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ROTHAMSTED RESEARCH

Report for 1975 - Part 1

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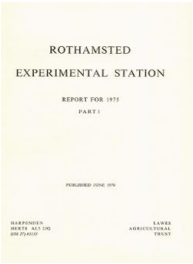
ROTHAMSTED
EXPERIMENTAL STATION

General Report

L. Fowden

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GENERAL REPORT

L. FOWDEN

The year 1975 provided many problems for agricultural practice and research in Britain. The extreme abnormality of the weather pattern meant that little was routine for the arable farmer. Some crop yields and prices were erratic; at the beginning of July Lincolnshire farmers were receiving more for a tonne of early potatoes than for strawberries! The financial climate for research was similarly disturbed, and the year was certainly the most difficult of the past decade. Nevertheless, in the last weeks of the year, the report of our Visiting Group pronounced the Station and its research generally to be in good health.

Staff. The moratorium on filling vacancies, which lasted until the end of March, caused the loss of about 30 established posts.

During the year two Heads of Department left the Station to take up more senior posts elsewhere within the Agricultural Research Service. G. W. Cooke became Chief Scientific Officer at Agricultural Research Council (ARC) Headquarters on 1 March, and J. M. Hirst moved to Bristol as Director of Long Ashton Research Station at the end of July.

G. W. Cooke joined Rothamsted in 1938 as a Ministry of Agriculture postgraduate student. His first experiments concerned the utilisation of phosphate fertilisers by crops, but gradually his interests shifted to emphasise the predominant role of nitrogen as a fertiliser and plant nutrient. He received widespread recognition as an authority on soil chemistry and fertility, and significantly advanced knowledge about the efficiency of fertiliser use by arable crops. He became Head of the Chemistry Department in 1956, and was appointed a Deputy Director of the Station in 1962. His scientific achievements were marked by the award to him of the Royal Agricultural Society of England's (RASE) Research Medal in 1967, the Fellowship of the Royal Society in 1969, and the Foreign Membership of the Lenin All-Union Academy of Agricultural Sciences in 1972. We at Rothamsted hope to maintain close contact with him in his new role at ARC Headquarters.

J. M. Hirst spent 25 years at the Station, joining the staff of the Plant Pathology Department after graduating from Reading University. He made important contributions to knowledge of fungal diseases of agricultural crops, especially in the assessment of aerial spore densities and movement in relation to epidemiology. His important work on potato blight and more recently on cereal diseases is acclaimed internationally. He was appointed Head of Department in 1967, received the RASE Research Medal in 1970 and was elected to Fellowship of the Royal Society in the same year. We look forward to continuing and fruitful collaboration with him as Director of a sister Institute.

Olive Coleman and H. A. Smith retired during the year after lifetime service to the Station. Mrs. Coleman joined Rothamsted's administration from school in 1932 at a weekly wage of 15 shillings (75p). In the intervening years she accepted major responsibility for the payment of salaries and wages, meticulously handling many millions of £ sterling and answering queries with quiet confidence and understanding. Smith had served the Chemistry Department for even longer (beginning in 1929), helping to provide a reliable service of element analysis in soils and plants for scientists of many departments. Others retiring after long and valuable service included Mrs. V. A. Roberts (Statistics, 32 years), G. C. Dibley (Entomology, 25 years), F. W. Ellingham (Stores, 24 years), H. Goodenough (Gardener, 17 years) and G. F. Jarvis (Field Experiments Section, 17 years).

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I. J. Graham-Bryce (Head of Insecticides and Fungicides Department) was appointed a Deputy Director with effect from 1 July.

To foster further the Station's collaboration with the Agricultural Development and Advisory Service (ADAS), Mr. H. Kingham, Regional Development Officer of the ADAS Eastern Region, Cambridge, now visits the Station regularly and serves as our direct link with the ADAS organisation and their work. Another innovation is the appointment of part-time Scientific Information Officers (P. H. Needham and J. Ashworth), whose role is to present effectively the Station's research achievements to the broadest public.

