slope accelerates soil erosion.

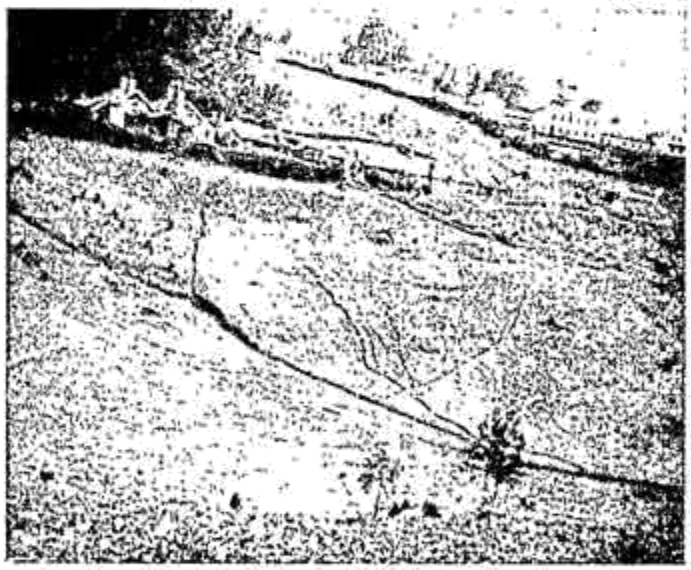

FIG. 2

Fallow lands are more exposed to soil erosion—rills and gullies developing.

FIG. 3

Soil erosion is the greatest destroyer of land.

FIG. 4

Bench terracing—an effective Soil conservation work on steep hill sides—Note front faces protected with grass.

FIG. 5

Contour Trenching—an effective soil conservation measure in plantation area.

FIG. 6

Protected lands retain Soil and sustain Agriculture—

Unprotected :— Soil erosion is Ram-

In poorly managed plantation areas where the crops have developed poor canopy and where soil erosion is rampant, measures like contour or staggered trenching with disposal drains are executed to effectively control soil erosion. The contour or staggered trenches are normally excavated at 10 ft. vertical interval. In addition, the soil conservation works taken up in the Nilgiris include Gully control, excavation of diversion drains, correction of stream meanders, stream bank protection, control of road-side erosion etc.

The soil conservation measures adopted for the Nilgiris conditions are so designed that during heavy and erratic rainfall, only excess water will be safely drained away from the land, at the same time allowing conservation of moisture needed for crop growth. These soil conservation measures will not only control soil erosion effectively but help retaining the organic and inorganic fertilisers applied to the land without being washed away by surface run off. The full benefit of the fertilizers applied will be available to the crop grown.

In addition to the mechanical soil conservation measures referred to above, the extension personnel advocate improved conservation farming practices on all the lands so protected against erosion. The conservation farming practices include contour cultivation and crop rotation, by which potato is followed by a green manure crop like lupin or buckwheat in addition to other improved agricultural practices like improved seeds, application of manures and fertilizers, interculturing, plant protection etc.

Progress of work through plan periods: The soil conservation works in the Nilgiris have been initiated during the year 1951 and to start with, the work was executed in an area of 90 acres comprising of sub-watershed of Ketty Valley Basin. This work was continued and further extended to cover a number of sub-watersheds in that valley, and also to the adjoining areas in the district. During the first five year plan ending 1955–'56, an area of about 600 acres have been covered with soil conservation works in this district. The progress during the second and third plan periods year-wise is furnished below.

Year	Area covered with soil conservation measures
Second Plan Period:	
1956—'57	850 acres

Year		Area covered with soil conservation measures
Third Plan Period:		
1961—'62	...	2,815 „
196'—'63	...	1,695 „
1963—'64	...	1,236 „
1964—'65	...	1,127 „
1965—'66(Programmed)	...	600 „
	Total ...	14,801 acres.

