1947

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(TWENTY-FIRST ANNUAL REPORT OF THE)

Presented to both Houses of the General Assembly by Leave

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MINISTER'S STATEMENT

THE work of the Department of Scientific and Industrial Research was very close to the heart of the late Minister, the Hon. D. G. Sullivan, who laid down long-range plans of development which are being pursued. The war has interfered with or slowed down many of these plans—for example, the development of improved varieties of plants, soil surveys, coal research and surveys, geological surveys, and investigations in the thermal regions, the three last being undertaken in long-range anticipation of requirements of fuel and power. Nevertheless, the work in these and other directions is proving useful by providing factual information in preparation for development and plans for action. It is becoming increasingly obvious, however, that, apart from the steady, long-range pursuit of new scientific knowledge and principles, industry and society are now much more alive to its significance, and there is a tendency and general desire to close the time gap between research and application.

The question of publication and dissemination of scientific information thus becomes increasingly important, firstly to the more applied workers in other Departments and in industry, and secondly in a form more intelligible to the general public. In the supplying of information for direct application to New Zealand's problems the work done by research associations and researches carried out in co-operation with representatives of primary and secondary industry play a very important part, since the results are made available at the point of maximum understanding. The servicing sections of the Dominion Physical Laboratory and Auckland Industrial Development Laboratories have been fruitful from these points of view, and the indications are that such activities will become important aspects of the future structure of industry.

During the past year a number of new research developments have been undertaken by the Department, adding further to its already considerable capacity to provide guidance and assistance for the Dominion's primary and secondary industries. The formation of Industrial Research Associations to serve the needs of particular industries has been encouraged through the Manufacturers' Research Committee, a number of such organizations being now firmly established and others in course of formation. Complete details are contained in the body of this report.

Apart from the problems of maintenance of local laboratories and of utilization of sources of scientific information for requirements more peculiar to the Dominion itself, there is also that of obtaining and integrating scientific information from researches carried out abroad. The volume of such work is increasing rapidly, since all countries are now expending so much effort on research. The Department is co-operating in the British Commonwealth scientific liaison scheme, whereby an effort is being made to systematically pool information as it becomes available, and to co-operate in scientific projects of general significance and application. Specialist officers of the Department continue to be sent abroad for study and research, and pre-war international exchanges of publications have been renewed and extended, these now covering nearly forty overseas countries.

From the record of recent achievements of the Department, many examples of the economic value of research conducted in New Zealand can be taken. Prior to the commencement of research work on the breeding and certification of New-Zealand-grown grass and clover seeds, a high proportion of the seed being sold was virtually useless for pasture purposes. Selected strains were improved by plant breeding, and field inspection and certification introduced. The results of this Department's research have been made available to the New Zealand farmer by the field service maintained by the Department of Agriculture. That the research was successful is indicated not only by the advantages that have accrued locally, but also by the increase in export value of New-Zealand-grown grass and clover seed.

In the sphere of industrial fuel conservation, a service to industry has been introduced whereby a saving of 20 per cent. of existing coal consumption can be achieved without costly alterations to present plant. The implications of this saving (amounting to some 100,000 tons of coal each year) involve a number of economic factors, labour in the mines, railway and shipping space, in addition to an estimated direct saving to industry of some £200,000.

Two factors have militated against progress during the year. The Department is suffering, in common with other interests in the community, from a shortage of suitable and sufficient accommodation. This has prevented a number of requests for investigations from being undertaken, thereby limiting the services the Department could otherwise render. There is also an overall shortage of the necessary scientific personnel, due in large part to the counter-attraction of higher salaries in academic, medical, and overseas appointments. This situation must be remedied if New Zealand is to keep pace with the progress of scientific development, or even to maintain her present position, and to this end an inter-departmental committee is now undertaking a survey of present and future requirements in scientific personnel.

A. H. NORDMEYER,
Minister in Charge of the
Scientific and Industrial Research Department.

SECRETARY'S REPORT

The Hon. A. H. NORDMEYER, Minister in Charge of the Department of Scientific and Industrial Research.

I HAVE the honour to submit herewith the annual report of the Department for the year 1946–47.

The end of 1946, which was a particularly difficult and busy year, saw the practical completion of the Department's reconversion of its activities from war to peace. Just as in the early days of the war it was a major task to convert the existing peacetime organization into a useful weapon for war, so in 1946 reconversion posed large and even more arduous problems in modifying facilities to meet the growing industrial requirements of peace.

Many of the staff recruited to serve the war effort in scientific work have been absorbed into peace-time establishment, but many of the younger members have left to complete their academic studies which were interrupted by the war. Other mature and skilled scientists who have had years of training have found avenues of advancement in University teaching or in the services of New Zealand industries and have thus indirectly extended the influence of the Department far beyond its own laboratories, while too many, perhaps, have been attracted overseas. The last-mentioned applies particularly to geologists. The necessary replacement personnel should be of the highest calibre if the Department's findings are to continue to be authoritative.

The work of the Department has been seriously hampered in many branches by the shortage of accommodation. This has meant that work has had to be carried on in temporary accommodation of a definitely unsuitable nature and has resulted in overcrowding within existing buildings. Such conditions cannot be regarded as ideal, and have prevented the inception of both research and service work

Apart from general reorganization and a continuance of our normal research work three main new activities have been embarked upon :—

(1) A Fuel Efficiency Service has been established in an effort to reduce the consumption of coal in industrial concerns.

(2) The Information Bureau has been extended to deal more systematically with the exchange of information for scientific workers of the Department and of the Dominion generally, and its dissemination amongst interested Departments and the public.

(3) A start has been made on the use of radioactive tracer elements in certain biological and chemical problems associated with soil processes.

Research on the nature of fats (particularly those occurring in dairy products) has been undertaken during the year by the Fats Research Laboratory. Basic statistical and biometrical control of a number of agricultural trials has been made possible by the work of the Biometrics Section. The rehabilitation of the Apia Observatory has proceeded during the year.

RESEARCH COUNCIL

The Research Council has met on five occasions during the year, and the Department is indebted for its advice and guidance. Its personnel was as follows :—

T. Rigg, K.B.E., M.A., M.Sc., F.R.I.C., F.R.S.N.Z., Chairman. J. C. Andrews, Ph.D., M.Sc. N. L. Edson, B.Med.Sc., M.B., Ch.B., Ph.D. (Cantab.). E. R. Hudson, B.Sc., B.Agr., Dip.C.A.C. R. O. Page, D.Sc. J. M. Ranstead, Esquire. W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D. R. B. Tennent, N.D.D. D. F. Sandys Wunsch, M.A. (Oxon.), B.Sc. (McGill), M.I.Chem.E., Assoc. Inst.M.M. E. Marsden, C.M.G., C.B.E., M.C., D.Sc., F.R.S., F.R.S.N.Z. (Secretary). F. R. Callaghan, M.A., F.R.E.S. (Deputy Secretary).