Three appointments to Headships of Departments were made having effective dates during 1976. Mr. E. Lester will become Head of Plant Pathology in February: at present he is Assistant Secretary in charge of the Plant and Soils Research Division at ARC Headquarters. T. Lewis is promoted to succeed C. G. Butler as Head of Entomology in April, and Dr. T. Woodhead (at present Reader in the Applied Physics Department of Strathclyde University) will fill the vacancy as Head of Physics in July.

The untimely death of R. W. M. Wedderburn in June saddened his many friends at the Station. During his few years at Rothamsted, Wedderburn had developed as an outstanding younger member of the Statistics Department.

Honours and awards. G. W. Cooke was honoured by being made a Commander of the Order of the British Empire, and E. Church became a Member of the Order in the Queen's Birthday Honours 1975. F. W. Ellingham was awarded the British Empire Medal in the New Year's Honours 1976.

M. Elliott received the Burdick and Jackson International Award for Research in Pesticide Chemistry for 1975 presented by the Division of Pesticide Chemistry of the American Chemical Society to mark his highly successful work on potent pyrethroid insecticides.

N. W. (Bill) Pirie became the first scientist to be awarded the Rank Prize for Nutrition and Crop Husbandry. The prize recognises his outstanding contributions over 25 years to the development of a successful process for bulk extraction of protein from plant materials. Characteristically, Pirie intends to use the entire £15 000 prize to support his future research.

Buildings. The new entrance road to the Station was completed in the spring and the nearby extension to the Statistics Department was almost ready for use at the end of the year. Rothamsted also was fortunate to receive funding for a new large laboratory block, the South Building, started in September. When completed, the Building will provide integrated accommodation for the different parts of the Entomology Department, and well-designed, unified facilities for the presently fragmented Molecular Structures Department.

Visiting Group. The Station received an ARC Visiting Group, the first since 1966. To cover adequately the broad scope of our research programme, the visit was organised as five Sub-Groups with Dr. C. C. Webster as Co-ordinating Chairman. The Group spent a total of 15 days with us. Under the new system whereby the Joint Consultative Organisation (JCO) reviews research programmes and policy and the Ministry of Agriculture, Fisheries and Food (MAFF) commissions a little more than half the total research effort of ARC-funded Institutes, Visiting Groups are required only to assess the effectiveness with which an Institute generally and its scientists individually are attaining the objectives of the agreed research programme. However, this task cannot be easily

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achieved without some consideration of the overall content of the Institute's programme, and senior staff at Rothamsted have some regret that the brief now given to a Visiting Group, whose corporate expertise is very considerable, provides little opportunity for its members to make positive suggestions about the future research programme. Nevertheless, the Group's visit was stimulating and rewarding, and the Report generally was a helpful and constructive document. Much time was spent discussing the organisation and prosecution of inter-disciplinary research, especially the present and future development at Rothamsted of inter-departmental projects concerned with soil structure, the chemistry of behaviour controlling compounds, host plant-fungal pathogen relationships, and new large-scale field experiments.

The Group suggested that the Station's effort in soils research, largely centred on the Chemistry and Pedology Departments, might be strengthened by amalgamating the two departments. The recommendation has been accepted in principle, and action is being taken to appoint a suitable Head for the combined departments. The need for continuing close association of the new department with the Soil Survey is clearly recognised.

