

to control caterpillars. Menazon, a systemic insecticide, applied at 0.25 per cent, gave excellent control.

Mr. C. O. R. Everard assessed the rodent problem on cocoa in West Africa. Most losses were of pods from the trees rather than during drying or in storage. Under conditions of good husbandry pod losses should not normally exceed 3 per cent. The use of the most efficient traps available would be unlikely to reduce losses appreciably, and probably the best means of protection lies in the use of relatively non-toxic repellents applied directly to the pods.

The working session on the final day of the conference concerned itself mainly with plans for the future, and it was agreed that entomologists at present concerned with experiments in mirid control in West Africa would communicate further with the view of developing standardized systems for evaluating candidate insecticides in the field and, if possible, for sharing some of the labour involved in the conduct of tests designed to provide fermented and dried samples of beans for taint and toxic residue tests. An appeal was made to the manufacturers to develop methods which would allow the use of smaller samples in taint tests, and embody greater accuracy. Some problems could not be dealt with on a joint basis, for example, testing candidate insecticides for their effects on popula-

tion-levels of other insect pests. Insects normally of only minor importance have been known to increase to pest status on cocoa following applications of insecticides⁷. While several of the species involved occur throughout West Africa, parasite and predator complexes of some of these have been shown to differ regionally. Population increases resulting from the removal of such biological restraints will vary with the effect of insecticides on the particular species complex concerned.

Delegates to the conference visited the Institute's experimental station at Gambari, twelve miles from Ibadan, where spraying machinery and methods in use in Nigeria were demonstrated and local entomological problems illustrated in the field.

The *Proceedings* of this conference will shortly be available from the Secretary, West African Cocoa Research Institute (Nigeria), P.M.B. 5244, Moor Plantation, Ibadan, Nigeria. P. F. ENTWISTLE

¹ Anon., *Proc. W. Afr. Internat. Cocoa Res. Conf.*, 1953 (1953).

² Anon., *Proc. Cocoa Breeding Conf.*, 1956 (1957).

³ Gerard, B. M., *Nature*, **201**, 353 (1964).

⁴ Dunn, J. A., *Nature*, **199**, 1207 (1963).

⁵ Wright, H., *Theobroma cacao or Cocoa, its Botany, Cultivation, Chemistry and Diseases* (Colombo, Messrs. Ferguson, 1907).

⁶ Cunningham, R. K., and Lamb, J., *Nature*, **182**, 119 (1958).

⁷ Entwistle, P. F., Johnson, C. G., and Dunn, E., *Nature*, **184**, 2040 (1959).

SOIL-PLANT-ANIMAL COMPLEX

A MEETING of the Nutrition Society was held in the University of Reading on July 17 under the chairmanship of Prof. R. G. Baskett (National Institute for Research in Dairying, Shinfield). This meeting took the form of a symposium entitled "The Effects of Soils, Fertilizers and Environment on the Yield and Nutrient Content of Plants". In his introductory remarks, the chairman mentioned that the subject of the symposium was something of a departure from the range of subjects normally discussed by the Nutrition Society, but it was clear from the reactions of members and guests throughout the meeting that they considered it entirely appropriate that nutritionists should concern themselves with problems of food production.

The first paper of the day was one by Prof. J. N. Black (Edinburgh) on "The Ultimate Limits of Crop Production". He began by reviewing the major factors limiting the yield of plants which have been emphasized in the past—soil fertility, including nutrient status, temperature, water supply, pests and disease and the genetic make-up of the plant. He continued by asking the question "If it were possible to remove all the factors acting to maintain yields at a low level, what would then determine yield and what might the yield then be?". The significance of this question lies in the fact that, if answered, it would provide a yardstick with which to measure the efficiency of an agricultural system and the rate of progress of improvements in technique. Recent work on the efficiency of the photosynthetic process was then discussed, culminating in the conclusion that, in the absence of other limiting factors, the productivity of crop plants is determined by the amount of solar radiation available. The complex interrelationship between solar energy, leaf area index (the ratio of leaf area to ground area) and crop-growth rate and ultimate yield was emphasized, and the necessity for interpreting the results of field trials, involving fertilizer and other treatments, in the light of these relationships was stressed.