Expenditure

The net expenditure was £498,439, which was £35,011 below estimate, the difference arising from delay in delivery of outstanding overseas orders of new instruments and materials to build up stocks depleted during the war. Unfortunately, these orders carry on into the ensuing year and swell the estimates accordingly. The expenditure of the Department during the year was as follows:—

	£	£
Permanent services—		
Head Office: Comprising general expenses of administration	25,336	
Dominion Laboratory (with branches)	60,993	
Dominion Observatory	2,534	
Geological Survey	33,586	
Magnetic Observatory	5,533	
Dominion Physical Laboratory	106,446	
Auckland Industrial Development Laboratories	19,593	
Apia Observatory	2,642	
		256,663
Research investigations		230,908
Grants and miscellaneous services, including Information Bureau and Scientific Liaison Services		93,311
		580,882
Recoveries		82,443
		£498,439

Grants made to research and allied institutions in Great Britain, £6,785.

Personnel

The personnel of the Department and its disposal at 31st March, 1947, was as follows:—

Auckland Industrial Development Laboratories	25	Geological Survey	40
Dairy Research Institute	28	Head Office and district offices	75
Defence Development Section	33	Information Bureau	15
Dominion Laboratory and district branches	98	Industrial Psychology	4
Dominion Physical Laboratory	161	Observatories: Apia, Magnetic, and Dominion	19
Canterbury Project	27	Plant Research Bureau and five Divisions	125
Fats Research Laboratory	12	Soil Bureau	51
Fruit Research	6	Miscellaneous	21

Total staff, including clerical officers, typists, technicians, and professional officers, 776 (312 permanent and 464 temporary). A considerable deficit of experienced research officers exists in almost all branches of the Department, and as a consequence work of national importance is either seriously delayed or cannot be undertaken at all.

A committee has been set up under the chairmanship of Mr. T. H. McCombs, M.P., to study the scientific man-power questions of the Dominion.

Research Associations

The policy regarding research associations directly responsible to industry has been actively pursued, and, in addition to those previously reported, the Pottery and Ceramic Research Association is now firmly established, and a Fertilizer Research Association also. Further research associations are under discussion dealing with (*a*) laundry and dry-cleaning, and (*b*) hops.

I am glad to be able to report on the sympathetic support given to the Department by organizations connected with primary and secondary industries. In the case of the latter we have received particular assistance from the Manufacturers' Research Committee.

It is obviously imperative that co-operation in research between industry, University colleges, and the Government should be fostered to the utmost.

The more general industrial servicing laboratories at Auckland and Christchurch have continued to give good service, that at Auckland having been particularly successful, while at Christchurch an effort is being made to reorganize the service as a tripartite arrangement between the Department, Canterbury College, and industrial organizations in the South Island.

Empire Science Conferences

Along with the Chairman of the Research Council (Sir Theodore Rigg), Sir Charles Hercus, and Professor Soper, the Secretary attended a series of Commonwealth Science Conferences in London in June and July, 1946. These Conferences were unique and inspiring. We were able to discuss the problems of organization with all other countries of the Commonwealth and the Empire. Satisfactory arrangements were made for pooling and exchange of scientific information and for co-operation in common projects of general and mutual interest.

I have to acknowledge the high standard of loyalty and service of the staff, very often under trying conditions as regards accommodation and loss of key personnel.

E. Marsden, Secretary.

REPORTS OF RESEARCH COMMITTEES OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH

Research work integrated by the above Committee has been continued during the year along the lines set out in the branch reports as indicated below. A building research chemist has been appointed, and steps are being taken to secure the services of a director.

Auckland Panel

Light-weight Concrete Investigations.—The scope of this investigation has so far been limited to studying the properties of concrete in which pumice has been used as a light-weight aggregate and compiling data on sawdust concretes.

Pumice Concrete.—Work along these lines has been greatly handicapped by the lack of essential equipment—viz., a temperature- and humidity-controlled mixing and curing room. However, experimental work has been carried out on the physical properties of light-weight pumice concrete—viz., moisture movement, drying shrinkage, &c. Further study has been made of the physical properties of pumice samples taken from the Rotorua district and records compiled showing sieve analyses, crushing strengths, &c.

Our main objective is to reduce the excessive moisture movement, which constitutes the chief drawback to the more general use of pumice concrete as a permanent building-material. It is very doubtful if it will be possible to make recommendations as to the exact possibilities and limitations of pumice concrete as a permanent building-material until such time as a temperature- and humidity-controlled mixing and curing room is provided, as without this equipment tests of identical mixes vary to such an extent as to make correlation of results impossible.

Testing Properties of New Building Materials.—In collaboration with the School of Engineering, a number of commercial products such as pre-cast building-blocks, slabs, &c., were tested. The results of these tests were required ultimately for the information of the Departments of Housing Construction and Public Works.

Information supplied to Industries manufacturing Building-materials.—Advice, technical literature, and references on manufacturing processes and techniques have been supplied to a number of manufacturers engaged on producing a variety of precast concrete blocks and other items for domestic building.

Investigation of Capping Methods used in testing Samples for Compression Strength.—An investigation has been conducted on methods of capping blocks for making compression-strength tests. Various capping materials and techniques have been investigated, and results have furnished interesting and useful information.

Acoustic Testing of State Houses and Flats.—Tests were made on the sound-insulation properties of various methods of construction used by the Housing Construction Department. A reverberation meter was also designed and an experimental model constructed. Mr. Lyttleton, who was in charge of acoustic-testing, has recently resigned and departed for England to undertake post-graduate study.

Acoustic Tests on Aircraft.—A test has been recently undertaken of the sound insulation of certain commercial aircraft.

Dominion Laboratory

Building-materials.—Inquiries dealing with a wide variety of subjects related to the manufacture and use of building-materials were dealt with. New locally produced materials were examined for suitability for use in building.

A variety of building-materials was examined, especially for the Housing Construction Department. Suggestions were made for improvements in the manufacture of concrete tiles.

Failures of clay roofing-tiles were found to be due in some cases to frost damage and in others to the presence of comparatively large amounts of soluble salts.

The suspected deterioration of concrete in a large irrigation dam was investigated, preliminary tests seeming to indicate attack on the concrete by an aggressive water.

A case of serious failure of concrete sewer-pipes and other underground pipes from the same locality showed that the concrete had been attacked by a very aggressive ground water containing 88 parts per million of free carbon dioxide and only about 18 parts per million of calcium bicarbonate, calculated as calcium carbonate.

Advice has been given on a wide range of painting problems, and analyses have been made of a large number of samples of paint for the Housing Construction Department, State Advances Corporation, and other Government Departments.

A comprehensive examination of paint failures on State houses in Auckland was carried out and a full report, with recommendations, was prepared.