Subject Days. This year Subject Days held in early June presented multi-disciplinary aspects of the Station's work on 'Nitrogen'. More than 150 people attended on each of three days. Our visitors included scientists, advisers and administrators from the public, university and commercial sectors of agricultural research, farmers, press, and the scientific attachés of several overseas countries. We were especially pleased to welcome Lord De Ramsey, Treasurer, and other members of our governing body, the Lawes Agricultural Trust Committee, Dr. W. M. (now Sir William) Henderson, Secretary of ARC, Sir Alan Neale, Permanent Secretary, and Dr. H. C. Pereira, Chief Scientist, of MAFF, Mr. P. R. Odgers, Deputy Secretary at the Department of Education and Science, and Lord Walston. Exhibits were grouped to illustrate the following main themes: nitrogen requirements in present day agriculture, the nitrogen cycle, nitrogen fertilising and plant response, the effects of previous cropping and nitrogen fertilising, and the relation of nitrogen status to diseases, pests, soil animals and weeds. Visits to field experiments concerned with these topics were included in the programme. Research seeking to enhance the efficiency of nitrogen utilisation attracted great interest, especially studies on biological nitrogen fixation including the use of *Rhizobium* inoculants for forage and grain legume crops and the use of carbon disulphide as an inhibitor of nitrification processes in soils after injection of aqueous ammonia. A booklet summarising work presented at the Subject Days is available from the Station's Librarian (price £1).

Visits and visitors. Once again the Station received several thousand visitors during the year ranging from individual scientists seeking specialised discussions in particular departments to large parties of school or college students or lay people wishing to learn generally about our research programme and objectives. A. C. Pattison, of the Field Experiments Section, who assumes a major responsibility for organising these visits, has produced four short films portraying the origins and development of Rothamsted and aspects of our present-day work. Many overseas visitors joined the Station as Visiting Workers, usually for a period of a few months to one year, but a few are here for longer periods to enable them to study for University higher degrees. Frequently, Visiting Workers are supported by Fellowships provided by the Food and Agriculture Organization (FAO) of the United Nations or the International Atomic Energy Agency (IAEA), or under various scholarship schemes administered by the British Council. We welcome such visitors realising that they often have a different viewpoint on problems, and thereby bring new ideas and colour to the life and work of the Station.

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This year we were especially pleased to welcome on separate occasions Sir Frederick Stewart, Chairman, and Dr. W. R. Boon, an independent member, of the Advisory Board of Research Councils. We also had the opportunity to show Mr. R. B. M. (now Sir Richard) King, Permanent Secretary of the Ministry of Overseas Development (ODM) and his wife some examples of research concerned with problems of tropical or sub-tropical agriculture supported by grants from ODM. Mr. E. S. Carter visited us in July shortly after his appointment as Deputy Director General of ADAS. Overseas guests included Dr. N. Giosan, President (Speaker) of the Romanian Grand National Assembly, Dr. L. K. Opeke, Secretary of the Association for Advancement of Agricultural Sciences in Africa (Headquarters, Addis Ababa), the Hon. Ira D. Auvergne, Minister of Agriculture and Lands, St. Lucia, and the Hon. Michael Douglas, Minister of Agriculture, Lands, Fisheries and Co-operatives, Dominica. Groups of foreign scientists received included a Russian delegation led by Mr. A. A. Koniguin, Chief of the External Relations Department of the USSR Ministry of Agriculture, visiting Britain under the terms of the agreement on Anglo-Soviet Cooperation in Agricultural Research, and about 20 Austrian Government fertiliser advisers accompanied by Professor Otto Steinbeck, Director of the Institute of Plant Nutrition, University of Vienna.