As detailed above, a total area of 15,401 acres, will only be covered in the Nilgiris by the end of the Third Five Year Plan as against an area of 22,000 acres under potato cultivation alone. Soil Conservation work in the River Valley Project watershed of Kundha Project are being attended to by the Madras Forest Department. Considering, the problem area in the district and other hilly regions in the State, what has been programmed to be done by end of the Third Five Year Plan is very little. The programme of work in hilly regions has therefore been extended to other tracts like Kodaikanal (Madurai district) and Shevaroys (Salem district). The programme in the Nilgiris is being intensified by the Forest Department.

In view of the high cost of soil conservation work involved and also in order to reduce the sudden economic impact on the beneficiaries, the soil conservation scheme for this district provides for executing the work by the Government, meeting the entire expenditure initially. Fifty per cent of the cost of the scheme is borne as subsidy by the Government and the remaining is only recovered from the beneficiaries in twenty equated annual instalments. The recovery commences from the third year from the date of completion of the work.

Maintenance and Follow up Practices: The importance of maintenance of various conservation structures like bench terraces, disposal drains, contour or staggered trenches etc. need not be over-emphasised. Considering the fact that these measures have an important role in controlling soil erosion which has been the basic stumbling block in the very agricultural production, it is necessary that these conservation structures should be maintained in proper condition so that they may continue to function as efficiently as

of soil erosion. The first step in the maintenance of the soil conservation works is to prevent animals from straying into the fields. Stray animals try to climb up and down the bench terraces or cross the structures like diversion drain, contour or staggered trenches etc. In doing so, they trample and damage the conservation structures. The front faces of the bench terraces quite often slip and allow overtopping of run off which attains concentrated flow down the slope and cause further deterioration. Fencing along the field boundary either with live hedges or with barbed wire and wooden posts, will be quite useful as a preventive measure to safeguard the structures against damages by the animals.

The front faces of the bench terraces should be protected by establishing grasses like *Phalaris tuberosa, Paspalum dilatatum, Erogrostis curvula, Digitaria* spp. and *Agropyron semicostatum*, etc. These grasses are not affected by frost and when established, will provide almost perennial protection to the bench terraces against slip and also erosion, provided these vegetative covers are attended to and properly maintained by filling up gaps, if any, periodic cutting etc.

The lands and the conservation structures should be periodically examined particularly after every heavy rains. If any rills or signs of erosion or slips are noticed, they should be corrected immediately. Care should be taken to see that at no point the excess run-off after rains overflows the structures. Obstructions, if any, to the flow of run-off should be removed forthwith. In all places free and safe disposal of excess water should be ensured.

It is important that the terrace gradient both inwards and lengthwise should be maintained properly. If these gradients are obliterated, as it often happens by trampling animals, faulty land management practices, it is likely that the rain water may stagnate on terraces and cause brown-rot disease to the potato tubers. In order to maintain the gradient, certain readjustment in the method of preliminary cultivation with digging forks, breaking clods and forming ridges and furrows for potato cultivation, will be necessary. The digging should start from end abutting the disposal drain and proceeded lengthwise along the terraces towards the farther end. Breaking of clods should also be carefully done so that the shallow drain excavated along the inner edge of bench terrace, is not

During the South-West Monsoon when the major portion of the rainfall is received and distribution is also even, the furrows and ridges may be formed at right-angle to the terraces, i. e. breadthwise, the furrows joining the shallow drain along the inner edge of bench terrace. This will enable rapid drainage of excess water towards the inner edge. During the North-East Monsoon periods, when the rainfall is ill-distributed, conservation of moisture will be necessary in addition to controlling soil erosion. For this purpose, it is recommended that the furrows and ridges for potato cultivation may be formed parallel to the terraces. Provision of cross drains breadthwise at every 15 to 20 ft. will be useful for collecting the excess water draining through each of the furrows and allow it to rapidly drain towards the inner edge.

The disposal drain, drop pits and diversion drain constructed on the top have all to be periodically examined and the cross section should be maintained right through in order to prevent over-flow of run-off at any point and resulting damage to the bench terraces lower down.