Three extensive paint-test fences were erected, one each in Auckland, Wellington, and Christchurch. The purpose of the fences is to determine by exposure to the weather the best types of paint for exterior wood surfaces, and to investigate such points as the effect of the preservative treatment of timber on paint durability and the possible value of a two-coat painting system in place of the usual three-coat system. A fairly wide range of types of finishing coats, paints, and primers is included in the tests. Practically all the paints used in these tests were formulated and made in the Laboratory.

Panels coated with the paints used on the test fences are being exposed in the Laboratory's "weatherometer" (accelerated-weathering machine). Thus it is aimed to establish a useful correlation between exposure out of doors and in the machine so that accelerated tests in the latter will provide an indication of how paints will behave in service.

The investigations on casein paints carried out in collaboration with the Dairy Research Institute were continued during the year. Interesting results have been obtained from exposure tests made in dairy factories and other food-manufacturing plants.

An interesting large-scale failure of comparatively new paint-work was found to be due to the use of an undercoat containing lithopone, coupled with a delay of several months before the application of the finishing coat.

Plant Diseases Division, Plant Research Bureau

Testing Toxicity of Wood Preservatives

(*a*) *Biological Evaluation of Toxicity with* Anobium punctatum.—The larval transfer technique, which was developed to give a rapid measure of relative toxicity, has been abandoned, since results secured were found to be unrelated to actual toxicity determined by the egg-laying technique. Using the latter, tests were laid down last flight season (December, 1946, to January, 1947) to ascertain toxic points of thirteen materials of possible commercial application. These will be recorded before next flight season.

(*b*) *Toxicity of Thin Layers.*—Tests have shown that some newly hatched larvæ can penetrate through thin layers produced upon the surfaces of twenty minutes' cold-dipped matai and white-pine by solutions of zinc and copper naphthenates at concentrations of 2 per cent. and 1 per cent. of metal respectively.

(*c*) *Treatment of Infested Buildings.*—Two approaches are being made to this problem: one is development of a solution to reduce larval population to a low level by fumigant action of materials applied by brush or injected into flight holes; the other, production of a suitable contact poison which will remain effectual upon the surface of timber for four years in order to kill adults emerging from any larvæ not destroyed by the fumigant. Suitable laboratory technique has been developed for testing materials for these purposes, and tests are in progress.

(*d*) *Mass Breeding.*—Fifteen hundred pairs of *Anobium* beetles were placed for mass breeding last flight season to provide material for future work.

Other Timber Insects

Work has been commenced on investigation of biology and control of the two-toothed longhorn (*Ambeodontus tristis*) and *Lyctus* powder-post beetles.

Testing Preservatives against Fungi

(*a*) "*Graveyard*" *Test.*—A soil "graveyard" test plot for oil-soluble preservatives has been laid down to secure information on loadings required to preserve timber brought in contact with the ground.

(*b*) *Fungous Preservatives for Building-timbers.*—Evidence indicates that agar plate and Kolle flask methods are unsuitable for testing preservatives used for building-timber. A method is consequently being developed whereby test blocks are exposed to fungous attack under such conditions that the moisture content is maintained about fibre saturation point (*circa* 30 per cent.).

Preservative Treatment by Pressure

Studies are nearing completion of gross absorption, net absorption, "kickback," and treating-time of three common timbers treated in cold aqueous solutions under a range of pressure systems.

DOMINION PHYSICAL LABORATORY

(1) *Heat Insulation of Houses.*—Work commenced last year entailing measurement of thermal transmittance made on two types of concrete construction, and also on a weatherboard house built over twenty years ago, has been continued. Values for this latter structure prove much more favourable than those for any modern house yet investigated.

(2) *Mould in State Houses.*—This investigation has been completed and a detailed report presented to the State Advances Corporation. The reasons for the occurrence of the mould are quite clear, and the factors involved are mainly inadequate thermal insulation of the walls, ceilings, and floors, linked with inadequate ventilation.

(3) *Other Work.*—A considerable number of other projects involving the testing of building-materials are reported in the Dominion Physical Laboratory report, page 57.

THE DAIRY RESEARCH INSTITUTE (N.Z.)

Director: Professor W. RIDDET

In this first complete post-war year the work of the Institute has been focused upon still further improving the quality of New Zealand export dairy products—butter and cheese—expanding the variety of products, reducing losses in manufacture to a minimum, utilizing skim-milk to the best advantage in feeding calves in New Zealand, and the influence of the plane of nutrition of the dairy cow during her normal dry period on the quantity and quality of milk produced in her subsequent lactation. An endeavour has accordingly been made to make some contributions to the present state of knowledge which may assist the dairy industry in making available to people overseas an increasing quantity of much-needed dairy products of uniformly good quality and high dietetic value. The following statement, prepared by the principal workers concerned, gives a brief account of the nature of the research projects undertaken and of the progress results. More detailed information will be contained in papers published in technical journals when the results of the work justify reporting in detail.

Land-cress Taint in Cream and Butter.—The finding that cress taint does not appear in the butter if cream from cows that have consumed cress is pasteurized at a temperature below 180° F. has been confirmed by further work. If a temperature of 180° F. is used, the time of pasteurization must be short, as is the case with vacreator

treatment. As a check on the effect of the low-temperature treatment on butter keeping-quality, trials were made with low-temperature pasteurization of normal factory cream free from cress taint. It was found that pasteurization at this temperature does not greatly affect the quality of the butter when fresh, but after eight months' storage there was a slightly greater decrease in grade score than for the control butter from cream treated at 200° F. It has been confirmed that garden-cress does not cause true land-cress taint and that nasturtiums do not cause the taint. It appears certain, therefore, that the taint is not due to the benzyl mustard oil glucoside present in the cress plant.

Parchment for the Wrapping of Butter.—Investigations are being made of the effects of various amounts of iron and copper in parchment on the keeping-quality of butter for which it is used as a wrapper. It is confirmed that the value for total copper and iron is of less importance than that for soluble copper and iron. The information being obtained will, it is hoped, serve as a basis in the formulation of a standard specification for copper and iron contents of parchment.

Treatment of Pinus radiata *Butter-boxes.*—Boxes of *Pinus radiata* timber treated with various surface coatings at the Dominion Laboratory have been tried for use as butter-containers. The treatments reduced the intensity of timber taint, but none of them was effective in preventing the wood taint from passing through the double layer of parchment to the surface of the butter.

Vitamin A Potency of Butter.—The survey has now been completed for a second year. The results follow the same trend as for the first year, although the minimum value has persisted for rather longer into the autumn months.

Disposal of Buttermilk Powder.—By arrangement with the Export Division of the Marketing Department, trials are being made of the keeping-quality of buttermilk powder under export shipping conditions. Trials are also under way on the use of buttermilk powder in ice-cream manufacture. Ice-cream made with inclusion of buttermilk powder was considered of satisfactory quality.

Neutralization of Cream for Buttermaking.—A chart has been prepared and distributed to factories showing the amount of sodium bicarbonate neutralizer required for cream neutralization, allowing for the effect of increasing carbon dioxide content of the cream with increasing acidity of the cream neutralized.

