SOIL MANAGEMENT PROBLEMS.

PROFESSOR J. SYDNEY DASH, B. S. A.

Although our knowledge concerning soil fertility has undergone considerable change since the days of Van Helmont and his willow tree experiment, Tull and others, it is only during the last hundred years that the more fundamental contributions to the study of soil science and plant nutrition have been made; in this connection, such names as de Saussure,

Liebig, Hellriegel, Lawes, Gilbert, Cameron, Whitney, Hall and Russell—to mention only a few representing various schools of thought up to the present day—should be familiar to everyone. During the period previous to 1804, nitre, water, air, fire and earth had at various times been regarded as agents in the nourishment of plants. Readers may be reminded particularly of the conceptions of Tull who taught 200 years ago that soil particles constituted the real food of plants and that if these were made fine enough by cultivation, the plants could then absorb these fine particles and produce crops continuously. With the discovery that the food of plants was both mineral and gaseous, the former from the soil and the latter from the air, the belief soon grew as a result of chemical and mathematical considerations that soils would eventually become exhausted from cropping unless provided with new sources of plant food. Thus, the developments arising from the investigations of Lawes and Gilbert on the problem of providing readily available substances to be added to soils in order to satisfy crop demands, and which paved the way for the extensive use of commercial fertilizers, further emphasized the view among chemists and agriculturists that all that was necessary was to feed the plant.

Up to this point, the plant itself had received little attention ; it is now recognized, however, owing largely to the researches of the geneticist, agronomist and physiologist, that soil, plant and climate must all be reckoned with as factors in crop production. This does not mean that the chemical aspect of soil treatment has lost in importance ; to mention only one recent investigation bearing on this question, in Hawaii studies on potash requirements of cane soils indicate that those containing more than '03 per cent. of potassium oxide soluble in one per cent. citric acid will not give profitable returns from potash applications. On the other hand, it is certain that no one branch of agricultural science can claim a monopoly in what concerns the all-important question of raising crops plentifully and profitably. Indeed the more closely it is studied the more complicated the problem seems to become, and in the final stages the agricultural engineer may play not the least part.

As a result of field and laboratory investigations up to the present time, there emerges the general fact that the tiller of the soil need no longer be unduly worried over the probability of soil exhaustion to a point where it will cease to produce; rather, he should be concerned with maintaining fertility at a standard which will allow of crops being grown at maximum profits and minimum expense compatible with the requirements of permanent agriculture. In this connection what causes the greatest possible concern—and for which adequate remedies are not yet forthcoming—is the heavy soil losses, apart from crop demands, to which good agriculturists are subjected year in and year out. To suppose that because a careful planter, by sound methods of management, puts into his soil much more food materials than his crop needs must expect to lose that which is not wanted, is equivalent to supposing that because a millionaire banks much more money than is necessary for his needs, the surplus should be lost. Awaiting a satisfactory solution of this problem, the good agriculturist in order to keep fertility up to the standard already indicated, must not relinquish his efforts in respect to

tillage, manures, amendments, rotations and the like, and the use of every possible means to prevent erosion and soil wash—both responsible for heavy losses under tropical conditions.

Dealing first with tillage, we are reminded forcibly of Tull's theory mentioned earlier and its corollary—tillage is manure. It is true to-day in the sense that tilling the soil helps to make potential plant food available and also provides better environmental conditions for plant growth. It is an aspect of soil management which is assuming increasing importance and must continue to do so in proportion as populations increase, sources of fertilizers become more and more exhausted, and with the growing recognition that crops need other things beside food. Slowly but surely these facts must reach the tropical planter who has hitherto depended too much on the natural conditions of soil and climate ; he should understand that perfection of factory and technological methods in the preparation of his produce mean little or nothing in the long run if the fields are not producing the raw material, and further, it is a sound economic law that improvements in one direction invariably call for improvements in another. Thus, the agricultural engineer in the handling and development of power and implements for efficient tillage, cultivation, irrigation, &c., with a view to increasing production and lessening costs is equally as necessary as the factory engineer. Moreover, tropical soils by virtue of their often compact and heavy nature demand that greater attention be paid to tillage and such practices which improve texture and tilth rather than the mere application of fertilizers.