In his paper on irrigation as a factor in increasing food production, Dr. H. Olivier (Sir Alexander Gibb and Partners) surveyed the history of irrigation practices from pre-historic times up to the present day, followed by a critical assessment of the potential increase in food production in selected countries and regions in relation to their land and water resources.

The vital role of increased irrigation in increasing crop production in arid and semi-arid countries was emphasized. Nevertheless, doubt was expressed as to whether present nutritional standards could be maintained in many of these countries if the present-day population forecasts turn out to be correct, even if potentially irrigable land and water supplies are fully exploited. The considerable value of supplemental irrigation for increasing crop production in countries such as the United States and Western European countries, including the United Kingdom, is much less generally recognized and it is a technique which no country in the humid zone can afford to neglect.

Dr. Olivier ended his paper by considering the present outlook for food production and concluded that no reliable estimate of world potential was possible at present owing to a lack of basic information on such vital matters as potential agricultural land and effective rainfall, particularly in areas where the most serious food shortages occur. He stressed the need for the extension of soil surveys, for the reorganization of meteorological observations to make them more meaningful for agricultural purposes and for the compilation of statistical data on crop yields by region and by soil types.

The relationship between plant nutrient content of soil and leaves and crop yield was discussed by Dr. C. Bould (Long Ashton Research Station). He began by summarizing the present state of knowledge concerning the factors affecting the availability to plants of the inorganic ions in the soil and outlined the difficulties inherent in chemical methods of assessing the nutrient status of soils. A biological method, namely leaf analysis, has been shown to provide a more reliable assessment of plant nutrient availability. It is possible to establish for many species a range of nutrient concentrations at specific stages of growth associated with gross deficiency, marginal supply and sufficiency, based on crop yield. However, it is not yet possible to predict how much fertilizer is required to raise the nutrient status of a crop from deficiency to sufficiency, although this may be possible when more precise information relating soil nutrient status to plant nutrient content is available for different soils and crops.

Prof. A. H. Bunting (University of Reading) read a paper on "Effects of Organic Manures on Soils and Crops"

and presented strong evidence derived in part from the results of more than 100 field trials conducted from the Rothamsted Experimental Station that the effects on crop yield of organic manures based on straw are for the most part produced by the plant nutrients which the manures contain. On soils which tend to compact, strawy manures, but not sewage sludge, increase the yield of crops to a greater extent than can be explained by their content of plant nutrients. This appears, as work at the National Vegetable Research Station, Wellesbourne, and Rothamsted Experimental Station has shown, to be the consequence of a change in the geometry of the soil which prevents it from compacting and increases the volume of larger pores, and consequently the amount of water which can be held at low tension. In ley fertility experiments, the effects of leys on subsequent crops have proved to be largely due to increases in the supply of plant foods rather than to increases in the proportion of water-stable crumbs. Organic matter *per se* does not appear to have any special properties influencing crop yield except on special soils where the effects are shown only by particular types of organic matter. It is now important to concentrate experimental work on these special soils (which are thought to occupy about one-tenth of the arable land of England), using factorial experiments so designed that the effects of nutrients can be measured separately.

The final paper was one by Dr. R. Waite (Hannah Dairy Research Institute, Ayr) on "The Chemical Composition of Grasses in Relation to Agronomical Practice". He emphasized that modern techniques of grassland management have resulted in greatly increased yields of digestible nutrients and presented data from his own experiments carried out at the Hannah Dairy Research Institute on the changes in composition of leafy herbage from several species of grasses during the growing season. The most significant change was in the fructosan : protein ratio, which was high in the early part of the season and low in the autumn. The former type of herbage would be expected to promote a predominantly propionic acid type of rumen fermentation, which would stimulate the production of non-fatty solids in the milk of cows and

promote fattening in beef animals. Herbage low in soluble carbohydrates, on the other hand, would encourage an acetic acid type of fermentation in the rumen and the resulting mixture of volatile fatty acids would be used more efficiently for butter-fat than for solids-not-fat production or for fattening. Herein may well lie the superiority commonly attributed to spring compared with autumn grass for fattening and milking animals.