Separation of Buttermilk.—A study is being made of the commercial possibility of separating fat from buttermilk.

Manufacture of Casein.—Assistance has been given to a number of dairy companies which have taken up the manufacture of casein during the year under review, and to the Internal Marketing Division in the adaptation of the vegetable-drying plant at Pukekohe to the drying of rennet casein.

Vitamin B Content of Milk.—Estimations made by the Plant Chemistry Laboratory of thiamin, riboflavin, and niacin in milk samples collected by the Institute from several groups of cows have shown that the milks contained normal amounts of these vitamins, and confirmed the results of workers elsewhere that Jersey milk contains more riboflavin and thiamin than Friesian milk.

Salt Flavour in Butter.—Manufacture of butter from salted cream did not reduce the salty taste of butter as compared with butters made from unsalted cream in the normal way to the same salt content. Reworking of butter in a vacuum worker to reduce the size of the brine globules did not give any consistent difference in the salinity of the butters to the palate until the examination six months after the butters were made. No difference in salinity was observed in butters of the same salt contents from vacreated as compared with flash-pasteurized creams.

Continuous Churning of Butter.—Contact with developments overseas on the continuous churning of butter has been maintained, and assistance is being given in the arrangements for trials of the machines purchased by the Department of Agriculture

for installation in selected New Zealand factories. Statistics have been collected from a number of butter-factories of the power utilization in the churning of butter under normal conditions of buttermaking.

Wrapping of Cheese in Pliofilm.—Previous trials have been continued. The 1 lb. portions of cheese wrapped in Pliofilm found a ready sale on the local market. Trials of the method on the commercial scale are now under way.

Starters for Cheese-manufacture.—The use of a series of single-strain starters in rotation is now almost universal in cheese-factories in New Zealand. Eight unrelated cultures of satisfactory activity are now available and most managers use them as four pairs in a four-day rotation. This system has proved most successful over the past two seasons. It almost eliminates the possibility of starter failure caused by bacteriophage derived from whey and present in milk as received at the cheese-factory.

The various devices used to protect the starter culture from air-borne phage during the course of its preparation in or near the factory are all proving satisfactory. They all depend either upon the exclusion of air-borne phage by filtration of air through cotton-wool or upon the destruction of air-borne phage by heat or by the action of ultra-violet light. The few failures which still occur occasionally are usually traceable to flaws in the equipment, with a consequent admission to the culture of untreated air.

The over-all position with cheese-starters is very satisfactory, some of the largest factories being quite free from trouble throughout the season.

"Phage-carrying" Starter.—Investigation of the phage-bacterium symbiosis mentioned last year has been carried a stage further by the trial of "phage-carrying" cultures in commercial cheese-factories. The culture used was a resistant form of one of our stock strains (HP) which "carries" the phage to which it was originally sensitive. The results in commercial practice confirmed the indications of the laboratory findings. Used as a starter, the "phage-carrying" culture was prepared in the factory without any protection from air-borne phage and it survived under these conditions. Only long-continued trials, however, will show whether the culture is proof against any phage which may occur in the surroundings. There is also a practical difficulty in that the phage persists in the culture only for a limited time. Hence constant laboratory control is necessary. It is not yet possible, therefore, to decide whether the phenomenon will provide a basis for an improvement in the already very satisfactory starter system in present use.

Survey of Cheese-milk Quality.—Following on the investigations into cheese quality carried out in the Hauraki Plains district last season, a survey of cheese-milk quality in the Waikato and Taranaki districts was made from October, 1946, to March, 1947. This work was carried out in co-operation with Dairy Division Instructors and the factory-managers in eleven factories. All the milk-supplies in these factories were subjected daily to a reductase test and to a modified curd test. The results are still being collected and examined in conjunction with the cheese-grading figures for the season.

Influence of Milk Composition on Cheese-manufacture.—In some cheesemaking experiments, attempts have been made to determine the relative influences of fat and casein on the moisture-holding properties of cheese curd. Previous work on the manufacture of cheese from milk from which fat had been abstracted or to which fat had been added had shown that fat probably has a proportion of moisture closely associated with it. This moisture is carried by the fat into the finished cheese. The remainder of the moisture in the cheese curd is apparently associated with the casein gel, and treatment of the curd in the vat must be designed to reduce this moisture to a definite figure which gives the correct final moisture in the cheese. Low-casein milk derived from Friesian cows forms a curd which needs more drastic moisture-expelling treatment than high-casein milk from Jersey cows. It is not clear whether this difference is due to differences in the nature of the curd from the two milks or merely to the fact that

more moisture has to be removed from the low-casein milk. The results of experiments carried out so far tend to favour the second explanation, but it is not yet possible to reach a firm conclusion.

Manufacture of Cheshire-type Cheese.—In collaboration with the Dairy Division and with Mr. W. Linton, of the Dalefield Dairy Co., several attempts at the manufacture of a Cheshire-type cheese were made throughout the dairying season. The cheeses were favourably reported upon in England, and modifications are gradually being made in an effort to satisfy the requirements of Cheshire-cheese consumers. The increased demand for liquid milk in England has reduced the amount available for manufacture of Cheshire cheese and thus provided an opening for a possible diversification of New Zealand's cheese trade.

Cleaning of Milking-machines.—Although there have been no controlled experiments on the cleaning of milking-machines during the past year, some observations in the Institute milking-shed have been made. The main point which emerges is that a shortage of boiling water for use through a milking-machine may be offset to some extent by the use of a hypochlorite rinse immediately before milking is started.

Dairy Cow Nutrition.—During the 1946–47 season the experimental herd has again been used in work designed to determine the influence of plane of nutrition during the last two to three months of pregnancy on the health and production of dairy cows and on the composition and manufacturing qualities of milk. As in the previous year, the herd was divided as evenly as possible into two groups of twenty-one cows each. For the last seventy days of pregnancy the animals in one group (LP) were grazed on bare pastures and given a small quantity of hay. These cows lost condition steadily over this period. The other group (HP) was fed as well as possible on winter grass, hay, and silage, and gained a considerable amount of weight before calving. After parturition the two groups were run as one herd, managed and fed as well as possible. Twenty-five of the animals concerned had been subject to the same treatment as in the previous year. As this experiment is in the second year of a three-year trial, a detailed examination of the data must be left until the conclusion of the work. Preliminary results show that in both seasons to date the butterfat-production has been significantly higher in the HP group. Differences in milk composition have been small, and need confirmation. The health records of the two groups are being followed closely, but, while some differences in the incidence of retention of afterbirth, staggers, and ketosis, and little difference in mastitis, have been noted, these observations also need confirmation. The body-weight records show that the LP groups lost less weight during the early period of lactation, and thereafter gained weight at a faster rate than the HP group. At intervals through the season the milk from the two groups of cows was made separately into cheese, as was done in the previous year. The only difference observed was a tendency, more accentuated in dry-weather periods, for the milk from the low-plane cows to form a curd which retained moisture more tenaciously than the corresponding high-plane curd. This difference, where it occurred, was usually reflected in the moisture contents of the final cheeses, and the low-plane cheese was consequently a little weaker than the high-plane cheese. The effect was, however, quite slight.