Of all the manures at the disposal of the agriculturist, farm manure is the most important; unfortunately, in many parts of the tropics labour, cost of making and applying is given as a reason for its limited use. Judged as a supplier of plant food only, this attitude is probably the correct one; as a tilth improver, however, there is scarcely anything to equal it. Measurements at Rothamsted have shown a saving of over 22 per cent. on the power consumption required for ploughing dunged as compared with undunged soil ; added to this is the gain in moisture content of the soil as a result of dunging, 5 per cent. and even more being reported—an important consideration where droughty conditions have to be faced. Its influence on the microflora of the soil should also not be lost sight of. Balancing cost with benefits, we are inclined to think that taking into account all the circumstances of crop production in the tropics, expenditure on farm manure is justified. Green manures are useful aids in supplementing farm manures, but they are not suited to all soils, and under conditions of poor rainfall may be distinctly prejudicial where moisture is lost through excessive transpiration from the green crop. With regard to their disposal in the soil it is believed by some that the plants should be allowed to wither after cutting before being turned in. Obviously, the problem needs further investigation since when turned in withered much moisture will have been lost and the soil moisture drawn on to assist in decay, the succeeding crop not infrequently suffering as a result ; on the other hand, if buried fresh in such a way that capillary action is interfered with and air excluded, as often happens where hand labour is practised, the early development of the crop that follows will be hindered. Passing a roller over the green growth and then discing in the material seems to offer the most efficient means of disposal. It is interesting to note that all crops do not appear to be able to make use of

the soil nitrogen accruing when legumes are grown ; for example, at Woburn Experimental Farm, investigations carried on year after year show that neither wheat nor barley seem to benefit from the nitrogen left by a tare crop, and the reason is not yet fully understood. Work of this kind on tropical crops should produce valuable results.

On fertilizers and amendments, little need be said of the substances usually employed as such and which are familiar to all agriculturists. Attention may, nevertheless, be drawn to the influence some exert in relation to tilth and resistance to passage of implements. At Rothamsted, a saving in power varying up to 15 per cent. was obtained by chalking heavy land ; in this connection, the use of ground limestone is becoming more general and recent results with it on a sugar estate in Trinidad were referred to in Vol. I, No. 11 of this Journal. It was also found in Rothamsted trials that sulphate of ammonia used along with minerals was beneficial in this respect but that nitrate of soda acted the opposite way and increased the power requirement. Crop plants themselves may act as tilth improvers or otherwise. On newly broken land for example, a deep rooting legume will be found most useful. In the West Indies, the growing of Uba cane on soils of poor physical texture thus replacing other varieties not adapted to such soils should prove beneficial. Unfortunately, as Uba cane has to be burnt before being harvested much organic matter is thereby lost ; to offset this to some extent, the last crop of ratoons might be turned in instead of being allowed to mature. On the other hand, the bad after-effects of a crop like sorghum both on the crops that follow and upon the physical condition of the soil have been frequently observed, especially under dry conditions. These bad effects, it may be noted, do not persist, else the growing of sorghum on a large scale would probably have long since ceased. Recent work on the problems as reported in the *Journal of the American Society of Agronomy*, Vol. XVI, No. 11, indicates that a toxic body is formed during the decomposition of the sorghum stubble which is soon volatilized or itself decomposed ; while it is active, however, the flora responsible for the generation of carbon dioxide is, to a large extent, killed off, and with accessation of carbon dioxide production, deflocculation of the soil takes place—the opposite effect of liming.

In respect of rotations generally, methods of crop production in the tropics do not often lend themselves to definite rotation practices similar to those favoured in temperate climates. The reasons are mainly economic in nature and it is hardly necessary to discuss them here. It is sufficient to say that the benefits to be derived from some form of crop rotation are no less in the tropics than elsewhere, from a soil management point of view. In any case, it may be confidently stated that the value of a practice so easy to adopt under most conditions as the growing of a leguminous cover crop periodically on soils subjected regularly to monocultural cropping, cannot be over-estimated, even as a weed control measure. This aspect of the subject was dealt with in *Tropical Agriculture*, Vol. I, No. 4.

Space permits only a brief reference to erosion and soil wash. When it is calculated that over 400,000,000 tons of soil is carried to the sea annually from American territory, that 11,000,000 acres of land have been abandoned and that over 4,000,000 acres have been actually destroyed by

erosion, the magnitude of similar losses in the tropics can scarcely be doubted. As the surface soil is principally involved under ordinary conditions of soil wash, the loss of humus and humic substances— by far the most important constituents of soils and the most difficult to replace—gives rise to the greatest anxiety. The problem is now receiving considerable attention, notably in Ceylon and the eastern tropics, where forest land has been cleared to make way for rubber. tea and other crops. Even under arable conditions such losses may assume important proportions where adequate measures are not taken to check the ravages of storm water and floods.

In conclusion, the system or systems of soil management adopted will always be influenced by the law of diminishing returns and the varying conditions governing crop production. Using sugar as an illustration, the two extremes of Cuba and Hawaii may be cited. In the former, no system of soil management may be said to exist and production per unit of land is low ; in the latter, most intensive methods are practised and the yield per unit of land, high—18 tons of sugar per acre being recently reported. The future of the two methods both agriculturally and economically will be watched with very great interest. Between these extremes there are a large number of cases where economic conditions are not so clearly defined and where a middle course seems more desirable, in keeping also with the requirements of permanent agriculture. For them, the question of how much or how little to spend on the land in order to get the best results financially is not easily answered. In solving problems of this kind, the need is for the closest co-operation possible on the part of those concerned.—Tropical Agriculture, Vol. II, No. 2.