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## Report for 1952

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## Introduction

### Sir William G. Ogg

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## INTRODUCTION

By THE DIRECTOR

By the death of Professor F. T. Brooks on 11th March, 1952, the Lawes Trust Committee lost a valued member who, for many years, was intimately connected with Rothamsted. He was appointed to the Committee as a representative of the Royal Society in 1937 and from 1946 until his death was Treasurer. Professor Brooks gave much time and thought to the work of the Station and took a very active interest in the members of the staff.

It is with deep regret that we also record the death of Dr. J. Henderson-Smith, which occurred on 26th November, 1952. He was appointed to the newly-formed Mycology Department in 1919 and became head in 1933 when its name was changed to the Plant Pathology Department; he occupied this position until he retired in 1940.

During the year, Dr. T. Goodey retired from the headship of the Nematology Department but is continuing his work at Rothamsted. He has been succeeded as head of the department by Dr. B. G. Peters. Dr. C. Potter visited East Africa for the Colonial Office at the invitation of the Kenya and Tanganyika Pyrethrum Boards to advise on the problems of the pyrethrum industry, and Dr H. F. Barnes went to Eire at the request of the Department of Agriculture to report on the heavy outbreak of wheat blossom midge and to discuss control measures. Dr. F. M. Roberts and Dr. T. Tinsley, of the Plant Pathology Department, continue their work for the Colonial Office in Zanzibar and the Gold Coast respectively, and Dr. J. Meiklejohn has been seconded for a year to survey and report on problems of soil microbiology in East Africa. Mr. M. J. Way has returned to Rothamsted after two years in Zanzibar where he did valuable work on a pest of coconuts. Under a scheme for the exchange of soil surveyors, Mr. B. W. Avery is spending a year in New Zealand. Dr. G. W. Cooke visited Belgium and the Netherlands to study recent developments in the production and testing of fertilizers. Dr. C. G. Butler was seconded during the winter to the Government of Ceylon, under the Colombo Plan, to advise on the development of bee-keeping. Dr. H. Greene spent a few months on soil work in the British territories in the Far East. Mr. J. A. Pollok resigned from the Soil Survey to take up the post of Director of the New Zealand Fertilizer Manufacturer's Research Association, and Dr. B. N. Singh was appointed head of the Department of Microbiology and Parasitology of the Central Drug Research Institute, Lucknow. Dr. C. B. Williams was elected President of the British Ecological Society.

Rothamsted was represented at the Second International Congress of Biochemistry in Paris, the Third International Congress of Phytopharmacy in Paris and the meetings of the Soil Chemistry and Soil Fertility Commissions of the International Society of Soil Science in Dublin. As a guest of the New York Academy of Sciences, Mr. F. C. Bawden attended a conference in New York on the nomenclature of viruses and rickettsia, and at the invitation of the University of California, Dr. D. M. C. MacEwan attended a conference on clays and clay technology.

#### VISITORS

There were, as usual, many visitors to the Station both from this country and overseas. They included Sir Thomas Dugdale, Minister of Agriculture, Lord Carrington, Joint Parliamentary Secretary to the Ministry and Mr. F. H. Boland, the Irish Ambassador. Among the visitors from overseas were the Ministers of Agriculture from Belgium, Norway, Thailand and Trinidad, the Deputy Minister from Ontario, the Irish Minister for External Affairs and the Speaker of the Bombay Legislative Assembly. Numerous organizations visited the Station; they included the Executive Committee and Plant Quarantine Working Party of the European Plant Protection Organization. An international congress on Insect Populations was held under the auspices of the Comité Européen d'Etudes de Zoologie Agricole, and two courses on field experimentation were provided, one for the British Council, which was attended by many overseas workers, and the other for members of the National Agricultural Advisory Service.

Overseas scientists who spent some time at Rothamsted included Professor H. J. Brodie, of the University of Indiana, who worked in the Plant Pathology Department, Dr. Charles E. Kellogg, head of the United States Soil Survey, Dr. G. Smith of the U.S. Soil Survey, who was studying questions of soil classification, and Professor W. Kubiena from Madrid, the well-known soil scientist, who gave lectures and demonstrations on the microscopic techniques which he has developed for the study of soil morphology.