Rothamsted staff again travelled extensively as advisers or consultants, especially under secondments to FAO or ODM. R. Bardner and J. M. Day returned after periods of one to two years in Kenya and Brazil associated with research developments supported by ODM, whilst P. Walker began a two-year secondment to the International Centre for Maize and Wheat Improvement in Mexico (CIMMYT), as a biometrics consultant. J. B. Free and Ingrid H. Williams both spent one month at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, working on problems of pollination of tropical legumes, especially pigeon pea. Free also visited Iran on behalf of FAO to give advice on bee-keeping, whilst K. A. Lord visited the same country as a consultant to an FAO-supported programme on pesticide residue monitoring. A. J. Arnold and P. S. Nutman spent short periods in the Caribbean, the former visiting Jamaica for testing a coconut pollen extraction and processing system designed and constructed at Rothamsted, and the latter going to Trinidad as a consultant to an ODM-sponsored project at the University of the West Indies seeking more effective *Rhizobium* strains for nodulation and nitrogen fixation in local cultivars of pigeon pea. J. A. Nelder, J. C. Gower and B. M. Church of the Statistics Department spent different periods in Australia at the invitation of CSIRO, where the Genstat programme is being introduced into the mathematical Divisions. D. S. Hayman returned in December after spending a year in Australia and New Zealand devoted to collaborative work on mycorrhizal endophytes in relation to phosphate uptake by plants. L. Fowden visited China in July as a member of a delegation of agricultural and biological scientists under the terms of the Royal Society—Academia Sinica Exchange Agreement, and travelled widely within the country visiting biological institutes of the Academy and the University of Peking, agricultural research institutes in several provinces, and selected communes. He also visited centres of scientific and agricultural research in the Arab Republic of Egypt at the invitation of the Egyptian Academy of Sciences, coupled with visits to the University of Khartoum and the Gezira Research Station, Sudan, returning to attend the annual meeting of the British Association for the Advancement of Science as President of Section K (Botany).

Many staff travelled overseas to meetings and international congresses; attendance at small conferences and working parties organised by the International Organization for Biological Control's European Section or the European and Mediterranean Plant Protection Organization is becoming an increasingly important aspect of the overseas visits programme.

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1975: An abnormal year for weather and crops. Autumn 1974 was exceptionally wet, and rainfall continued to be higher than average for all months between January and May 1975, except February. Sunshine also was less than average over the period January to May, so an unusually mild winter was followed by a cool spring, in which the soil remained at field water capacity until the last week in May. Harvesting, particularly of potatoes and sugar beet in autumn 1974, was seriously delayed by the extremely wet conditions, and the cultivations necessary for winter cereals for 1975 harvest were often done under very bad conditions, many experiments being drilled into poor seedbeds. Similarly, the wet soil conditions prevailing in spring seriously delayed the sowing of barley and sugar beet, which was not finally completed until the second half of April. The early-sown cereals, by then emerging, were suffering from waterlogging and cool conditions, whilst the growth of April-sown crops was to suffer from the drought of the later months. During June, July and August rainfall was only one-third of normal, and these months were the driest at Rothamsted since 1921. Sunshine totals were much above average for these three months, and continued above normal until the end of November. The summer was hot, the mean daily maximum temperature for August being almost 25°C, 4·5° above average. Water loss by evaporation and transpiration was particularly large and by the end of August the potential soil water deficit had risen to 280 mm. In contrast to 1974, the harvesting of the 1975 crops presented few problems and was completed relatively early, the subsequent autumn cultivations and sowings being done under almost ideal conditions.

The unfavourable conditions at sowing and the exceptionally dry summer adversely affected the yields of spring barley, potatoes and sugar beet. Potatoes not receiving irrigation gave yields little more than half of those obtained from irrigated experiments; even with irrigation yields at Rothamsted were much less than in previous years. The few crops of beet in England receiving irrigation took full advantage of the summer sunshine and warmth and made good growth, but deficiency of water severely restricted most crops and contributed to the below average national yield. At Rothamsted, spring beans were another crop that suffered from drought, and yield was further impaired by splitting of pods before harvest or shattering on first contact with the harvester, resulting in much shed seed. However, winter wheats and oats whose sowing had not been unduly delayed yielded quite well; presumably they had rooted sufficiently deeply to avoid excessive water stress. Spring-sown lupins (*Lupinus albus* var. Kievsky) also grew satisfactorily, perhaps because the summer was abnormally hot and dry. Undoubtedly for most spring-sown crops, climatic factors were more important than major pathogens in influencing crop physiology and yield.

Crop diseases and pests. Our scientists not only maintain a watching brief on the familiar pests and diseases affecting Britain's major arable crops, but also monitor 'new' crops grown under conditions likely to increase pest infestation and disease to gain information about future hazards to plant health, and methods for control.

