SOIL EROSION*

THE importance of problems of soil erosion and desiccation in the Empire was recently stressed by Sir Frank Stockdale, Agricultural Adviser to the Secretary of State for the Colonies, when he addressed an informal meeting in London of Forest Officers from all parts of the Colonies.

In his address Sir Frank first considered the problems from the physical aspects of climate, soil, steepness of slope and rainfall.

He pointed out that many soils eroded more rapidly than others, the rock-base possibly having an important influence on this character, and instanced the low liability to erosion of heavy calcareous soils in Jamaica compared with the rapid rate of erosion in soils derived from schists.

The steepness and aspect of slopes and the distribution of rainfall were other important factors affecting rate of erosion. In areas subject to a long period of drought, erosion was intensified since soil-particles tended to dry out and become surrounded with a layer of air which retarded absorption of moisture and the wetting of the soil.

From the biological side he stated that the problem involved an understanding of vegetation and the reactions to the way in which land was used for purposes of agriculture and pasturage, man-made erosion being usually due to interference with the vegetative cover and was capable of material retardation and prevention by protection of streams and general methods of conserving water supplies in the soil.

Thirdly, he stressed the fact that the livelihood of the people is always of paramount importance, and that such customs as shifting cultivation, cannot be abruptly upset but that attacking the problem in such economic and social circumstances can be successful by gradually building up a continuous system of agriculture aiming at intensification of agricultural operations in place of the practice of extensive native methods. He stated that there were two methods of counter-acting shifting cultivation such as is practised in Fiji. One way was by providing a good rapid growing cover when land was thrown out of cultivation, the other was by the adoption of animal husbandry and mixed farming as a means of maintaining fertility.

As regards Fiji, it may safely be stated that soil erosion has been taking place for a considerable time as is evidenced by the general flat topography of the low red hills, the fineness of the soil deposited in valleys and the greater fertility of such soils in comparison with the residual eroded materials.

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Many of the so-called river flats in Fiji are not composed of true alluvium, but are a mixture of true alluvium and the fine soil from the neighbouring eroded low hills (*i.e.* colluvial soils). The fertility of these soils is due in no small measure to their admixture with the eroded surface materials. Many profiles examined in the course of soil survey studies suggest the complete erosion of the surface horizon and the infertility of several soils can be directly attributed to this cause.

Much erosion by water action is masked by the system of native agriculture which permits of rapid growth of secondary vegetation in eroded areas : nevertheless, sheet erosion is very prevalent particularly in soils overlying soapstone and volcanic tuffs.

In the neighbourhood of Suva the soapstone is covered in many cases by only a few inches of soil, and although this formation is fairly recent there are locations where from natural causes erosion has been prevented and several feet of residual soil exists in association with the parent material.

In the Kalabo area the erosion of two feet of soil in the course of five years has been recorded. Again at the Experimental Station, Nasinu, particularly shortly after clearing, it is possible to witness sheet erosion and in small depressions the sandy clay soil type is mechanically separated, the fine silt and clay being washed away and the coarse and fine sand left to tell the tale. Chinese market gardeners are cultivating garden food-crops on an extensive scale at various sites along the Prince's Road, most of the cultivation being on sloping lands and, in the normal Chinese manner, clean weeding forms a feature of their agricultural routine. Erosion is extensive in certain locations in this area, and Chinese market gardeners have been known to build up soil in eroded locations, without making any provision for its subsequent retention.

In general, it can be stated for Fiji that wherever land is cleared of timber and subsequently cleared for cultivation, sheet erosion takes place in the undulating country and its severity depends upon the type of crops grown, the slope of the country, the soil type, system of cultivation and soil management, while in the steeper country cleared of forest, gully erosion is prevalent.

Practically all the alluvial flat country of Fiji is under cultivation or pasturage and apart from flooding there is little damage caused by erosion of these soils, since, as a rule they are very fertile and are mostly managed by the Colonial Sugar Refining Company whose methods of liming, green manuring and crop growth give rapid results. Where they are left to fallow, these soils are soon covered by a thick mat of sensitive plant, and Para and other introduced grasses. Organic colloids are high in these soils and owing to the binding nature of the organic constituents, they thus resist erosion to a great extent. Erosion through overstocking of flat pastures is almost absent in Fiji but on the slopes of the hills erosion is more noticeable, particularly where no provision has been made to retain the soils.

