

A Study of Grass Root Systems, with
reference to five tropical Grazing Grasses.

Introduction: The need for higher world food production becomes increasingly great as world population increases, not only in order that people may be fed as well, or as badly, as they were before, but also in order that average nutritional standards in many countries may be increased above the low levels at which they may stand at present. Russell (1954) quotes F.A.O. figures of a 12 percent increase in world population from 2,142 millions to 2,407 millions between 1937 and 1950. He points out that the problem of world hunger, though staved off temporarily in the past by such practices as plant breeding and the use of synthetic fertilizers, is again a serious consideration for agriculturists, since F.A.O. studies have shown that average nutritional standards in many countries are declining.

Although export and import of surplus food crops plays an important part in the economics of countries of similar food habits, this is not of such great importance between, for example, the rice-eating peoples of the Eastern Hemispheres and the wheat-surplus-producing countries of the Western Hemisphere. Thus food supplies in many countries must be mainly increased by the intensification of their own agriculture, by bringing more land into cultivation, and by intensifying production from land already being tilled.

It is evident that grass, either as a natural or a seeded "crop" within a rotational system, may, under suitable conditions of natural environment and management, have a marked beneficial effect on soil conditions relative to subsequent crop growth. These effects have been investigated by a large number of workers, with reference both to their benefits to subsequent crops and to their effects on soil erosion losses. (Sprague 1933, Weaver, Hougen and Weldon 1935, Weaver and Noll 1935, Uhland 1935, Rostovseva and Avaeva 1935, Martin 1944, Weaver 1947, Tsyganov 1949, Peerlkamp 1950,

Theron and Haylett 1953, Low 1955 etc.). Under increasing pressure on land, the grasses that will be most beneficial in this capacity will be those species that produce maximum development of desired effects in the shortest possible time between cropping periods.

Soil erosion tends to be severe in areas where high intensity rainfall occurs. It has been shown that the amount of erosion per unit time occurring from a given area is proportional to the total amount of kinetic energy received. (Laws 1940, Eckern 1950, Ellison 1952). In tropical countries the position may be aggravated by the fact that the beneficial effects of organic cements derived from decomposition products of plant roots are found to be of far less significance than in cooler temperate climates. (Martin and Craggs 1946, Parnell 1947, Maher 1950, Theron and Haylett 1953, Pereira, Chenery and Mills 1954, Mohr and van Baren 1954, Klintworth 1956.). Several proposals have been put forward, whose main theory is that decomposition of root materials by bacteria, which are found generally to predominate over fungi at high soil temperatures (Mohr and van Baren 1954, Martin and Craggs 1946), occurs more rapidly and completely than in temperate climates. This decomposition has not been found to produce such stable organic cements as are produced by fungi, and possibly by actinomycetes, more frequently found at lower temperatures. Since grass is acknowledged to be an effective soil modifier for conservation work in the tropics as well as in temperate climates, it seems, therefore, that the relative importance of the physical binding action of the living and dead but undecomposed root material is far greater under grass stands in the tropics than in temperate areas. In tropical regions, however, it seems likely that the relative importance of roots of grasses in promoting stable structural conditions is far less than in cooler regions, while the importance of the above-ground parts, in preventing raindrop impact at the surface, is proportionally greater.

From a survey of literature it is evident that much

work has gone into determining the nature of the effects of grass as a general "crop" on the soil, and in discovering the mechanisms by which the soil conditions are modified. However, although the relation between soil conditions and soil and water conservation is understood, little work has been published to show the relative effectiveness of various important species of grass in preventing soil erosion. (Pearse and Woolley 1936, Stevenson and White 1941, Ward 1949, Stark, Hafenrichter and Moss 1950.). It seems desirable that an attempt should be made to standardise methods of comparison of grass species with particular regard to modification of soil conditions.

Differences in ability of grasses to affect the soil have been noted by a number of workers, but most have been reported from temperate areas. (Tsyganov 1949, Pavlychenko 1941, Barley 1953 etc.). Little has been published on this aspect of work under tropical conditions, (Martin 1944, Tella 1956, Nwosu 1954) despite the fact that erosional problems are as great or perhaps greater in such areas as tropical Africa than in many temperate countries. This fact may be attributed to the lack of money and equipment to allow suitable studies to be undertaken.

The study of grass effects on structural conditions relative to soil and water conservation has largely been instigated by the observation that a more or less stable structural condition is maintained in a temperate climate during cropping periods subsequent to the breaking of a grass sward. Attempts have been made to determine the factors controlling this persistency of structural condition. Under a tropical environment however, the grass-induced structural conditions easily visible in an upturned turf seem to be dependent for their maintenance upon the presence of living and dead but undecomposed grass root material.

In order to determine the effectiveness of the grass plant as a whole in preventing soil erosion, it is necessary to

consider what conditions of the plant-soil relationship are conducive to low erosion loss. These may be divided roughly into four categories :-

(a) The degree of rainfall interception by the canopy of a grass cover will determine in some measure how far the infiltration capacity of the soil surface will be reduced by rainfall of a given intensity. (Weaver and Flory 1934, Weaver and Noll 1935, Ellison 1947, Osborn 1950, 1956, etc.).

(b) The resistance of a grass sward to bodily removal by potentially erosive overland flow, and the degree of impedance provided to that flow will lower the erosive capacity of the flowing water to a greater or lesser extent. This will be dependent upon such factors as density of cover at ground level, and depth, spread and strength of rooting of the species.

(c) The grass plant may allow approximation to the provision of adequate pore-space to allow percolation and storage of all water penetrating the surface layers of the soil. (Musgrave and Free 1936, Norton and Smith 1937, Pearse and Woolley 1936, Free, Browning and Musgrave 1940, etc.).

(d) The durability of a more or less persistent structural stability allows maintenance of percolation and infiltration characteristics for as long as possible, both during the period when the grass is growing in situ and after the area has been broken and planted to other crops. (Rostovseva and Avaeva 1935, McHenry and Newell 1947, Theron and Haylett 1953.).