#### BUILDINGS

The conversion of the Manor House into a Hall of Residence has been completed and has provided accommodation for seven families, rooms for twenty single workers and two guest rooms. Some of the large public rooms are available for lectures and general institutional purposes. The fabric of the older part of the building, part of which dates back to the 13th century, has been carefully preserved. The greater part of the cost was met by the Ministry of Agriculture, but the Station also received encouragement and financial aid from the Pilgrim Trust. The conversion has greatly enhanced the amenities of Rothamsted, and the accommodation is particularly useful for the younger members of staff and temporary workers from overseas.

#### THE WORK OF THE STATION

The soil investigations fall into two groups, one dealing with rock weathering and the formation and classification of soils, and the other with soil fertility. In the Pedology Department the projects include a study of soil minerals and of the effect of organic compounds on their properties; a survey is being made in Lancashire of the occurrence of trace elements in both rocks and soils and of the distribution in certain clayey sedimentary rocks of molybdenum (an excess of which is known to cause the disease known as "teart" in cattle). Further investigations on ill-drained soils has shown the pronounced effect of even simple water extracts of plant materials on the movement of iron and aluminium in the soil profile. The work on certain Gold Coast soils reported in 1951 is about to be published and further investigations have been carried out on

soils from Tanganyika and the Sudan. In connection with a problem of poor sisal growth in Kenya a number of Black Cotton soils have been examined and poor growth has been found to be associated with a heavy black clay.

Investigations on fertilizer placement have been continued by the Chemistry Department. Experiments on potatoes carried out on 33 farms in the past two years gave about one ton per acre greater yield when the fertilizer was placed in contact with the seed or in a sideband than when it was broadcast before planting. The planting was done by machine from the flat. It would appear that two parts of placed fertilizer gave the same average yields as three parts broadcast. It was again noted that heavy dressings of fertilizer applied in actual contact with the seed sometimes checked early growth and on light soils slightly reduced the yields. For commercial machines a planting shoe with double walls on each side to serve as fertilizer coulters would be useful. Preliminary experiments on market garden crops showed some gains from placing fertilizers in sidebands. Further work has been done on "nitrophosphate" fertilizers in co-operation with the National Agricultural Advisory Service, the Northern Ireland Ministry of Agriculture and the Macaulay Institute. Experiments on potatoes and grass have been carried out with these materials prepared in three countries by somewhat different methods and they were found to differ in their effects; observations on the way in which the granules broke down in contact with moisture suggested that this may be due to methods of drying and granulating rather than to the different processes used to dissolve phosphate rock.

Further progress has been made with the problems of forest nurseries. "Partial sterilization" of the soils by formalin especially in old nurseries has again given excellent results. Other materials have also been tried and chloropicrin was found to be very promising. In one nursery with a substantial eelworm population, the numbers were greatly reduced by both these substances. In the past, serious losses of productivity of conifers have occurred in many Forestry Commission nurseries where calcareous seed-covers were commonly used until at our suggestion they were banned in 1947. Further evidence has been obtained that, even in a very acid heathland nursery, repeated applications of calcareous seed-covers are detrimental to Sitka spruce.

There has been much interest during the past year in synthetic soil conditioners and small-scale trials have been conducted at Rothamsted, at a number of farms in eastern England and in a few forest nurseries. These preliminary tests showed little effect on soil structure and no benefit to crop growth. Further work is necessary, however, before conclusions can be drawn.

A paper has been published giving the results of field experiments on liming carried out over a number of years in co-operation with the Advisory Soil Chemists. Various alternative liming materials including Magnesian limestone were used and it was shown that the type of material was unimportant and that, after taking into account the cost of transport and spreading, the ease of incorporation and allowance for subsidy, farmers should select the form which gives the desired neutralizing value at the lowest cost. It was also found

that there is no need to grind limestones more finely than is required to give 40 per cent through a 100-mesh sieve. This was fully as effective as equivalent amounts of burnt lime. Further progress has been made in investigations on soil organic matter and on the availability of manganese to plants. Radioactive phosphorus has been used in some preliminary field experiments to study phosphate fertilizer problems. Previous work on the chemical nature of soil nitrogen, which showed that at least 30-40 per cent. of the organic nitrogen was in the form of protein, was extended by an investigation of the amounts of amino-sugar nitrogen present in various soils. This showed that only 6-10 per cent. of soil nitrogen was in the form of amino sugars. The chemical nature of the rest of the non-protein nitrogen remains obscure. Some of it is in the form of nucleic acids but the major fraction appears to be combined with lignin-like complexes, and no satisfactory methods of investigating the chemical nature of this nitrogen are yet available.