Fungal pathogens. In recent years the foliage of beet crops has been subject to light and late infection by powdery mildew (*Erysiphe betae*), but in 1975 crops almost throughout the country became heavily infected; leaves were covered with resting spores (cleistothecia), a situation new to Britain. Inoculum for infection of future crops must now be widespread, and the disease could easily reappear if summer weather conditions favouring the pathogen were soon to recur—a somewhat unlikely possibility.

The search for new sources of vegetable oil, protein and fodder has led to more extensive cultivation of oilseed rape, grain lupins and forage maize. Whilst new crops often enjoy a period during which little disease develops, oilseed rape grown intensively suffered more from leaf diseases (leaf scorch, *Pyrenopeziza brassicae*, and downy mildew,

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Peronospora parasitica) than previously. Lupins grown for the first time at Rothamsted developed powdery mildew, but only very late in the season, and *Fusarium* wilt was also found. Maize remained remarkably free from damaging fungal pathogens, even where grown on the same plot for several years.

Good progress has been made in studies with fungicidal compounds capable of downward translocation in plants, so opening up new possibilities of controlling root and tuber diseases with foliar-applied chemicals. Detailed studies should reveal their mode of action and so provide the basis for further developments in this field where it has been difficult to find fungicides (and insecticides) with appropriate mobilities.

Pests and virus diseases. The winter, the fifth in a mild series, again favoured the survival of many species of insect pest. The peach-potato aphid, *Myzus persicae*, was again numerous in beet areas in July and aphid-transmitted virus yellows disease became prevalent in late summer, although incidence was less than the record levels of 1974. Few winged *M. persicae* were caught in traps during autumn, so there is no immediate threat of yellows virus spreading early in 1976.

Insecticidal sprays generally delayed the onset of yellows infection, but certainly did not contain it. Resistance in *M. persicae* to organophosphorus insecticides is a most worrying factor in crop protection work and has attracted further attention; our recent work has confirmed that such resistance is widespread in field populations on beet. A simple technique for detecting the presence of resistance has been developed and will be field-tested in summer 1976. If successful, the method should be applicable, with little or no modification, to similar determination of possible resistance in aphids infesting potato and cereal crops. At Rothamsted, aphid-transmitted potato virus Y spread rapidly through potato crops and almost all plants in some experiments showed leaf drop streak symptoms by the end of August. More generally, the level of infestation of seed crops in Scotland by the potato aphid appears to be increasing, raising problems of health within seed stock. Cereal aphids were also more prevalent in 1975 and barley yellow dwarf virus was widespread.

The increasing problem of resistance to organophosphorus insecticides has stimulated research and development into alternative possibilities for crop protection. The highly active new pyrethroids with enhanced photostability reported in the past two years are now under commercial development and are being evaluated against many crop pests in field trials throughout the world. Results so far have confirmed the early promise of these compounds, especially 'NRDC 143' (permethrin).

Insecticidal sprays can be most effective when sensitive monitoring systems are available to give timely warning of probable infestations. Our research has progressed rapidly towards the development of a monitoring system for the pea moth based on the use of potent sex attractants as 'bait' for male moths; work has been conducted on the optimum design of traps and their placement within the crop. This project has provided valuable experience in the use of behaviour controlling chemicals in monitoring and may serve as a model for the development of similar systems for other pests.

A specialised approach to the control of virus spread in potatoes is attracting attention. Insect-trapping hairs are present on the leaf surfaces of certain wild potato species and have been transferred to hybrids with the cultivated potato. The potential for control has been demonstrated in the glasshouse where the foliage hairs of the hybrid effectively prevent aphid movement.

Two aphid-borne viruses were found on lupins. The first, bean yellow mosaic (BYMV), has been reported in lupin crops from many countries, and was observed in field experiments with the crop in England in 1974; the other virus was almost certainly clover yellow vein (CYVV), which has not been identified before in lupins. Aldicarb added to

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the seedbed increased grain yields, possibly by reducing virus incidence and by restricting direct damage by *Sitona*.

