By W. J. S. Sloan

Introduction.

During recent years the problems of soil erosion and loss of soil fertility have received increased attention, and publicity has been given to criticism of modern methods of cultivation and the extensive use of artificial fertilizers. In general, "would-be" agricultural reformers claim that the salvation of agriculture lies in the adoption of "back to nature" methods, the abandonment of inorganic fertilizers, and a revision of methods of soil preparation and crop cultivation. There is no monoculture in nature, that is, the growing of single crops in pure culture; mixed culture is the rule. Cultivation tends to destroy the fertility reserve in the soil which under natural conditions is built up in the form of humus in the upper layers of the soil by the activities of microorganisms, earthworms, and the like, from the residues of plant and animal life. Therefore, critics assert that stable agriculture and successful food production can only be secured by imitating as closely as possible, the processes which operate in nature. However, the improvement and maintenance of the soil humus content is not an easy problem and this paper is presented for the purpose of briefly examining methods advocated as substitutes for present day practices by several writers.

Maintenance of Soil Humus in Cultivated Land.

Howard [2] believes that the ideal method is to make humus in specially prepared compost heaps from plant residues and the dung and urine of farm animals and then return it to the fields. Ploughing, thorough drainage and sub-soiling, he says, are all essential for aeration of the soil, but he condemns the continued expansion of the machine in agriculture because manure from animals is necessary for correct humus production. Apart from improvement in the soil structure and the addition of plant nutrients, the benefits of specially prepared humus are claimed to include the creation of a favourable soil environment for the development of mycorrhizas on the roots of crop plants. This fungal root association is suggested as the basis of healthy plant growth and resistance to pests and diseases. Howard [3] and Sykes [7] claim further that the health of stock is improved when they are grazed and fed on crops produced by the use of humus. Moreover, Howard believes that the health of the populace generally would be raised if a keener appreciation of the use of properly prepared humus could be developed in farming communities. Biodynamic farmers [6] are in agreement with the greater part of Howard's thesis with even greater emphasis on the need for mixed farming, and the use of farm animal manures in humus production. The basis of their argument is that the soil must be fed, not the plant. A fertile soil is rich in organic matter and is alive by virtue of the fact that it contains enormous populations
of microorganisms. If the latter are fed with properly prepared humus, healthy plant growth and high quality produce are a natural sequence. Biodynamic farmers hold extremist views with regard to humus preparation, and believe that manure and compost heaps should be treated with certain mysterious starters prepared by fermenting at specific depths in the soil special herbs and plants in close contact with certain parts of animals. Emphasis is laid particularly on the value of humus prepared from animal manure and urine in the belief that such humus contains special growth promoting substances.

A variation has been introduced by Faulkner [1] in a popular, but unscientific book, which has received considerable publicity. Humus production and the imitation of nature's methods are the main theme, but the use of the mouldboard plough is violently opposed because the complete burial of organic matter is in sharp contrast to the rotting down of organic matter on the soil surface which takes place under natural conditions. Soil preparation and crop cultivation therefore should be limited to the top few inches of the soil. Faulkner believes that the drainage problem is accentuated by the deep burial of organic matter, because rain water would be absorbed by the soil and not accumulate in hollows if the soil surface was maintained in an open granular condition by the incorporation of plant wastes in the top few inches only. Unlike the writers previously mentioned, he does not define any method for preparing humus under special conditions off the field, the emphasis being laid on sheet composting in the field itself by chopping up green manure crops and plant residues with disc harrows or similar implements in a manner comparable to the operation known as stubble mulching.

Although it has received greater prominence in recent years, the value of soil humus has long been recognised. No modern agriculturist of repute has failed to appreciate the merits of organic matter in soil conservation and crop production and to advocate consistently the maintenance and improvement of the humus content of cultivated soil. However, the artificiality of agriculture is a problem which cannot be overcome. While the need for rotations is recognised, there is no alternative to monoculture over large areas of arable land. Under natural conditions the law is survival of the fittest, but under cultivation the aim is to prevent the growth of all plants other than the main crop. Sowing fields with mixed cultures of crop plants would create chaotic conditions in cultivation and harvesting. Clearing and fencing land, row cropping, the production of new strains of crop plants, are obviously unnatural, but very necessary to maintain the volume of primary produce.

The need for maintaining humus at an adequate level in cultivated soil is undeniable, but methods must be both practical and economic. Preparation of compost heaps under special conditions would require a considerable expense in labour and add to costs of production. Moreover, the machine has come to stay in agriculture and the number of farm animals will steadily decline in the future on farms mainly devoted to the cultivation of a single crop. The claim that well prepared humus confers on the soil special properties of significance to growth of crops, apart from its mineral nutrient content and the beneficial effects on soil structure, has not been satisfactorily proved. There is strong evidence
that mycorrhizas are associated with vigorous growth of certain forest trees, but Laycock [4] investigating the effects of endotrophic mycorrhizas on cacao found that they tended to be more prolific on unthrifty trees, indicating that they were not of importance in the nutrition of the cacao tree. Prepared plant hormones are used for improving the rooting of cuttings, but there is no evidence that vitamins or other specific growth promoting substances which may be present in organic manures increase crop yields or have any special nutrient effect.

The intelligent application of green manuring, trash conservation, and grassland rotation where possible, offer the best solution to the cane farmer in maintaining and improving the soil humus content. Green manuring, although it does not add greatly to the humus content, does supply valuable nitrogen and in addition protects the soil from unfavourable weather conditions and arrests the loss of humus. Crop residues provide the best source from which the cane farmer can make an appreciable addition to the soil organic matter. Trash conservation is probably of more importance on some soils than others.