Dairy Calf Nutrition.—A study of the value of meal when given to calves receiving skim-milk and good pasture after three to four weeks of whole-milk feeding has been advanced a further step in the 1946–47 season. Two groups of Jersey calves were reared, both receiving skim-milk on the basis of 10 per cent. of live-weight, with a limit of 2 gallons, but one being given, in addition, ½ lb. meal daily. An 8 lb. difference in live-weight at weaning at twenty-two weeks was recorded in favour of the meal-fed group. The cost of this advantage, with meal at £20 a ton, was approximately 10s. per calf. Furthermore, the spring was the most unfavourable experienced for many years, and neither group did as well as groups receiving skim-milk alone in previous years. It is believed that the basis of skim-milk feeding was set too low for the adverse season experienced.

Mastitis.—For the third consecutive season the use of penicillin in the treatment of cases of mastitis has been studied. Favourable results have again been obtained in the present season where streptococci have been associated with the trouble. With staphylococcal mastitis the treatment has not been so successful, and variations of dose rate and timing are being tried to determine whether results can be improved.

Hormone Studies.—The relation of the thyroid gland to milk production and composition is being studied making use of thyroprotein to give conditions of high thyroid activity, and thiourea to depress the concentration of the natural hormone. The doses of thiourea required for varying effects on the thyroid have been determined from histological studies of the glands of thiourea-treated cows. This work has established a basis for the interpretation of results from feeding thiourea on the production and composition of milk.

Identical Twins.—In order to increase the efficiency of physiological studies in dairy cattle, a small herd of identical twins is being assembled. Seven sets of these twins have been obtained in the 1946–47 season and will be available for milk-secretion work in 1948.

School Milk.—The Institute has continued to pasteurize and bottle, on behalf of the Department of Health, milk supplied to schools in the City of Palmerston North and the Manawatu district.

Dissemination of Results of Work.—Results of research work carried out in the past and previous years were communicated by members of the staff to and discussed with over one hundred dairy-factory managers and first assistants assembled at the fifteenth Annual Factory-managers' Week held at the Massey Agricultural College from 6th to 8th May. Messrs. H. A. Foy, Director, Dairy Division, Department of Agriculture, and R. L. Hill, of the A. P. V. Co., London, kindly gave addresses at this meeting which were greatly appreciated.

Four issues of the *News Circular* have been published at quarterly intervals and sent to dairy-company directors, managers, and principal assistants during the year. Items of topical and domestic interest have been dealt with in these *Circulars.*

Many groups of farmers and others who have visited the Massey Agricultural College during the year have been shown over the laboratories, dairy factory, and experimental dairy-farm and had explained to them the nature and results of the work in progress.

The following technical papers have been published during the year:—

No. 175: The Collection of Quarter Milk Samples by Milking-machine. (*J. Dairy Res., 14,* No. 3.) F. H. McDowall.

No. 176: Variations in the Carotene and Vitamin A Contents of certain New Zealand Butterfats. (In the press.) C. R. Barnicoat.

No. 178: A Simple Agar Medium for the Growth of Lactic Streptococci: the Role of Phosphate in the Medium. (*J. Dairy Res., 14,* No. 3.) G. J. E. Hunter.

No. 182: Studies on the Detection of Mastitis in New Zealand Dairy Herds—VI: Mastitis Milk in Relation to Manufacture of Cheese. (*N.Z. J. Sci. & Tech., 27,* No. 6A.) F. H. McDowall.

No. 183: The Estimation of Copper and Iron in Cream, Butter, and Dry Butterfat. (In the press.) A. K. R. McDowell.

No. 184: Control of Moisture Content of Butter during Butter-manufacture. (*N.Z. J. Sci. & Tech., 28,* No. 1A.) F. H. McDowall.

No. 185: The Effect of Hydraulic Pressing on Cheese Texture. (*N.Z. J. Sci. & Tech., 27,* No. 5A.) H. R. Whitehead and L. J. Jones.

No. 186: The Influence of a Diet of Separated Milk and Pasture on the Growth Rate and Health of Dairy Calves. (*N.Z. J. Sci. & Tech., 27,* No. 6A.) S. L. Green, I. L. Campbell, Mona K. Cook, and W. Riddet.

No. 187: Payment for Milk for Cheesemaking: Report on the Operation of the "Costed Cheese" System by a Commercial Factory during the Three Years 1942–45. (*N.Z. J. Sci. & Tech., 27,* No. 6A.) F. H. McDowall.

No. 188: Butter Moisture Control Chart. F. H. McDowall.

No. 189: Bacteriophage in Cheese-manufacture. (In the press.) H. R. Whitehead and G. J. E. Hunter.

No. 190: Control Measures against the Cheese Mites *Tyrolichus casei* (Ouds) and *Tyrophagus longior* Gerv. (*N.Z. J. Sci. & Tech., 28*, No. 1A.) J. Muggeridge and R. M. Dolby.

No. 192: The Utilization of Buttermilk in New Zealand, Parts I and II. (*N.Z. J. Sci. & Tech., 28*, No. 2A.) F. H. McDowall.

No. 193: Studies on the Neutralization of Cream for Buttermaking—VII: Neutralization in Practice in the Butter-factory. (*N.Z. J. Sci. & Tech., 28*, No. 2A.) F. H. McDowall.

No. 194: Land-cress Taint in Cream: (I) Introduction; (II) the Essential Oils of Land-cress (*Coronopus didymus*) and of Garden-cress (*Lepidium sativum*). (*N.Z. J. Sci. & Tech., 28*, No. 5A.) F. H. McDowall, I. D. Morton, and A. K. R. McDowell.

No. 195: Some Modifications of the Schibsted Fat Aldehyde Test. (In the press.) W. R. Mummery.

No. 196: Growth Requirements of Lactic Streptococci—Differences within the Group. (In the press.) G. J. E. Hunter.

No. 197: Cream Neutralization Chart for Sodium Bicarbonate. F. H. McDowall.

No. 198: The Thiamin, Riboflavin, and Niacin Contents of some New Zealand Milks taken at Fortnightly Intervals throughout the Lactation Period. (*N.Z. J. Sci. & Tech., 28*, No. 5A.) F. H. McDowall, N. O. Bathurst, and I. L. Campbell.

No. 199: Land-cress Taint in Cream and Butter—III: Relation of Conditions of Feeding Land-cress to Cows to Incidence of Land-cress Taint in Cream and Butter. (In the press.) F. H. McDowall, I. D. Morton, J. J. O'Dea, and A. V. Allo.

No. 200: Annual Report, 1945–46.