The symposium ended with a summing-up by Prof. P. W. Arnold (University of Newcastle upon Tyne), who high-lighted the major themes from the various papers and directed attention to some of the important gaps in our knowledge of the way in which plants interact with their environment.

The majority of papers read at this meeting were mainly concerned with the quantitative aspect of the production of plant foods and, indeed, this aspect covers a vast range of problems. The qualitative aspect of the influence of the environment on plants for human and animal consumption is of at least equal interest to nutritionists and might well provide the subject for another symposium.

The re-statement at this meeting of the fundamental dependence of the animal kingdom on the plant was most salutary, and a reminder of the rate at which the total food requirements of the human population of the globe are increasing can never be given too often. It is clear, however, that basic information on the methods by which the production of plant foods can be increased by the use of fertilizers, by growing improved varieties of crops, by irrigation and by better husbandry is freely available. The application of this knowledge is largely a problem of administration, education, finance, power supply, engineering and industrial production, and the avoidance of famine in the latter quarter of this century depends on its solution. The outlook is not wholly depressing, for it has been estimated that by the adoption of improved agricultural techniques, including the more efficient use of water, it would be possible to double the present yield from each acre of land at present under cultivation.

T. G. TAYLOR

SEARCHING FOR CREATIVITY

THE search for creativity—in all its forms—would seem to be commendable and, indeed, of supreme importance for the future of man, yet, reviewing progress so far achieved, P. E. Vernon can rate it no higher than the "latest fashion in American educational psychology"¹. Those who have interested themselves in the problem have been moved by the impression that the whole educational system fosters conformist attitudes among pupils and students, which gain further support from present-day intelligence and aptitude tests. Prof. Vernon doubts if these strictures necessarily apply to the selective tests of pupils in England and Wales at 11+ and 18+.

He refers to the work of Calvin Taylor, who, on the basis of a number of investigations, including some carried out on industrial and Air Force scientists, maintains that in adult life there is little association between productivity and originality, and previous educational achievement; in fact, the correlations between the results of tests for creativity on one hand, and intelligence on the other, are not greater than 0.2–0.4.

In this context, Prof. Vernon thinks that L. M. Terman's long-term follow-up of a group of children of high intelligence quotient merits attention, both because the test used—Stanford-Binet—was a good one, and because the scores obtained in tests in early youth have been compared with later achievement over the best part of a life-time. As a whole, the group has been very productive in the

arts and sciences, although scarcely any member could be characterized as a genius. Here, intelligence is of some relevance, as it is in the findings of Terman and C. M. Cox that, from their biographies, few men in history of outstanding ability had an intelligence quotient below 120; while D. W. Mackinnon's results suggest that above a certain minimum figure, about 120, intelligence quotient plays a relatively minor part in creativity.

J. P. Guilford has carried out a long series of investigations of high-grade adults, and claims to have identified about 60 separate factors concerned with mental ability. Prof. Vernon questions the validity of these factors, partly because they have not received full confirmation from other workers but chiefly because he considers that in itself factorial analysis of mental quality cannot produce the answers unless the factors correspond with what is recognized as 'originality' in daily life.

Another series of tests, similar to Guilford's, has been applied by J. W. Getzels and P. W. Jackson, this time on young high-school pupils. In their case, one group in the top 20 per cent on creativity tests, but not of outstanding intelligence quotient, were compared with another group from the top 20 per cent for intelligence but not of outstanding originality. In scholastic achievement both groups did about equally well; but since, as Vernon points out, the intelligence quotient of the group of high creativity