The drop pits should be examined periodically for silt deposition and the silt, if any deposited, should be cleared and proper depth maintained. If the drop or the height of bench is more than 5 ft., it will be better to provide stone pitching at the bottom of the drop pits. This will facilitate easy maintenance and at the same time prevent formation of deep pits due to waterfall conditions created when the excess water drains down the slope.

In addition to attending to the above items of maintenance, all improved agricultural practices including improved strains of seeds, application of cattle manure and compost and chemical fertilisers, crop rotation, growing of green manure crops and incorporating it *in situ* etc. should also be followed. These conservation farming measures maintain the physical characteristics of soil and improve its infiltration capacity so that a good portion of rainfall may soak through and the residual run-off to be managed may be comparatively less. This itself will help reducing the cost of maintenance to a great extent.

Benefits: The benefits of soil conservation measures especially in the hilly regions like the Nilgiris, are multifold. The soil conservation measures

man's neglect to protect the land against erosion has been vividly reflected in the Kettery Reservoir in Ketty Valley Basin. This reservoir which was constructed nearly 60 years ago has been completely silted up and now it has been abandoned. The Hydro-Electric Power that was once generated for meeting the entire demand of the Cordite Factory, could no more be available for running this factory. The power needed is being obtained from the Electricity Board.

On the agricultural land, the soil conservation measures like Bench Terracing has been very useful in arresting soil erosion immediately and building up the soil for permanent production. Fortunately the soils encountered in the Nilgiris has a capacity to recouperate and respond favourably to heavy manuring, when once soil erosion is effectively controlled. Potato being the principal crop grown in this tract and the quantity of manure applied for this crop being large, observations have shown that immediately after bench terracing, the crop yield has increased. In order to assess the extent of increase in crop yield as a result of bench terracing, the Director of Statistics, Madras, has conducted crop cutting experiments from the year 1954–'55 to 1963–'64 excepting the years 1957–'58 and 1961–'62 when no experiment was conducted. The details of the experiments conducted are furnished in Table 1. It could be seen from Table 1, that the average additional yield of potato after bench terracing, has been in the

TABLE 1

Statement showing the additional yield of potato in terraced plots in the Nilgiris district as determined by crop cutting experiments in different years

Year	No. of pairs of experiments		Average yield in terraced plots		Average yield in control (unterraced) plot		Average additional yield		Percentage increase due to bench terracing
	Planned	Considered	lb./ac.	kg./hect.	lb./ac.	kg./hect.	lb/ac.	kg./hect.	
1954–'55	11	11	15,745	17,648	10 307	11,553	5,438	6,095	53
1955–'56	50	49	19,840	22,238	16,840	18,875	3,000	3,363	18
1956–'57	50	50	15,530	17,407	11,588	12,988	3,942	4,419	34
1957–'58	———		No Experiments Conducted						———
1958–'59	100	86	18,643	20,896	14,959	16,767	3,684	4,129	25
1959–'60	100	93	17,299	19,390	14,014	15,708	3,285	3,682	23
1960–'61	100	100	18,999	21,295	16,428	18,413	2,571	2,882	16

order of 2,571 lbs. to 5,438 lbs. which worked out to 16 per cent to 53 per cent of the average yield of potato on unterraced plots. The results of experiment were found to be statistically significant showing the real increase in yield of potato crop on bench terraced lands over un-terraced ones. The average increase in yield of potato for all the 8 years of observation, works out to 3,846 lbs. per acre. In the process of bench terracing, the long and continuous slope is divided into series of platforms which are separated by almost vertical faces. Since cultivation is done only on these platforms, after bench terracing the land available for cultivation will on an average be 87½ per cent of the original land area before terracing. If one acre of land is bench terraced, only 7/8 acre will be the net area available for cultivation after bench terracing. The average increase in yield of potato from one acre of land after bench terracing will therefore be (18,452 x 7/8—14,606) 1540 lbs.