No. 201: Temperature and Humidity Control in Cheese-curing Rooms. (In the press.) T. R. Vernon.

No. 202: The Properties of New Zealand Butters and Butterfats—I: Iodine, Reichert, Saponification Values, and Softening Points of Monthly Samples of Butterfat from Nine Commercial Factories over Four Years. (In the press.) G. A. Cox and F. H. McDowall.

No. 203: Phage-resistant and Phage-carrying Strains of Lactic Streptococci. (In the press.) G. J. E. Hunter.

Incorporation of the Institute.—Following upon discussions between the interested parties extending over a period of time and the unanimous recommendation of representatives of dairy companies assembled at the thirteenth Dominion Dairy Conference convened by the Dairy Board in August, 1945, steps were taken by the Management Committee during the year to have the Institute established as an incorporated body. Effect was given to this under the Religious, Charitable, and Educational Trusts Act, 1908, in terms of a memorial presented by representatives of the Hon. Ministers of Scientific and Industrial Research, Agriculture, and Marketing, the New Zealand Dairy Board, Massey Agricultural College, and the N.Z. Dairy Factory Managers' Association (Inc.). Incorporation took effect from 1st April, 1947, and the body is known as "The Dairy Research Institute (N.Z.)."

FOOD RESEARCH

The Committee has surveyed information already available in New Zealand on the composition of locally produced foodstuffs. Extensive data are available for dairy products and for flours, but in other directions the information is relatively meagre. Some preliminary data were obtained by the Plant Chemistry Laboratory on the vitamin content of various types of meat, and the results are comparable with oversea data. Other matters reviewed were the vitamin C content of various fruits, the vitamin B_1 and crude-fibre content of a range of cereal foods, and the relative food values of milk and ice-cream. Arrangements were made for two New Zealand laboratories to participate in a United States of America collaborative vitamin study on standard samples of canned food products.

Outside the scope of the Food Composition Committee, the Department has given considerable assistance to the Refrigerated Cargo Research Council of Great Britain in supervising the installation of special distant-reading thermometers in refrigerated cargoes on board ship. The results of these temperature surveys will be of assistance in improving the design of shipboard refrigerated spaces.

FRUIT COLD STORAGE RESEARCH

Officer in Charge: Mr. L. W. Tiller

Refrigerated Gas Storage of Apples

Experimental work was in abeyance this season, as the storage chambers and plant were undergoing renovation and alteration. They are now ready for use on 1947 season's fruit. A small quantity of Sturmer apples was kept under gas storage in cabinets and used in a very successful display of the process at the Nelson A. and P. Show.

Influence of Rootstock and Intermediate Scion on Core-flush in Granny Smith Apples

An attempt was made to extend this work by increasing the range of orchards from which fruit was drawn, but a lack of response from growers made it impossible to obtain more reliable data than had already been secured. The results this season were less conclusive than hitherto, but showed at least that when worked on M XII rootstock the variety is less susceptible to core-flush than when on Northern Spy Stock. Further progress in this work will demand a more rigorous and more extensive sampling of material.

Deep Scald in Jonathan Apples

The Australian recommendation of a temperature decreasing progressively from 38° F. to 32° F. for the Jonathan was subjected to test on Nelson-grown fruit. The severe scald induced by continuous storage at 35° F., and particularly at 32° F., was very greatly lessened by initial periods at higher temperatures, but the results failed to show any significant advantage over continuous storage at 38° F.

Effect of a Pre-harvest, Fruit-fixing Spray on Superficial Scald

A claim was made that a proprietary anti-drop spray material also rendered the fruit less susceptible to superficial scald in cold storage. Samples of Granny Smith apples were provided from a commercial orchard, and it was found that the sprayed fruit was very much more severely scalded than the unsprayed. When oiled wraps were employed, however, the difference was very slight because of the almost complete control of the scald by the wraps.

Transport of Oranges

(*a*) *Use of Pliofilm Wraps.*—A sample of Pliofilm wraps was sent to the Cook Islands and used on one-half of a small experimental shipment of oranges. The wraps substantially increased the percentage of sound fruit by retarding maturity, thereby reducing loss from rots, and by reducing loss of weight through wilting. The high cost of the material, however, outweighed the saving, but further work is warranted when lighter-weight Pliofilm is again available.

(*b*) *Use of Diphenyl-impregnated Wraps.*—A quantity of paper wraps impregnated with the volatile fungicide, diphenyl, was also sent to the Cook Islands and used on half of each of two experimental shipments from two different islands in the group. The wraps proved highly economic in reducing losses from fungous rots, particularly after the fruit had been held subsequently for a period in New Zealand. The regular use of the wraps in commercial consignments can be advocated under present circumstances, although much improvement could also undoubtedly be effected by attention to spraying and improved orchard hygiene in the plantations.

(*c*) *Comparison of Harvesting Methods.*—At the request of the South Australian Department of Agriculture an examination was undertaken of two experimental shipments of Washington Navel oranges harvested part by clipping and part by plucking. Unfortunately, the consignments were severely pillaged in transit, and from the material that arrived it could not be said that either method of harvesting possessed an advantage over the other. The increased loss from rots in the later shipment suggested that such shipments would be better carried under refrigeration.

Effect of Fertilizers on Cold-storage Quality of Apples

The data were generally consistent with previous results obtained in a year of heavy crop. Nitrogenous fertilizer was responsible for a rise in breakdown and some reduction in wilt, unless balanced by phosphate and potash. With Dunn's Favourite and Jonathan, however, the differences are not as great as in a light-crop year. The storage quality of Delicious was again little affected by manurial treatment.

Cold-storage Quality of Coloured Strains of Apples

A high-coloured strain of Cox's Orange, one of Jonathan, and two or three of Delicious were at least equal to the standard types in storage quality, but the other red strains were distinctly inferior.

Effect of Rootstock on Cold-storage Quality

Some variation in storage quality from tree to tree made assessment of the results difficult in some instances. It was clear, however, that the storage of Delicious is still unaffected by rootstock influence, that M I rootstock is rather better than M XII, M XV, or Northern Spy for Granny Smith, and very much better for Cox's Orange. M XII was the best stock for Jonathan.

FRUIT RESEARCH

Officer in Charge: Mr. L. W. Tiller

The new research orchard at Earnscleugh, Central Otago, is now in course of development, and the Plant Diseases Division is collaborating with the Auckland Industrial Development Laboratories, the Dominion Physical Laboratory, and the Meteorological Office on the frost-control project.

At the Appleby Research Orchard an additional area of about 8 acres is being brought under cultivation for subsequent planting to provide much-needed material for spray, rootstock, variety, and pruning investigations.

