

throughout, provided the varnish has just the right penetrating, hardening and insulating qualities. R. Newbound and R. T. Rushall (British Thomson-Houston Co., Ltd.) and H. R. Heap (Crompton Parkinson, Ltd.) reported on this matter. It is perhaps not surprising to find that thermo-setting varnishes incorporating phenolic resins tend to provide a better mechanical job than the older oil-oxidizing varnishes, but it would have been difficult to foresee that the use of phenolic varnish would lead to less oxidation and sludge formation when the coils are operated in oil, either by more effective covering of the copper surface, which acts as a catalyst, or by some direct inhibiting action. The difficulties of devising tests for the required combination of qualities are obvious.

On the larger scale the impression left is that chemical advances have not influenced practice so much as might have been expected. Traditional materials like mica, shellac, paper and mineral oil still seem to dominate the whole picture. It is true that polyethylene, polystyrene and the new ceramics have made possible important advances in the radio and radar fields, that glass fabrics, nylon, terylene and the silicones introduce the possibility of improvements in particular directions at a cost which may not be prohibitive, and these and many similar matters received due consideration; but no contributor was found to suggest that any revolution in practice on the large scale is in sight.

Nevertheless, the symposium as a whole gave an encouraging picture of activity and progress on a very wide front; the many widely scattered workers thus brought together for the first time appreciated its stimulating effect, and the industry cannot fail to benefit in due course as the ideas and knowledge assembled become more widely disseminated throughout the main body of its members.

L. HARTSHORN

ORGANIC MANURES AND FERTILIZERS

IN the Section of Comparative Medicine of the Royal Society of Medicine a discussion was held on May 20 on "Organic Manures and Fertilizers and the Production and Composition of Food for Man and Animals". The president of the Section, Prof. C. L. Oakley, was in the chair and introduced the speakers.

Sir William Ogg (Rothamsted), who opened the discussion, outlined the present position and dealt with the soil aspects of the question. In order to maintain or increase fertility it has, from very early times, been the practice of farmers in most parts of the world to return to the soil, crop residues, animal manure and domestic waste and to rest the land for periods under grass. If production is not too intensive, this system is usually quite successful provided there is not a deficiency of some essential mineral nutrient. With increasing population and its concentration in towns, new problems have arisen. Through modern systems of sanitation, much of the manurial residue which used to find its way back to the land is now carried as sewage to the sea. The introduction of fertilizers just over a century ago enabled farmers to make good these losses and also to increase production. They have not superseded farmyard manure, which, in addition to its manurial value, has important physical effects on the soil; but they are

a source of additional plant food and without them the present population of the world could not be fed. It has been estimated that, in terms of readily available nutrients, the total amount of farmyard manure made annually in Great Britain provides only about a third of the nitrogen, a quarter of the phosphate and half the potash applied in the form of fertilizers. Fertilizer consumption has practically trebled in Britain and the United States in the past fifteen years and this has been a major factor in increasing food production.

Attempts have been made to create a controversy over the respective merits of organic manures and fertilizers. The conflict of opinion is, in fact, between those who advocate a proper use of both and a very small minority who oppose the use of fertilizers. It is sometimes alleged that fertilizers poison the soil and are injurious to the health of plants, animals and human beings. There is no sound evidence to support these views, provided that fertilizers are properly used. They do no harm to the earthworms or to the bacteria and other micro-organisms; nor do they bring about soil erosion. There is no evidence that they render plants more liable to suffer from insect, fungus or virus attacks. Organic manures and fertilizers are complementary, and in good farming practice both are employed.

Dr. G. C. Ainsworth (University College, Exeter), as a botanist and microbiologist, directed attention to the complexity of the total situation which determines health and disease in plants and of which the soil-plant interaction is only a part. Green plants are not dependent on the soil for their carbon, but they are for their other nutrients. Under natural conditions, plants die and decay *in situ* and so repay their debt to the soil together with interest in the form of organic matter. On cultivated land, man periodically removes a crop, and this inevitably leads to a depletion of the soil which must be made good. In primitive societies the exhausted soil is abandoned—an impossible procedure in more advanced and densely populated countries, where a balanced use of chemical fertilizers would appear to be the rational and most convenient way of maintaining the nitrogen, phosphorus and potassium, that trinity of elements basic for plant growth. Chemicals, too, are an appropriate source of the small quantities of boron, copper or other 'trace elements' which may render an unsatisfactory soil fertile.

An agricultural soil has not the simplicity of a controlled and mechanically irrigated sand culture. The organic matter it contains has a vital role in conserving moisture and in providing a substrate for the growth of micro-organisms which, in their turn, affect the physical condition of the soil by determining crumb structure and in making available materials which can be utilized by higher plants. At the same time, the microflora competes with the higher plants for nutrients, and certain fungi may cause disease, while another class, the mycorrhizal fungi, set up a symbiotic relationship with higher plants. The use of farmyard manure is the age-old solution to the problem of maintaining both the inorganic and organic constituents of the soil and the microbial population, but the advent of the internal combustion engine has rendered this solution inadequate and new sources of organic manures are having to be explored. Sometimes it is necessary to introduce the requisite symbiont for a particular plant when the plant is grown in a new situation. Finally, the summation of the soil-plant interaction, as manifest

by the response of the plant to the weather and the pathogen, was touched on and the recent work on systemic fungicides and insecticides recalled, for it is possible that plants absorb such substances from the soil.