In the Physics Department attention is being given to soil structure and further observations have been made on the effects of grass roots on this and on water movement in the soil. The experiments on deep and shallow ploughing and on irrigation have been continued and, again, substantial increases in yield have been obtained from irrigation particularly on early potatoes and grass. Equipment has been devised and built for the Plant Pathology Department to measure the water vapour of the air around the foliage of growing crops. This will facilitate studies of the atmospheric conditions which have a bearing on the spread of plant diseases. Other work includes investigations on the flocculation of clay minerals and on a method of determining "lime requirements" of soils. Following on the disastrous sea-flooding in February, 1953, gypsum is likely to be used to counteract the bad physical state of some of the heavier land. The correct rates of application can only be worked out from the results of soil tests, but whilst the principle underlying these tests was already known, recent research in the Physics Department has greatly reduced the time and trouble involved. These developments will enable the advisory services to handle many more samples than would otherwise have been possible.

Methods by which the soil's population of micro-organisms can be changed are important not only in soil fertility but also in the control of root diseases. One method is "partial sterilization" and the effects of formalin and of steam treatment on forest nursery soils are being studied in the Soil Microbiology Department. A study is also in progress of the effects of an antibiotic-producing organism (an actinomycete) on a fungus (*Fusarium culmorum*) which attacks plant roots. It appears that the fungus is checked not only by the antibiotic substance but by competition with the actinomycete for nutrients. The work previously reported on the breakdown by bacteria of insecticides, fungicides and herbicides when they reach the soil has been continued and progress has also been made with the study of bacterial activities in ill-drained soils. Investigations on the nodule organisms of leguminous plants continue to be one of the main projects in the department, and work has been done on competition between "virulent" strains capable

of infecting clover roots and " avirulent " strains which are incapable of doing so. This competition may have practical importance and is being further investigated. The influence of secretions from legume roots on the formation of nodules is also being studied and it has been found that the secretions from young seedlings stimulate nodule formation but those from older plants check it. It is not yet known whether this difference is due to the nature of the secretions or to the concentration.

In view of the amount of spraying with insecticides and fungicides which is now done and the introduction of overhead irrigation of crops in some parts of the country, information on the possibility of applying fertilizers in solutions sprayed on the leaves is desirable. Work on this subject by the Botany Department has been continued. In pot culture experiments, it was found that the uptake of any one nutrient from a solution sprayed on the leaves of sugar beet plants was independent of the presence or absence of other nutrients in the solution. It was also shown that nutrient uptake from the soil was affected by uptake through the leaves; plants sprayed with a solution supplying only nitrogen took up more phosphorus and potassium from the soil than plants sprayed with water, and spraying with solutions supplying potassium but no phosphorus increased the absorption of phosphorus by the roots. It was again shown that nutrients applied to the leaves are taken up about twice as efficiently as those applied to the soil. The possibility of increasing the protein content of sugar beet tops by spraying the leaves with a solution of nitrogenous fertilizer was further investigated in a field experiment. Solutions of ammonium nitrate or urea sprayed late in September doubled the yield of protein in the leaves at harvest in October. About 30 per cent. of the nitrogen applied was converted into leaf protein. The percentage of sugar in the roots was slightly reduced but the sugar yield was not significantly changed. As in the pot experiments, solutions sprayed on the ground at the same times were only about half as effective as the solutions sprayed on the leaves. A solution of ammonium nitrate sprayed on a field crop of wheat in May and June produced as great an increase in grain yield as the same amount of nitrogen applied as a top-dressing in April but had a much smaller effect on straw yield. In contrast with the experiments on sugar beet, the spray applications to the leaves were only slightly more effective than applications to the soil made at the same time. In the studies on the biology of wild oats, further work has been done on the effects of organic matter and of cultivation on germination.

In the Plant Pathology Department further work has been done on the spread of virus diseases. Exposing infected leaves to ultraviolet light gave results suggesting that viruses such as cabbage black ringspot, which are most frequently transmitted by aphids that feed only momentarily on infected leaves, occur mostly in the surface layer of cells. In field experiments the benefit of raising sugar beet stecklings in areas remote from other crops susceptible to sugar beet yellows was again demonstrated and the incidence of yellows was also reduced in other areas by raising stecklings in cover crops and by spraying with systemic insecticides. Experiments on cauliflower seedbeds showed that barrier strips of other

plants reduced the incidence of virus diseases and strips of wheat and barley proved the most effective.