Research Orchard, Appleby

(*a*) *Manurial Investigations.*—On all varieties of apples under test—viz., Cox's Orange, Dunn's Favourite, Jonathan, Delicious, and Sturmer—the initial importance of nitrogenous fertilizer and the still greater significance of the necessity for phosphate and potash in addition have again been strikingly demonstrated. Many trees in plots receiving unbalanced manuring are showing symptoms of ill health in varying degrees, and a Sturmer tree in an unmanured plot has died from general debility and final attack by the silver-leaf fungus.

(*b*) *Rootstock Trials.*—With the varieties Jonathan, Red Delicious, and Granny Smith, the rootstock M XII has given the maximum growth, and M XV is only a little inferior. With Cox's Orange, M XV is slightly in advance of M XII in growth. Northern Spy occupies an intermediate position throughout, and M I is characteristically semi-dwarfing. In yield, Northern Spy stock is still in the lead, except with Jonathan, on which M XII is maintaining its superiority.

(*c*) *Varietal Trials.*—Observations have continued on a large number of hybrid varieties and strains of standard varieties. One or two of those that have already fruited show some merit, but no accurate assessment can be made till all trees are in regular bearing. The Plant Chemistry Laboratory has examined the vitamin C content of some of these fruits, and one or two are moderately good, although most of the others are fairly low.

(*d*) *Spraying Trials.*—These form part of the fruit work of the Plant Diseases Division.

Plant Diseases Division, Auckland

I. *Pomology*

Rootstocks.—Apple: A summary of results of test block trials to date indicates:—

(1) Sturmer scions on Sturmer rootstocks have made better growth than on any other stock; next in order of growth are trees budded on Malling XII stocks; least satisfactory in growth and yield are trees budded on Northern Spy (Plant Diseases Division selection) rootstocks.

(2) Jonathan has made excellent growth when budded on Malling XII stocks, and fair growth on Northern Spy.

(3) Cox's Orange has made good growth on Malling XII and Malling XVI rootstocks, whereas when budded on Northern Spy stocks, scions have made inferior growth and produced less fruit.

On Malling I Stock, trees are remarkable for their semi-dwarf habit and high fruit yields.

(4) Gravenstein on Gravenstein stocks has produced sturdier trees and is almost as early in bearing as are trees on Northern Spy stocks. Furthermore, they appear to be more resistant to gnarling than when worked on Northern Spy stock.

(5) Delicious trees are larger when worked on Delicious stocks than on Northern Spy, but fruiting is much delayed.

Stone-fruits: Investigations with rootstocks have been extended to include stocks for English and Japanese plums, apricots, and peaches. A number of combinations have been produced for experimental planting in the Otago research orchard next year.

Citrus: (1) New Zealand Grapefruit: Sweet orange and citronelle rootstocks have been budded with this variety to ascertain which is more suitable under New New Zealand conditions.

(2) Lisbon Lemon: Scions were worked on sweet orange, sour orange, and citronelle rootstocks. Largest trees with heaviest yield of fruit developed on citronelle stock, smallest trees on sour orange, and trees of intermediate size on sweet orange.

II. *Variety Trials*

Apple.—Records have been maintained of yields, keeping-quality, and disease resistance of some seventy new varieties produced overseas when compared with standard commercial varieties. Three varieties which have proved to be outstanding in quality and production are Laxton's Epicure, Laxton's Exquisite, and Ellison's Orange Monarch. They have the added advantage of maturing between the Gravenstein - Cox's Orange season.

Strains within the varieties Delicious and Cox's Orange have been isolated and classified and keeping-qualities compared. No strain of Delicious has been found which is immune to mouldy-core, but several have been isolated which exhibit resistance.

Peach.—Observations have been continued on approximately one hundred varieties. Quality of fruit and resistance to disease of all have been recorded. Twelve varieties resistant to leaf curl have been isolated. Those worthy of field trial are being worked for development elsewhere; the others have now been discarded.

Sub-tropical Fruits.—Records have been continued on flowering and fruiting characteristics of some fifteen persimmon varieties.

Citrus.—Approximately twenty varieties of citrus, including Satsuma mandarins, have been imported from Japan for trial as rootstocks and/or dessert.

III. *Plant Diseases Investigations*

Codling-moth.—Work on the seasonal cycle is being continued in Hawke's Bay. Results to date show that one main generation is produced extending from late October to the end of January, with a partial second generation in February.

Various modifications of the current spray programme are being tested with a view to improving control of this pest, trials being made with D.D.T. at different stages of development of blossoms and fruits and at different dosages.

Bacterial-spot of Plums.—Of three sprays used in a field-scale experiment, Bordeaux mixture (1–2–50) alone gave adequate control, lime sulphur (1–80) and Fermate (5–100) proving almost worthless.

Apple-mosaic.—Experiments have demonstrated that this widespread disease is caused by a bud-transmitted virus.

Shell-bark of Lemons.—Prevalent in many Tauranga orchards, this disease has been found to be caused by *Diaporthe citri*, hitherto secured only from stem-end rot of fruits. Work is being carried out on its control.

IV. *Tests of New Therapeutants*

Black-spot of Apple.—Dithane, Fermate, and Phygon, each at three dosage rates, have been compared with the current spray programme for control. Though experiments are not completed, results to date indicate that Phygon has given a high degree of control, Dithane is more effective than, and Fermate comparable with, the current programme.

Ripe-spot of Apples.—Comparative trials are being made at Appleby Research Orchard with Dithane, Phygon, and the standard spray of Bordeaux mixture for improvement in control of ripe-spot.

Woolly-aphis.—Gammexane at several dosages gave almost complete control of this pest in the research orchards at Appleby, Oratia, and Owairaka.

Red-mite.—The proprietary Selocide and Dynone were tested on apple-trees for control of this pest. The former gave almost complete control of both European and clover red-mite, while the latter was less effective.

Gammexane at the high dosage rate of ½ lb. to 100 gallons also gave control of both species.

Brown-rot of Peaches.—Control trials were made at Oratia on the variety Paragon with the proprietary Phygon. Results were inconclusive, since only slight infection developed owing to the dry season experienced. After six days in store, however, fruits from treated plots showed considerably less infection than fruits from check plots.

Cawthron Institute, Nelson

Magnesium-deficiency Investigations.—Further analyses of individual leaves from apple shoots have been made to determine their magnesium and potassium contents. The results have confirmed the data reported in previous years. This work is now being prepared for publication. It is clear, moreover, that much more information on the seasonal variation in magnesium and potassium contents is required before a complete picture of the changes in concentration of these elements in the leaves will be available.

Long-term Manurial Experiments at Annesbrook Orchard.—Dougherty trees treated with different fertilizers for many years now show outstanding differences as a result of the omission of particular plant foods. The trees with complete fertilizer (nitrogen, phosphate, and potash) are outstanding in growth and yield characteristics. Those treated with phosphate and potash only come next in order of merit. Trees with phosphate and nitrogen only are now showing severe "die-back," resulting in the complete failure of some trees. Untreated trees, as noted in earlier reports, showed severe "die-back" symptoms several years ago.