Dr. David P. Cuthbertson (Rowett Research Institute) dealt with the relationship of manures to the health of man and animals. He pointed out that no amount of composting can return to a farm the products which move out of it in the form of crops and livestock, and that the use of natural organic manures alone cannot supply the trace elements which are deficient over considerable areas of the world. Australian agriculture would largely collapse without fertilizers.

The advocates of organic farming state that the full benefits of composting, the four-year ley and grazing as fertilizing agents are not achieved by orthodox farming, since the manure from livestock fed on concentrates will be deficient in certain essential minerals. There is no evidence to support this generalization, always provided that there is intelligent balancing of fertilizers and farmyard manure, and that the soil is not intrinsically deficient in some minerals.

Regarding the effect on protein and the free amino-acids, there is no evidence that the application of fertilizers has any adverse effect on total amino-acid content. Man consumes a variety of proteins of both vegetable and animal origin and the essential amino-acid requirements are generally met. This may also be said for non-ruminant farm stock; in the case of the bird, special care has to be exercised so that all critical amino-acid requirements are covered. The ruminant is well protected against amino-acid deficiency owing to the microbial activity in the fore-stomach.

The genetic stability of plants is generally of greater significance than climate, soil or fertilizer treatments in respect of vitamin content.

The increased use of fertilizers has not affected adversely the general decline in infant mortality or the increase in the expectation of life of man. The best health conditions which can be observed are compatible with the general consumption of foods grown on chemically manured soil. The health statistics of the Netherlands are as good as those of Great Britain, although the fertilizer consumption of the former is five times the latter per unit of agricultural land. Again, the United Kingdom health statistics are as good as those of Eire, while the corresponding ratio of fertilizer consumption is about 3 to 1.

The belief that the improvement in grassland culture has led to an increase in the so-called metabolic diseases of cattle has not been proved.

Until proof has been obtained that the heavy application of fertilizers may give rise to disease in man or beast, the use of fertilizers as practised in orthodox farming is to be recommended as a means of increasing food production in Great Britain.

Sir James Scott Watson (Ministry of Agriculture) dealt with the maintenance of soil fertility in the future. Our present knowledge is in part the result of farming experience built up over some eight thousand years, and in part the product of scientific investigation during recent times; and Sir James discussed some of the problems of reconciling science and tradition. The list of essential plant nutrients is now probably complete; the chemist can produce a solution of pure salts, in distilled water, that will

support normal plant growth, and we have no evidence that the plant products when fed to experimental animals are in any way deficient in nutrient properties. Plant growth, however, depends not only on nutrients but also on a reasonably constant supply of water, and root activity demands a supply of oxygen and is inhibited by a relatively low concentration of carbon dioxide. These requirements imply the maintenance of crumb structure, and loss of this structure is one of the major causes of erosion by wind and water.

The maintenance of good structure depends on several factors. One of these is tillage at the right time when the soil has an appropriate moisture content and when frost and thaw can play their part. Another is the nature of the soil minerals; sandy soils can be improved by applying clay and marl or vice versa. Yet another is the provision of a mild binding agent, and the natural one consists of the colloidal decomposition products of organic matter. The organic matter may be partially decayed as in farmyard manure and composts, or it may be undecayed; and in the latter case the rate of decomposition depends in the main on the ratio of carbon to nitrogen compounds. More research is required on the balance between the grass and clover components of pasture and on management. The practice of growing crops specially for 'green manuring' also deserves further study, and probably the most promising are quick-growing grasses with very heavy seedings and high applications of fertilizers. Sewage sludge, preferably composted with straw, is a useful source of organic matter but is costly to transport and handle. Certain synthetic plastics have recently been shown to be effective in stabilizing an existing crumb structure, but the immediate obstacle to their general use is their high cost.

GEOLOGICAL SURVEY BORING IN GREAT BRITAIN

AT a meeting of the Geological Society on July 1, Dr. W. J. Pugh, director of the Geological Survey of Great Britain, gave a brief account of the investigations by boring carried out within the past year by the Geological Survey.

Proposals for a programme of Survey boring were made in 1945 by a Committee of the Advisory Council of the Department of Scientific and Industrial Research; and since then several deep boreholes have been drilled as the work of the field staff and the availability of funds have permitted.

Summary accounts of the results obtained from four of these boreholes, one in Needwood Forest (Staffs), one at Whittington Heath (Staffs)¹, one at Stowell Park (Glos) and one at Rashiehill (Stirling), have been published or are in the press. From four other holes, one of them not yet completed, important information has been obtained; and Dr. Pugh gave an outline of the results so far to hand and referred to the deductions to be drawn from them.

Ashton Park. In the Bristol and Somerset Coalfield the strata between the Carboniferous Limestone Series and the Coal Measures are masked by Triassic deposits at the surface and had not been adequately seen either underground or during boring operations. In order satisfactorily to elucidate the structure of the field, the geological survey of which has been recently completed on the scale of 6 inches to the