Insecticidal sprays were tested for their effects in controlling various virus diseases with varied results. On cruciferous seedbeds they were valueless; on sugar beet they sometimes gave worthwhile results and sometimes did not and on potatoes they greatly reduced the incidence of leaf roll but had less effect on virus Y. Further studies have been made of the effects of fairly high temperature on susceptibility to viruses and it was found that when plants systemically infected with tomato bushy stunt, cucumber mosaic or carnation ringspot viruses were kept at 37° C. this produced seemingly healthy shoots and cuttings from such shoots often gave rise to virus-free plants. Obviously the virus content was much reduced but the treatment was insufficient to free the plants from virus in every case. The electron microscope has proved of great value in virus investigations and techniques for cutting sections have now been developed which enable tobacco mosaic virus to be seen in infected cells.

In the mycology section studies have been made of the spore and pollen content of the atmosphere and it has been shown that certain types of spore which were not supposed to occur in the air to any extent, are in fact often the predominant type. Previously unsuspected variations in the types of spores present in the air at different times of the day were also detected. Further work has been done on wheat diseases and large increases in yield have been obtained by controlling eyespot, take-all and weeds by various methods. On land infested by the eyespot fungus a wheat yield of 49 cwt. per acre, one of the highest recorded at Rothamsted, was obtained by sowing Bersée at 1½ bushels per acre, spraying with sulphuric acid and applying 4 cwt. per acre sulphate of ammonia in March. Decreasing the seed rate from 3 to 1½ bushels reduced lodging and increased the yield; the spraying reduced eyespot and lodging and increased the yield by 11 cwt. per acre.

In the investigations on cereal mildews it has been found that the later the spring crops are sown, the more they are affected and that increasing the growth rate of the crop, for instance by adding nitrogen, also raised the incidence of the disease. Further work was also done on potato blight and on club-root of cruciferous crops.

The main work of the Biochemistry Department has been an examination of a number of enzyme systems in the plant, particularly those that lead to a loss of infectivity in partly purified preparations. A study of this system should throw light on the factors controlling infectivity in the plant and so help in devising means for the direct treatment of plant virus diseases. There is so far no evidence about the nature of the actions involved. Other systems on which work is in progress include those responsible for the breakdown of nucleic acid and for the oxidation of a number of plant constituents such as amines, tryptophan, phenyl acetaldehyde, indoleacetic acid, and manganese. Many of these systems interact and the study of each throws light on the mechanism of the others. Another investigation is on the rôle that resistant parts of fungal mycelia may play in the building up of soil organic matter, and factors affecting the decomposition of the mycelium have been

studied. Amongst these is the use of mycelium as food by other organisms in the soil and in this connection the relationship between breakdown of the mycelium and the activities of the varied population of the soil is of interest. It has been shown, for example, that some nematodes causing plant diseases are able to break down fungal constituents as well as cellulose. In this work, too, it is becoming apparent that the subject of research cannot long remain isolated but rapidly develops connections with the work of other departments with a final gain to all concerned.

Eelworms parasitic on plants are microscopic in size, mostly transparent and rather inaccessibly buried in soil or plant tissue. At first glance many of these look alike, and very similar non-parasitic forms often occur along with them. In the Nematology Department much time is therefore being given to methods of collecting eelworms and identifying them. There are many species and within a species there are sometimes "races" practically identical in appearance but differing in their host plants and in their effects on these. With improved equipment and better techniques more accurate identification is now possible and this is helping greatly in the experimental work on eelworm control. One of the lines of work in the department is a study of the factors which influence the building up or decline of eelworm populations. In the potato root eelworm it was found that most of the seasonal increases in numbers occurred in July and August.