Direct drilling and the soil fauna. The practice of directly drilling crops without cultivation is expanding very rapidly, in response to improved equipment and high fuel costs. This technique greatly changes pest problems and brings the role of soil animals in maintaining fertility into a new perspective. The Entomology and Nematology Departments have been studying these problems since the introduction of direct-drilling in 1963. Contrary to expectations, not all pests are encouraged by lack of cultivation. Slugs are much more serious in direct-drilled crops and to a lesser extent so are wireworms. However, attacks by stem-boring fly larvae and leatherjackets have tended to be less in direct-drilled than in conventionally cultivated crops, whilst nematode populations are little changed. Earthworms, whose numbers are increased, have proved to be extremely important in maintaining soil structure under a regime of continuous direct-drilling.

Weed beet. In the past season, a few fields of sugar beet have contained large numbers of wild annual beets, that are indistinguishable from the crop at the seedling stage, but soon bolt and produce seed. A source of the wild contaminant has been triploid monogerm seed produced in Mediterranean countries to ensure good germination. The wild annual beet is indigenous there and, in spite of precautions, contamination occurred equivalent to a few plants per hectare. Modern methods of sowing the root crop, with dependence on herbicides rather than hand labour, have allowed the weed to establish. If this problem is to be contained, it is now extremely important that seed should be checked thoroughly for possible contamination by wild beet before supplying to growers. Regrettably, some beet soils are now contaminated with wild seed, and this will continue to germinate over several years: an extensive research effort is being mounted to suggest solutions to this problem.

Soils research. We study soils by many different techniques seeking information about the nature and properties of soils *per se*, and their role as the matrix and source of nutrients for plant growth.

Cooperative work on soil structure. The Departments of Chemistry, Pedology, Physics, Soil Microbiology and the Soil Survey are involved in a joint study of aspects of soil structure. The following measurements are made: determination of pF curves (soil water retention), coarse porosity by thin section and 'Quantimet' examination, porosity and gaseous diffusion within the crumbs, pore-size distribution of the fine pore-space, structural stability by ultrasonic dispersion, stability of crumbs and strength of soils by empirical methods, and microbiological characteristics. The study is essentially comparative and determinations are made on pairs of soils having similar textures and general profile descriptions but where one is 'easy' and the other 'difficult' to manage under field conditions. In addition to assessing diverse physical properties of the soils, we hope to be able to define methods more useful in characterising soils with difficult physical properties and so explain the reasons for them being 'difficult'.

Soil nutrients and crop growth. Much of our work on the availability of soil nutrients to plants still centres on three principal elements—nitrogen, phosphorus and potassium. We seek to relate basic knowledge of the physical, chemical and metabolic processes in soils with measurements of nutrient availability to and absorption by plants. Three distinct approaches to this general theme are reported.

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Nitrogen. Interconversion rates of the various forms of nitrogen in soils have a pronounced effect on the efficiency with which the element is utilised by plants. A major source of nitrogen loss is the leaching of nitrate from soil and for this reason considerable effort is devoted to field methods of limiting the rate of oxidative conversion of ammonia to nitrate (nitrification). 'N-Serve' is a relatively expensive, commercial nitrification inhibitor, which we have compared with carbon disulphide (CS_2), itself identified as an effective inhibitor in our previous experiments. The two inhibitors have been tested in field experiments, being injected simultaneously with aqueous ammonia under grassland in November. CS_2 appeared to be somewhat more effective than 'N-Serve' in inhibiting nitrification in both Rothamsted and Woburn soils, and both inhibitors increased yields and %N in the first cut of grass at Rothamsted. They were less effective on the light Woburn soil, perhaps because the cation exchange capacity is lower and so less ammonium ion was retained: an alternative possibility is that the inhibitors were lost more rapidly from the injection zone in the Woburn soil. Further experiments are in progress to assess the value of CS_2 when used with aqueous ammonia for other crops, including potatoes.