Unfortunately, the war years have brought about an increase in the burning of cane before harvesting and large quantities of organic matter which might otherwise have been utilised for soil improvement have been lost. However, the cane roots and the trash which survives burning, particularly from well fertilized crops, do add an appreciable amount of organic matter when ploughed in. Molasses and mud or press cake are other excellent sources of organic matter where they are available to farmers. The grassing of idle land for a few years is undoubtedly one of the most important methods of raising the organic matter status of the soil. The grass roots also promote a desirable crumb structure favouring the formation of good tilth and moreover, the grass land rotation assists to lower the weed population.

The Role of Inorganic Fertilizers.

Antagonism to the use of so-called “artificial inorganic fertilizers” is unscientific and not based on sound experimental data. Fertilizers like potash, guano, lime and sodium nitrate, are derived from natural deposits and are no more artificial than the mineral particles of the soil. Inorganic fertilizers in general are not harmful to the physical and chemical condition of the soil if applied intelligently. It is true that the continued use of sulphate of ammonia may increase soil acidity, but this is readily checked by periodic applications of lime. Sodium nitrate may also have an adverse effect on heavy soils, but this can be avoided by using other nitrogenous fertilizers for this type of soil. Indiscriminate use of fertilizers without correct soil management to maintain good physical condition may give disappointing results but on the other hand additions of organic matter low in plant nutrients may be equally unsatisfactory unless supplemented with inorganic fertilizers. The population of microorganisms is higher in soils treated with organic manures, but the normal rates of application of inorganic fertilizers have not been proved to be harmful to these organisms. Nor has it been shown that the resistance of plants to pests and diseases and the quality of produce are lowered by the use of balanced inorganic fertilizers.
There is no doubt that organic matter is of great value in arresting soil erosion, but there is no evidence that the correct use of balanced fertilizers has directly caused it on a large scale. In the case of some unskilled farmers, artificial fertilizers may have been a contributory cause in so far as they influenced neglect of soil management. However, inorganic fertilizers have been very useful on eroded soils in helping the establishment of soil stabilising plants and thus preventing further erosion. Their use in cane produces larger crops and makes available a greater quantity of trash and roots for incorporation in the soil. However, there is no question that inorganic fertilizers must be used intelligently, otherwise results may be disappointing. Balanced fertilizing is required and there is definitely a limit to rate of application, above which gains are not economic. Consistent success is only achieved when fertilizing is combined with soil management to maintain a good structural condition of the soil.

**Soil Preparation in Relation to Crop Residue Management.**

Criticism of modern agricultural methods is essentially based on the question whether land should be cultivated deeply and the organic matter turned under, or whether soil preparation should be limited to chopping up weeds and crop residues in the top two or three inches of the soil without any disturbance of the lower layers. Burial of the greater portion of the organic matter in land preparation is necessary to provide a good seed bed, help weed control, enable efficient planting, cultivation, irrigation and harvesting in rows with machines, and to facilitate the decomposition of organic matter to humus. Moreover, deep ploughing to leave a lumpy surface promotes penetration of rain and thus reduces erosion. If organic matter fails to rot down before planting, the growing crop will often exhibit nitrogen starvation which, unless corrected, may adversely affect yields. This possibility is increased where the organic matter is merely incorporated in a shallow layer of surface soil. The elimination of ploughing would cheapen seed bed preparation but cultivation costs would be higher. Practice has shown that inadequate preparation aggravates the weed problem. Nutgrass, couch and summer grasses are more difficult to control unless the land is well cultivated, particularly if rain should occur at or just after ploughing. Rotary tillage is claimed by some as the solution to the problem of eliminating the need for ploughing, but it is doubtful if consistently good results can be obtained by this means alone. Alternation with deeper ploughing or grubbing or subsoiling would be required periodically to break up the hard pan which continued use of rotary tillers will produce in cultivated land. A recent paper by Matthews [5] gives interesting information on the value of various ways of incorporating crop residues in the soil for dry land crop production. This constitutes a summary of results obtained over a number of years in experiments at field stations in the Great Plains and Columbia River basin of U.S.A. Small grain crops, chiefly wheat, were grown and the soil treatments included leaving all the residues on the surface, leaving a portion of the residues on the surface and completely burying the residues. Yields were much the same for all soil treatments. The conclusion was that the need for leaving crop residues on the surface was largely dependent on a long term view of erosion rather than the expectation of materially influencing current yields.
Conclusion.

Dogmatic opinions in agriculture are unwise and usually not in the best interests of the farmers and the community generally. Experience has taught that most soils and farms need their own individual treatment. Given certain well founded principles, the farmer's own knowledge must supply the details for the management of his land to the best advantage. Nevertheless, the views discussed above, while lacking evidence from sound experimental work to support their extravagant claims, do contain a useful warning to farmers. It is a matter of everyday observation that where trash is left on the surface, rainfall absorption by the soil is better, run-off is thereby reduced, and the rate of erosion slowed down. Uncovered bare soils are liable to serious deterioration in tropical and sub-tropical areas of high rainfall. It is true that some farmers powder the soil unnecessarily by over-cultivation, and some tend to rely too much on inorganic fertilizers without due regard for the structural condition of the soil. The commonsense view is to combine the use of inorganic fertilizers, properly balanced for the soil under consideration, with soil conservation by the use of green manuring and the return of organic matter to the soil. Fortunately the cane farmer is using a crop which has many advantages. There is a prolific growth of roots, the soil is protected by a leafy canopy during the period of high temperatures and heavy rains, and run-off and erosion are checked by the fibrous roots and stools.

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REFERENCES