As has been explained early, the entire cost on soil conservation scheme is initially borne by the Government and recovered with interest in 20 equated annual instalments from the beneficiaries.

The annual cost on soil conservation works that the beneficiary may have to pay, works out to Rs. 37/-, per acre, assuming the cost of soil conservation scheme as Rs. 500/- per acre. Against this amount, the benefit due to increase in crop yield works out to Rs. 154/- (cost of 1,540 lbs. of potato at the rate of Rs. 20/- per bag of 200 lbs.). It could therefore be seen that the benefit by way of increased crop yield in terms of monetary value is nearly four times the cost of the scheme to be repaid by the farmers. In addition, the beneficiary will be able to save the cultivation expenses by way of 12½ per cent of the original cost incurred before bench terracing (ie. Rs. 150/- approximately) since he has to cultivate only 7/8 acre against the one acre before bench terracing.

Extension of work to other Hilly Regions: In view of the encouraging results obtained in the Nilgiris, the soil conservation scheme has been extended to the Kodaikannal Hills (Madurai district) in the year 1956–'57. In this tract, the soil conservation works included, bench terracing on steep cultivated lands in the Upper Palnis and construction of contour stone walls by way of disposal of stones available *in situ* for the plantation areas in the Lower Palnis. Contour or staggered trenching are also adopted in the plantation areas to control soil erosion and dispose excess water carefully.

Banana) have registered an increase of 25 per cent. Even here, the additional monetary gain is estimated to be more than four times the annual levy paid by the farmers.

Summary and Conclusion: In the Hilly regions like the Nilgiris, the problem of soil erosion is intense in view of steep and undulating topography, friable nature of soil and heavy and erratic rainfall received. Extensive cultivation of erosion permitting crops like potato on all types of lands irrespective of steepness of slope and faulty agricultural practices of cultivating up and down the slope have further aggravated the problem. The problem of erosion has reached such a dangerous proportion that in majority of cultivated lands on steep hill sides, the entire top soil is already lost; and cultivation is done on subsoil by applying heavy doses of fertilizers. Realising the need for immediate protection of land against erosion, the scheme for soil conservation in the hills was first initiated during 1951 in the Nilgiris. Upto end of the third five year plan, it is expected that in all 15,401 acres will be covered under the scheme against a total area of 33,500 acres under cultivation of annual crops. Considering the problem of soil erosion and the area affected, what has been done already is very little; and the scheme need to be intensified and further extended to other hilly regions in the State.

The Director of Statistics has been conducting crop cutting experiments from the year 1954–'55 to 1963–'64 in order to assess the effect of bench terracing as a major measure of soil conservation on steep hills, on the crop yield. The results of the experiments have shown that, there has been consistent increase in yield of potato to the extent of 3,846 lbs. per acre on an average which works out to 27 per cent of the average yield obtained from unterraced land. A comparison of the monetary benefit derived as a result of additional crop yield due to bench terracing, has shown that the benefit is more than four times the annual levy on cost of works which is repayable to Government by the beneficiaries in twenty equated annual instalments.

Encouraged by the beneficial effect of soil conservation scheme in the Nilgiris, the scheme has been extended to Kodaikanal Hills in Madurai district and later on to Shevaroys Hills in Salem district. The nature of soil conservation measures executed in the hilly regions and the maintenance works to be attended to have also been e.

The need for soil and water management is all the more important in the hilly region, since the damages caused on such terrain is multifold. In order to tackle this problem on a national basis, it is necessary to enlist the willing co-operation of the farmers. Considering the benefit as explained above, the cost of soil conservation works on the hills is not really high. It is therefore hoped that all the farmers in the hilly regions will lend their full co-operation for the successful implementation of this scheme in the hills so that the cultivated lands, plantation areas and all other lands which are affected by soil erosion can be effectively protected against this hazard. Only then, economic cultivation and sustained increased agricultural production will be possible and also the economic status of the farmer and the Nation in general can be improved.