Further tests have been made in the control of this pest by chemicals and a recently-introduced soil fumigant 'chloro-bromopropylene' has been found to have a high lethal power, comparable with that of D.D. mixture, but these substances are expensive and none of them is wholly satisfactory. Ammoniacal gas liquor which has sometimes been suggested as a cheap source of nitrogenous manure was tested. The initial effect was to kill a considerable proportion of the eelworms present, but later the numbers increased rapidly and at the end of the season there were three and a half times as many eelworms in the treated plots as in the untreated. There are some varieties of the various agricultural crops which are more resistant to eelworm attack than others and efforts are being made to find resistant varieties, for instance in oats and potatoes. This search is complicated by the fact that different biological races of the same species of eelworm often have very different effects. One race may fail to enter a particular variety of a crop, another may enter but give rise to no symptoms and a third may produce symptoms of disease. In co-operation with Reading and Cambridge, investigations have been continued on the substances diffused from the roots of some plants which induce certain eelworm larvae to hatch and in the absence of suitable host plants they would starve. Some grasses are known to stimulate the hatching of potato root eelworm larvae and 14 species are at present being tested. Other work in the department includes the study of eelworms which cause galls on the roots of many plants. These root-knot eelworms used to be thought of mainly as glasshouse pests but recently they have been reported from rye grass in Wales and maram grass on the coast of Northumberland.



In the Entomology Department much attention continues to be given to aphids. It has been shown that their distribution in the air during periods of high wind is of greater importance than had previously been suspected. In collaboration with the Agricultural Department of the University of Nottingham, a study is being made of the effect of wind direction on aphid infestation of fields. The investigations of the effect of ladybirds and hoverflies as predators on the bean aphid is almost ready for publication. The work on earthworms has been continued, and it has been shown that the liming of acid soils usually causes a large increase in numbers. Wireworms are often abundant in permanent grassland and were major pests during the ploughing up campaigns of the two world wars. The war-time wireworm survey was chiefly concerned with the study of the susceptibility to wireworm attack of various arable crops and with recommendations for cropping infested fields, but ley farming is again on the increase and attention is being given to the rate at which the wireworm population builds up when arable land is put down to grass. It has generally been assumed that the increase in numbers is slow but investigations have shown that under grass there can be a build-up to the danger level in three years; under lucerne it is slower.

In the application of control measures against insect pests one of the problems is the risk of fresh infestation from weeds and neighbouring crops. This has been studied in the case of the swede midge which causes damage to many cruciferous crops. It can attack leaves, stems and inflorescences and amongst other damage is responsible for the unsightly "crumple leaf" and for loss of seed crops of various brassicas. It has now been shown that the swede midge can keep up its numbers by breeding on numerous cruciferous weeds and no fewer than eight completely new host plants have recently been discovered. Another important point is that certain other midges which attack various weeds and were supposed to be of different species have proved to be identical with the swede midge. Studies are also being made of the insects in some forest and old grassland soils and marked differences in species and numbers have been shown to be associated with degree of acidity and other soil conditions. The numbers in some cases are enormous, as many as 3,000 million, mainly mites, having been found in one forest soil.

The researches on the physiology and behaviour of the honeybee carried out in the past few years by the Bee Department are now finding application in problems of pollination and practical bee-keeping. The conclusion has been reached that food-sharing takes place very widely amongst the bees of a colony and this almost certainly explains the heavy mortality that sometimes occurs when only a few foragers bring back to their hives small quantities of food contaminated with certain toxic substances. It has also an important bearing on the distribution of drugs fed to colonies in attempts to control disease. Again, food-sharing has been shown to be responsible for the development of individual colony odours which play a most important part in enabling the bees of a colony to distinguish between members of their own and other colonies. Another investigation deals with the problems of introducing queens

into strange colonies and of uniting colonies together. In this connection the way in which colonies of bees become "alerted" and commence to protect themselves against intruding workers from other colonies has been studied. It has been found that, with the exception of robber bees whom the guard bees attempt to seize and sting on sight, the fate of other intruders is almost entirely determined by the attitude they adopt when intercepted by the guards. Further work has been done on the effect of fertilizer treatments on nectar secretion in red clover in order to determine whether it is possible to increase the attractiveness of seed crops to pollinating insects. The composition of the nectars is also being studied. In co-operation with East Malling Research Station the same thing was done on apple trees and the results show that extra potash significantly increased the average quantity of sugar produced per flower, and that phosphate also possibly increased it, but that if adequate potash is present, nitrate tends to decrease it. The conclusion was reached that suitable fertilizer treatments increase the nectar yields of apple trees and hence their attractiveness to pollinating insects. Work has also been done on the foraging behaviour of bumblebees and on the relative efficiency of honeybees and various species of bumblebees as pollinators of red clover. On bee diseases, very interesting results have been obtained in the control of *Nosema* by a new antibiotic, fumagillin which was first used in Canada for this purpose. Large-scale field experiments have been commenced with this drug which appears to offer high promise of providing an efficient treatment for a widespread and serious disease. Work on European Foul Brood disease is also in progress. In bee-breeding a number of distinct strains have been maintained and multiplication of queens of two of these strains has been commenced. Other investigations in the department deal with swarming, pollen supplements, wintering and cluster formation.

