

I. INTRODUCTION.

Soil Aeration in Agricultural Practice.

The art of cultivation, so important in arable farming, has two main objects: to impart to the soil a good tilth and to control the growth of weeds. Good tilth is associated with looseness and a high proportion of space between the particles, and presumably it facilitates the movement of air and - by reducing the mechanical resistance of the soil - the penetration of roots. Most soils can be brought into a temporary state of good tilth by skilful use of implements when the moisture content is at an optimum. The majority of natural soils, whether under forest or grassland, also possess a crumbly structure in the surface layer; the reasons for this have been discussed very elegantly by Bradfield⁽¹⁾.

The permanence of a crumbly structure depends mainly on the organic-matter content and the calcium status of the soil. In general, the degree of saturation with calcium varies inversely with the extent of leaching and the intensity of rainfall. The organic-matter content is mainly a function of the temperature, because the intensity of microbiological activity depends on temperature; thus Jenny⁽²⁾ has found that accumulation of large amounts of organic matter cannot occur above 25°C , ^(77^oF) For two reasons, therefore, soils of the humid tropics may be expected to show poor development of structure and, when the cycle of nature is interrupted, rapid deterioration and loss of all structure.

In the production of annual crops the air supply can be improved by tillage, which increases the total pore space of the soil, and by drainage, which reduces the proportion of the pore space occupied by water and may also retard the loss of soil structure. (The extent to which such improvement in the air supply itself benefits crops is a matter about which little certain information exists). The amount of cultivation that can be carried out in perennial crops is limited to occasional loosening

of the soil (e.g. with a fork), and even this may do more harm than good, because of damage to roots. The digging of drains is then the chief means of improving aeration, and is important if the climate is wet.

Surface drains may be advantageous on all types of soils, because it is seldom that heavy rains can be absorbed by and percolate through the soil sufficiently rapidly not to impair aeration. Deeper drains can presumably only be of additional value if the physical properties of the soil are such that water can run through under the influence of gravity. Thus, apart from removing surface-water that never enters the soil, open drains in clayey soils can probably only affect the layers that possess natural or artificial granular structure. Free water-tables may occur in permeable soils, and in such cases the construction of deep drains may be beneficial, because of lowering the water-table. Vageler (3) has mentioned the desirability of really deep cultivation for crops of perennial growth, which is narrowly limited, however, after the crop has been established on the field. He recommends the preparation of deep broad pits for the single plants, the growing of various green-manure crops that have a beneficial influence on the physical state of the soil, and the digging of aeration pits in different spots from year to year, to be filled with organic waste.

The probable importance of soil aeration as a factor influencing cacao productivity has recently been stressed by Hardy (4), because clay soils that do not possess good natural structure are very common in Trinidad and it is doubtful whether they are capable of producing high yields of cacao for a satisfactory length of time, even when nutrient deficiencies are remedied by manuring. The soils of Trinidad are at present being classified primarily according to their natural drainage (5); this is because of the role of drainage both as a pedogenic and as an ecological factor.

Several observations can be made with regard to the effects
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of cultural practices on the aeration of cacao soils:- (1) In Trinidad and Tobago cacao is always grown under Immortelle shade-trees, the functions of which are undoubtedly complex but, according to Dr. T. G. Mason, probably include a beneficial influence on soil aeration. (2) The existing cacao trees were generally not provided with good sites, by the digging of deep broad pits in which to plant them. (3) At one place - River Estate, under the management of the Department of Agriculture - a practice known as "trench-mulching" is in use. In this system, trenches about a foot deep are dug between the rows of trees every few years and filled with organic matter and pen manure, covered over with soil; a result is to produce long narrow strips of soil having very good structure. (4) Drains are maintained in most cacao fields on flat land; their efficacy in removing surface water is sometimes limited for reasons of topography; but in some areas the beds between the drains are then given a steep camber, thus achieving rapid run-off - which may be a cause of serious soil erosion.

The practical considerations, which have been briefly stated, indicate that there is great scope for quantitative investigations of soil aeration in relation to perennial crops such as cacao. The majority of quantitative methods used in the investigation of soils aim at assessing their composition generally or with special reference to the constituents important in the nutrition of plants. Extensive measurement of various physical properties, such as the wilting coefficient and the proportions of total and capillary pore space, is also possible and is important(6); such properties greatly affect the distribution of roots and the water and air supply of the soil. However, the ecological factors that affect crop growth directly are dynamic; they are more difficult to study, one reason for this being that the process of measurement is very liable to disturb those factors, and another, that they vary so greatly in small intervals of time and of space that large numbers of measurements are required, so that the technique

technique must be very simple.

In quantitative investigations of soil aeration direct methods should receive attention first; indirect methods may be simpler, but they are only of real value if correlations with the results of direct methods are available.