

pipes, and a 500-ft. length of buried pipe carrying natural gas is now being observed under actual operating conditions.

Satisfactory progress is also reported in the high-way research programme. The co-operative cloud physics and hail research programme is now in its fourth year, and the results should indicate whether Alberta hail is generally similar to that studied in Europe or whether there are significant differences in structure. The special weather-radar continues to give much information on the cloud systems moving

through the area, and a meso-network of some thirty microbarographs has now been arranged at intervals of about 10 miles. Preliminary results from the study of nucleation represent a major advance in the basic approach to the hail problem, and following the study of nucleation commenced last year at McGill University, the work was continued during the summer with the project group at Penhold, where a method of determining the amount of 'freezing nuclei' in rain-water, or water obtained from melted hailstones, was applied.

## ROTHAMSTED EXPERIMENTAL STATION

F. C. BAWDEN, whose style of writing could profitably be copied by directors of other research institutes, states in his annual report for 1959 of the Rothamsted Experimental Station\* that the ultimate aim of agricultural research must be to increase the efficiency of agriculture by lowering unit costs of production and improving the quality of the produce. The very wide range of activities described in this report offers scope for assessing the contribution of Rothamsted towards this goal. Whether this aim will be better served by the empirical approach of much of the work reported, or by the establishment of general principles formulated on research of a more fundamental nature, is obviously a question which must exercise the mind of any good scientific leader. Perhaps the best compromise is to encourage developments along both lines, the correct allocation of resources depending on many factors.

There is no question that the work on the use of fertilizers, irrigation, and the control of weeds, pests and diseases has the immediate practical aim of increasing agricultural efficiency; but there is plenty of evidence throughout this report of more academic inquiries covering such varied matters as the underground activities of organisms as diverse as slugs, earthworms, fungi, nitrogen-fixing bacteria and an eel-worm that transmits a soil-borne virus; the internal structure of viruses and the relative infectivity of intact virus particles and their separated nucleic acids; the activities of enzymes in insects, bacteria and leaves; the biology of weeds and the relation between the potassium supply of soils and the nature of the clay minerals.

In the Chemistry Department, where work on fertilizers has always loomed large and has been responsible in no small measure for the present high efficiency of arable crop production in Great Britain, much basic work is now proceeding on soil organic matter, nitrogen, phosphorus and potassium. It might fairly be said that soil fertility studies at Rothamsted have suffered in the past from the 'NPK' (nitrogen-phosphorus-potassium) complex; but attention is now being directed towards other elements such as magnesium and molybdenum. Judged by the increasing incidence of hypomagnesaemia in farm animals, this interest is timely or even late, and if the work on micronutrients merely indicates that deficiencies of such elements are likely to be rare in Britain, it will serve its purpose.

Biochemistry increasingly emerges as the central discipline in agricultural research; and its impact can be seen in many departments ranging through soil chemistry, botany, pathology, insecticides and fungicides. In the Biochemistry Department itself, work is concentrated on plant enzyme systems, but there is some collaborative work with the Nematology Department on eel-worm hatching factors. One wonders whether the work on the extraction of protein from leaves has not now served its valuable purpose and should be handed over for large-scale development to industry and governments in countries where malnutrition is still a serious problem.

Russian claims that inoculation of soil with *Azotobacter* increases crop yields have been treated with scepticism in the Western world. None too soon, these reports are being properly investigated by the Soil Microbiology Department, and under some conditions, at present ill-defined, inoculation has increased yields significantly.

One of the dangers when a research station reaches the size of Rothamsted is that each department may work on isolated problems when more progress is likely to be made, particularly in biological research, by inter-departmental co-operation. There is disappointingly little evidence of this collaboration where it might be most valuable, for example, between the Chemistry Department, Pedology Department and the Soil Survey of England and Wales. That such co-operation is possible and fruitful is evidenced by the work of the Macaulay Institute in Scotland. On the other hand, it is pleasing to see the Botany Department is studying the effect of soil-water deficit on plant growth, clearly complementing the work in soil physics, where the study of agricultural meteorology, which has already had a notable effect on the practice of irrigation, is being extended into the field of micro-meteorology.

There is an encouraging sign of collaboration in the report of the Entomology Department. Changes in soil fauna brought about by long-term bare-fallowing are being studied, and at the same time other departments will study changes in soil organic matter, microflora, physical properties, organisms causing crop diseases, nematode populations, and the survival of weed seeds. Perhaps this will be the forerunner of other co-operative work, and for a start one might suggest similar studies when land is put down to grass. After all, grass is still the most important crop of Britain, and unless the Agricultural Research Council objects to duplication of effort, it would be stimulating to see Rothamsted paying more attention to grassland soils and some of the problems of herbage production.

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\* Lawes Agricultural Trust. Report of the Rothamsted Experimental Station for 1959. Pp. 288. (Harpenden: Rothamsted Experimental Station, 1960.) 10s.