Phosphorus. Experiments at Woburn designed to relate the yields of potatoes, barley and sugar beet to the amounts of soluble phosphorus in soils on two sites with contrasting histories of previous cropping and manuring are reported in Part 2. Yields of the crops were always larger on a soil containing residues of organic manures than on an old arable soil. The crops responded to additional superphosphate on the soil containing the most organic matter even when soluble phosphorus levels were very high. These experiments show that the previous history of a site is sometimes more important than the experimental treatments applied and illustrate the difficulties of relating crop yields unambiguously to soil analyses even on the same farm. Clearly, there is still much that we do not understand about the processes within soils governing phosphorus availability.

Potassium. Previous kinetic measurements of the exchange of K^+ indicated that soil potassium could be divided into three sources which released the nutrient to the soil solution at different rates (*Rothamsted Report for 1972*, Part 1, 35). When measurements of total soil potassium and the particle size distribution of the clay and fine silt fractions of a soil are assessed in relation to this kinetic data, mathematical analysis permits estimation of the amounts of potassium associated with each source and the apparent diffusion coefficients of K^+ from them; it is then possible to derive all the data necessary to predict the maximum amounts of potassium available from each source to crops growing on different soils.

New soil maps. The Soil Survey of England and Wales has published a map of soils at a scale of 1:1 million. For each of 71 map units, the legend lists: dominant and associated or co-dominant soil groups; soil parent materials and/or substrata described in geological terms; agriculturally-important soil properties including texture, effective depth and water regime; relief as ranges of slope and elevation; and the main land use, from agricultural census data. Each delineation is numbered and coloured according to the main soil group.

The overall pattern of land use for agriculture in England and Wales is related to broad climatic and altitudinal zones but it also reflects the more local influence of soil type on choices of management system and crops. The map identifies the soil physical factors influencing land use, and allows discussion of agriculture and regional and national planning in relation to our national soil resources. It should help the exchange of ideas with geologists, ecologists, geomorphologists and hydrologists and have a useful role in teaching at schools, agricultural colleges and universities.

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The British National Committee for Geography has chosen the 1:1 million soil map for inclusion in the British contribution to the exhibition in connection with the International Geographical Congress in Moscow in 1976. It will be accompanied by a 1:63 360 scale map of predicted underdrainage treatment for arable land use of an area in Oxfordshire, and maps at a scale of 1:10 560 of the soils of an area in Cambridgeshire compiled on an airphoto base. These are both new developments in the Soil Survey's programme.

Computing. A most important event of the year was the completion of negotiations for an ICL System 4-72 to be added to the present 4-70 system. The equipment on order will include a high speed data exchange link between the 4-72 and the 4-70. Sophisticated switches are being provided to enable selected input/output of storage devices to be assigned to, or even shared between, the two computer systems. Users will be assigned to one or other of the systems and their demand for an improved multiaccess service will be met in this way. These techniques will also enable users of one system, together with their work, to be transferred in a controlled manner to the other system. In this way, it will be possible to maintain some form of service in the event of a major breakdown in one of the central systems, thus improving the resilience and continuity of the service. To achieve these objectives substantial new system software will be required and the contract stipulates that this will be achieved through a joint ICL/Rothamsted Project. The project team has been assembled and a Manager appointed: resources and schedules have been substantially agreed.

Some Rothamsted staff have been heavily involved in designing and planning the new accommodation for the 4-72. On present schedules, the 4-72 will be delivered by June 1976, and be commissioned before August. The first phase of the dual System 4 service could be in operation before the end of 1976.

Other developments in 1975 include the provision of remote job entry terminals at four external institutes: their equipment has been singly connected into the main processor and full integration of the terminals into the service is imminent. The first full year's processing of the ARC's Project-Costing Scheme has been completed on the 4-70, and the results appear acceptable to institutes within the Agricultural Research Service.

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