TROPICAL FOREST LANDS.*

SO much has been written about the presumed natural high fertility of tropical forest soils, that it might be well at this stage in the rapid development of many tropical regions, to enquire into the reasons which may or may not justify the general acceptance of the idea. There have been many instances of disappointment following attempts on the part of settlers in tropical countries to bring humid virgin soils into successful cultivation for certain crops. Things have gone very well for a few years, and then a rapid diminution in productiveness has been experienced. Mr. E. A. Walters ably discusses a particularly interesting case in his article appearing in the current issue of this journal. He has described how the forest lands of St. Lucia in the British West Indies have given very unsatisfactory results when utilized for banana growing. He attributes failure to the profound changes that have occurred in these lands since the ancient forest covering was removed. He stresses the concomitant adverse effects caused by surface erosion which leads to loss of soil organic matter, and by reduction of wind belts which results in loss of soil moisture. Anyone conversant with the agricultural development of humid tropical countries could doubtless quote similar instances of soil degradation following land exploitation.

It is not generally realised that many tropical forest soils, despite their superficial appearance of high fertility, are deficient in plant nutrients. Some years ago, the late Sir John Harrison wrote as follows about the forest soils of British Guiana. "The question has been raised as to how it is possible for the British Guiana soils, if they are so lacking in fertility as appears from chemical analysis, to support as they do a heavy forest growth. In the case of a forest, the nutrient constituents of plant food are taken up by roots which traverse a very wide area. In that of cultivated plants, the space occupied by the roots is comparatively small. Hence the trees can draw their necessary food from a relatively enormous mass of soil compared with that which the cultivated plants can utilize. The mineral constituents in the case of trees accumulate in the leaves and in the small branchlets, but little being retained in the wood of the stem. When the leaves are shed, the mineral substances are returned to the soil. Similarly, a considerable proportion of the plant food is, in the case of certain trees, returned by fallen flowers. The plant food thus returned to the soil from which it was derived, is set free by decomposition, and is again utilized by the trees. Thus it may be described as circulating and performing its functions in a practically endless circuit from soil, through the tree to its leaves and flowers, and back to the soil. The tendency in the forest is for much of the plant food gathered by the deeper roots to accumulate in the upper layers of the soil. In our tropical forest, this has taken place in the course of ages to such an extent that the trees which now flourish therein are largely surface feeders so that their roots spread through the thin layers of vegetable débris on the surface soil in a widely extending plexus. With the majority of cultivated plants, the constituents of the manurial plant food are largely removed in the products, and are thus lost to future generations of plants raised on the same soil. Hence

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soils capable of supporting a long continued forest growth may, and as repeated experience during recent years has amply proved, do, when under economic cultivation, fail after very few seasons to produce crops of any value. Further, forest trees appear to flourish on soil solutions of far lower salt contents than the majority of plants of economic value can do, and it is a matter of interest to ascertain if this power of utilizing soil solutions of greater diluteness may not be due to the trees growing in symbiosis with some of the fungal organisms with which the upper layers of our forest soils teem."

Dr. Ramann, the famous German soil scientist, puts the same conclusions very aptly when he writes: "The tropical forest works with a small capital of nutrients and a rapid turnover," so that "a small amount of nutrient circulating quickly suffices for the maintenance of luxuriant vegetative growth."

There is urgent need at the present time for detailed investigation into the genesis and evolution of humid tropical forest soils, and of the effects of man's interference with the natural processes that have given rise to them. In recent years, extensive study has been made of the part played by climate in the evolution of soils. So far, however, the work has been confined mainly to temperate and sub-tropical regions, notably Russia, Germany and the United States of America. The most comprehensive statement of the principles of this new branch of soil science is due to the Russian investigators. Their generalizations are now being assiduously tested and applied in the United States and, to a lesser extent, in Great Britain.

The scientific investigation of tropical soils has only just begun. Until considerable headway has been made, it is more than likely that wasteful and unremunerative exploitation of virgin tropical land will continue unabated, and that many further mistakes will be made. It is not sufficient merely to apply the results of accumulated knowledge of the properties and behaviour of well-established cultivated arable soils. It would indeed be entirely futile to do so, for, whereas in cultivated agricultural soil the components of the soil proper have been more or less thoroughly mixed by repeated tilling, natural undisturbed soil shows a gradual transition from the surface downwards, often over a considerable distance. There is no distinct subsoil, and the natural vegetation pushes its roots to different depths depending on its botanical composition. Thus, some of the vegetation may be rooted exclusively in the surface layer of leaf débris, whilst other species may have their root systems developed in underlying soil strata, or even in the parent material itself.

It is evident that an entirely new technique will have to be elaborated for the examination of undisturbed tropical forest soils, and that experimental areas will have to be studied in detail before any general rules can be formulated for their successful utilization in agriculture. Different districts will have to be taken entirely on their merits, always with the view-point of their adaptability or otherwise to the growing of any specific crop.

It is from this aspect that a study of tropical forest soils has recently been inaugurated at the Imperial College of Tropical Agriculture. So far, the work has been confined mainly to old established cacao lands in Trinidad. These comprise forest regions that have been adapted to the growth of cacao under tree shade with little disturbance of the original soil beyond that caused by the construction of surface drains. Areas of different ages with reference to the time when they were first planted in cacao are being compared between themselves and with adjacent areas still under virgin

forest. Further comparison with areas that were once under cacao and are now growing sugar-cane is possible, and may form a continuation of the present investigation.

The method of soil examination consists in the laboratory study of soil samples obtained at different depths from the surface in holes especially dug at selected sites. The profiles exhibited by the sections are described; their natural differentiation into conspicuous strata is noted; the thickness of each of these strata is measured, and finally, soil samples representative of the individual layers are procured. In the laboratory, quantitative determinations of such factors as degree of acidity or of alkalinity, content of soil organic matter and of humus, mechanical composition, concentration of total and specific soil nutrients and calcium carbonate content are made on each of the samples of soil.

Trinidad appears to be especially suitable for studies such as these because of its diversified geological structure, its varied topography and its unequal rainfall distribution. The number of different soil types presented therein is quite large; they range from mature sedentary soils to recent swamp and stream alluvium. A considerable proportion of the land is still agriculturally undeveloped, and several forest reserves have been demarcated both in the uplands and in the plains.

From the biological aspect, much work requires to be done on the indentity and activity of various organisms that comprise the soil flora and fauna. The question of microbial nitrogen transformations in tropical forest soils is almost untouched. The possibility of tropical forest trees utilizing symbiotic mycorrhiza as absorbing organs for obtaining supplies of different nutrients is worthy of careful study. The form in which the trees obtain nitrogenous nutriment, whether it be ammonium compounds or nitrates, and whether or no the reaction of the soil environment plays a part in this relationship, still remain to be elucidated. Some information on these subjects has been accumulated for temperate forest soils, but it does not necessarily follow that this knowledge can be applied without qualification to humid tropical conditions.

Only when an accurate understanding of the genesis, composition and nutrient status of tropical forest soils has been acquired can one hope to be able to assess the potentialities of any particular tropical forest area, to predict what is likely to happen when the forest covering is removed, and to prescribe ultimate tillage and manurial treatments requisite for the formation of new types of soil suitable for the cultivation of remunerative crops.

To proceed with the wholesale exploitation of our tropical forest lands without at least an appreciation of these fundamental problems is to court disaster, if not wantonly to waste one of Nature's greatest gifts.