In the Insecticides Department much attention has been given to investigations of the mode of action of the various kinds of insecticides. When poisons are applied as suspensions, particle size is of some importance in deciding the speed of action of the poisons. However, the size of the effect varies from one poison to another, depending on their physical properties, especially their speeds of solution in oils or waxes such as those found on the outside of the insects' bodies. Further work has been done on the way in which the organo-phosphorus group of insecticides kill insects by acting on their enzymes. The chemical constitution of insecticides derived from plants such as pyrethrum has been further studied and in collaboration with the Colonial Products Advisory Bureau the insecticidal activity of different strains of pyrethrum plant has been compared; attention is also being given to synthetic products related to these natural insecticides derived from plants. Other activities of the department include work on the toxicity of plant protective chemicals to honey bees and study of the changes in resistance to insecticides which occur in insect eggs as they develop. It is known that strains of insects are developing which are not readily killed by insecticides and this is being studied by applications of these substances at various concentrations to successive generations of

the survivors. On the field side, the experiments on the control of wireworms has been continued and successful results have been obtained by combine-drilling various insecticides with the seed. On beans, large increases in crop yield have been obtained by a single insecticide application at an early age of infestation of bean aphid; the effect on the parasite and the predators of the aphid is at the same time being studied.

The Statistics Department has continued its own researches on statistical methods and has also given much assistance to other Rothamsted departments in the planning and interpretation of their work. The experimental data on the manuring of field beans and on the effect of seed rate on yield of potatoes have been summarized. The department has devoted much time to assisting the Agricultural Research Council and the Ministry of Agriculture, particularly the National Agricultural Advisory Service. It has, for instance, played a large part in co-ordinating and analysing important series of experiments on the value of feeding antibiotics to pigs and on feeding iodinated casein and thyroxine to dairy cows. Reports were issued during the year on the Survey of Restored Opencast Coal Sites, and the Survey of Fertilizer Practice was continued in ten districts. The latter showed, amongst other things, that the large apparent decline in fertilizer consumption between 1950 and 1952 was partly due to the running down of stocks held by farmers and merchants. Work has continued on the Survey of Maincrop potatoes and there are in progress smaller surveys on animal diseases, farm tractor utilization and rabbit damage. As in the past, much work has been done for the Colonial Office and no fewer than thirty-one colonial officers visited the department for varying periods during the year. Results of twenty years' experiments on sugar cane in Trinidad have been summarized; similar work is being carried out for British Guiana and assistance has been given to the Overseas Food Corporation in connection with their field experiments on groundnuts.

The number of experimental plots on the Rothamsted and Woburn farms in 1952, was 3,124, of which about 500 were small plots testing fertilizer placement on vegetable crops and the effects of a soil conditioner on farm and market garden crops. The Classical experiments were continued on both farms; part of each of the permanent barley plots at Woburn was sown with winter barley as the spring barley suffers severely from competition with spurrey. The winter barley gave an excellent crop whilst the other was a partial failure. The experiment will be repeated in 1953 with the position of the two varieties changed. The ley-arable experiment is now giving measurements of fertility differences due to the various grasses and legumes ploughed in and a new three-course rotation designed to study further the long-period effects of applications of raw straw to arable land was begun in 1952. The annual experiments included four on fertilizer placement, three on tests of "Nitrochalk" and nine on the field study of plant disease problems. Four other large experiments were concerned with farmyard manure and its residual effects, methods of fertilizer application to potatoes planted by machine and the top-dressing of cereals with nitrogen late in the season when the crop is in ear.

The results of these last experiments were closely in line with previous ones, although in 1952 the late nitrogen was, on the whole, less effective in increasing the protein than in the two previous seasons. Early varieties of hybrid maize were again tested at Woburn and good yields were obtained in spite of poor ripening weather. The results brought out the importance of sowing as soon as the soil is warm enough for satisfactory germination. Crops of 14-16 tons per acre of green material were obtained from yellow sweet lupins (variety Weiko), which appears to have some promise as a fodder crop for acid soils and tests of birdsfoot trefoil were continued.

The scientific departments have, as before, had willing co-operation and valuable assistance from the farm manager and his staff.