Many of the soils of Fiji—due to absence of organic colloids and their peculiar mechanical composition, a high content of fine silt and fine sand—are very easily eroded. These soils, if cultivated, expand and contract during wetting and drying, forming in some cases a patterned surface, and in others deep and

extensive cracks. Where cracks are extensive in soils overlying soapstone, the percolation of water to the slippery soapstone surface has the effect of moving soil *en masse* on the sloping surfaces. The extent of this movement is controlled by the mechanical composition of the soil, the depth to which cracks extend, the amount of cultivation and the slope of the land.

In the dry zones of the Colony, contour cultivation of the hilly lands is frequently seen but in the wet zones Indians tend to plough up and down hill in order, it is stated, to facilitate drainage and in consequence much erosion takes place and frequently results in the flooding of roads in rainy weather.

Outside the sugar cane areas the system of agriculture adopted by the Indian peasant is to till the soil, plant one crop and to continue with that crop until the soil is exhausted or the crop succumbs to disease. He then moves on to another selected area and continues the same wasteful practice. The exhausted areas are then abandoned and apart from the fact that no provision is made during cultivation to conserve soil, the exhausted condition of the soils after abandonment, is such in many cases as not even to permit of a quick return to natural conditions as instanced in the Kalabo area near Suva.

The Fijian shifts his cultivation at frequent intervals and although this practice is wasteful it has the merit that soils are not exhausted and usually revert fairly rapidly to natural conditions. Also, the Fijian very rarely clean-cultivates his land and some of his methods definitely tend to counteract erosion of the soil. Thus, in soils subject to sheet erosion the native method of disturbing only the soil in the immediate vicinity of the planting hole causes little erosion compared with the Indian method of entire tillage of sloping areas.

The Department of Agriculture, through its Field Agricultural Officers and Demonstration areas, is attempting to teach the native a sounder system of agriculture, based on soil management and crop rotation. By this means it is hoped in time to limit his agricultural effort to a definite area which he will farm according to the advice and under the supervision of the agricultural officers who have, in certain areas, demonstrated the conservation of soils on hillsides by contour cultivation, terracing, liming, green manuring and cover cropping.

The serious nature of soil erosion in Fiji is not fully appreciated at the present time, but it may be pointed out that areas which have suffered extreme erosion are being abandoned ; many of the eroded areas are close to roadways, waterways, and ports, and new land is being opened up in steeper areas and is thus more subject to erosion. The total available agricultural land is ample for the present population but with increasing population exhaustion of soil and soil loss through erosion will steadily become more serious factors in land settlement and hence, the gradual adoption of a soil conservation and restoration policy is indicated.

Amongst well known methods for counteracting soil erosion, mention may be made of contour terracing, contour tillage, strip cultivation, broadbase terracing, contour hedges, cover cropping, rotation cropping, contour planting of protective belts of trees, mechanical means (usually too expensive, except in highly populated areas) the maintenance of permanent cover (forest) on steep slopes, mountain and hill tops and reafforestation. These and other methods of conserving soil moisture lead to the growth of agricultural and

cover crops which in turn conserve and bind the soils. Gully erosion is of common occurrence in Fiji and requires special methods of control including the provision of diversion channels to direct flood and stream water away from the gullies, the erection of brushwood and other inexpensive dams, and the planting of suitable trees on the slopes and bottoms of the gullies. Small gullies can also be filled by ploughing across the contours.

The agricultural education of all races is important as a factor in the gradual reduction of losses of soils and of soil fertility : instruction towards this end is already being given by the Department of Agriculture through its officers and by ocular demonstrations at various native agricultural centres where such work is still very much in its infancy.

The principal causes of our soil erosion are undoubtedly shifting cultivation, uncontrolled timber cutting, fire and to much less extent, grazing. The general effect of these forces is already rendering much of our accessible land infertile and unremunerative and in consequence it is desirable that attention should be directed to the need for the proper use of our soils and our vegetation which combine to form the greatest asset of this Colony. The task of preparation is Herculean, but much can be done if the many persons concerned each endeavour to do their own little " bit " towards the reduction of erosion and thus endeavour to leave to their descendants a valuable inheritance of land on which fertility has been built up by wise and judicious means of cultivation and utilization.

The problem of repairing the destruction of soil fertility resulting from erosion by water, wind and heat, is gravely exercising the minds of many nations to-day, particularly in Africa and North America where many millions of acres of rich fertile soils have been dissipated in the course of a few generations—even within the memory of living men.

Fiji is still fortunate in that loss of vegetation and erosion have not yet been extensive, thanks to sparse population but enough damage has been done to indicate the need of watchfulness to stem its progress and of education to stimulate agriculturists to economize in their use of land. Also needed is a sound permanent system of farming leading to the establishment of a permanent native peasantry in contrast with the unsettled shifting cultivation which accompanies communal agriculture at present.