Plant-food Status of Permanent Manurial Blocks at Research Orchard.—Samples of soil taken from the main manurial blocks at the Appleby Research Orchard are being analysed to determine the fate of the manures which have been applied over the last fifteen years. Three sets of samples taken in 1932, 1939, and 1947 are available for examination.

Little phosphate or potash applied in the manures has penetrated the soil below 12 in., while the topsoils show great enrichment in phosphate wherever this plant-food has been used in the manures, and they are more acid and nitrogen status higher where ammonium sulphate has been used.

" *Die-back* " *in Moutere Hill Orchards.*—The analyses of samples of soil taken from four orchards badly affected with " die-back " show that the topsoils are well supplied with available phosphate with moderate potash, but the subsoils tend to be very low in these plant-foods. All the soils are very acid, with pH values ranging from 4·8 to 5·1. Base saturation in several cases is very low, with figures from 21 per cent. to 34 per cent. The pH values and base-saturation figures indicate that lime treatment is desirable, but lack of lime is not necessarily the cause of " die-back."

Subterranean Clover for Soil Improvement.—Analyses of soil samples taken from both subterranean clover and clean-cultivated plots in an orchard at Tasman confirm the presence in the soil during January of a greater supply of available nitrate nitrogen on the subterranean-clover plot. It is interesting to note, however, that still higher figures were found on a plot where a good crop of blue lupins had been turned under in the spring.

Apple-stock Experiments at Annesbrook Orchard.—Tests of Double Vigour (French crab vegetatively propagated) for the Statesman variety of apple continue to show to advantage over Northern Spy stock.

A vegetatively propagated stock derived from the Epp's variety has given much greater growth with Cox's Orange and Jonathan than with the Northern Spy stock. Yield of fruit is better in the Jonathan variety on the more vigorous stock, but with the Cox's Orange variety little difference has resulted so far.

Effect of Penicillin on Fruit Fungi.—About fifty fungi, including duplicate strains from different sources, were tested, the penicillin being applied in Oxford cups or directly on agar in advance of the growing mycelial tips of young cultures—*i.e.*, not to the spores.

Complete inhibition of mycelial growth was not shown by any organism tested, nor was there widespread arrest in growth. Some retardation of growth, however, was shown in a number of cultures.

Elgetol Spray.—In view of the good reports in United States of America concerning Elgetol as a controllant of black-spot of apples and pears, this spray compound was tested as a ground spray over dead leaves of Glou Morceau pears and of Dougherty apples, varieties very susceptible to black-spot infection. The spray was tested at a strength of 1 per cent. by volume in water during the first half of September and showed some measure of control. In both experiments the trees received the usual Bordeaux and lime-sulphur sprays during the growing season of the fruit.

Black-spot Ascospore Maturity.—Perithecial development in apple and pear leaves was studied from the beginning of August until ascospore discharge in early September at Riwaka, Tasman, Wakatu, and Nelson. Only slight differences were noted.

Disease Survey of Orchards.—During the harvesting period a number of orchards in different parts of the Nelson District were visited in order to record any unusual disease status of the trees. The amount of disease was small. Eye-rot, mouldy core, and mildew were present only in small amount, and black-spot infection was light. Little, if any, fireblight was noticed, and no case of black-rot was reported by orchardists who were visited.

Raspberry Investigation.—At Tapawera the same treatments that were employed last season were repeated in a new experiment laid out as a Latin square with suitable guard rows between the fertilized bushes. No burning of the leaves occurred this season on bushes receiving the heavy potash applications, probably due to the use of sulphate in place of muriate of potash in the fertilizer mixture. Besides improvement in the leafage of all treated bushes, there was a definite indication that a complete fertilizer was more satisfactory than blood and bone in the first year of application. On the original experimental rows some additional benefit from the complete fertilizer carrying extra potash was seen. The complete fertilizer, even in the new experiment, resulted in better development of the berries.

At Rakau, last year's treatments were repeated, with the same response as at Tapawera. In addition, bushes were laid off in plots for treatment with Epsom salt, dolomite, and borax in conjunction with a complete fertilizer. No response was obtained from the magnesium compounds, but borax at 28 lb. per acre brought about improved cane and leaf growth.

Miscellaneous

Fruit By-products.—The Fruit Section of Head Office has collaborated with the Chemical Engineering Section of the Dominion Laboratory in investigating the dehydration of bananas on behalf of the Government of Fiji. A first-class product of light golden colour and good flavour has been prepared. Further investigation has also been made into the development of an alternative method of extraction in order to improve the quality of unfermented apple-juice. The Department has continued to advise the Internal Marketing Division on the technical aspects of commercial dehydration of apples.

INDUSTRIAL PSYCHOLOGY DIVISION

Director: Mr. L. S. Hearnshaw

Research

(1) *Eyestrain in Two Clothing-factories.*—A survey was carried out in co-operation with two qualified opticians on the eyesight of girl workers in two clothing-factories, 241 girls being optically examined (57 in factory A, and 184 in factory B). Of these, 37 per cent. in factory A and 46 per cent. in factory B complained of some degree of eyestrain. These complaints were nearly twice as numerous among those whom the opticians regarded as not properly equipped with glasses as among those who were properly equipped. As is to be expected, proper optical equipment greatly reduces the tendency to eyestrain, though it does not altogether remove it. A check-up on the lighting in these two factories showed that in neither was the lighting up to the usually recognized standards. Several tentative recommendations have been made as a result of this investigation.

(2) *Occupational Analysis.*—A trial analysis of the building trades has been commenced during the year. Such an occupational analysis endeavours to assess what sort of human material the occupation requires, what aptitudes, skills, and temperamental qualities are needed, what sort of educational background and specialized vocational training are desirable, and so on.

Work so far has been mainly within various Government Departments, rehabilitation training-schools, and housing and public-works contracts, and attention has been paid primarily to carpentry, though information about the other building trades has been collected.

(3) *Seating.*—Four years ago, as a result of observations on the generally unsatisfactory seating for factory workers in New Zealand, the Division was instrumental in getting a local manufacturer to produce an adjustable posture seat suitable for factory use. Hundreds of these seats have since been installed in factories. A follow-up survey

was made to assess the value placed on the use of adjustable chairs by both employers and employees. Twenty-seven employers in the Auckland District were approached, representing twenty-three factories and four offices, using a total of 612 adjustable chairs.

Management generally was of the opinion that adjustable chairs are superior to non-adjustable, and the majority intend to continue to supply their employees with adjustable chairs as the need arises.

Neither employers nor employees were taking full advantage of the adjustable chairs, nor using the adjustments to secure the best possible posture. The education of both managements and employees into the use of posture seating was shown to be necessary.

(4) *Youth in Industry.*—An investigation into the adjustment of youth in industry has been commenced in Christchurch to parallel that into girl workers, the report on which is now in the press. A large number of youths leaving school have been interviewed, and these youths are being followed into their jobs with a view to studying their adjustment to the industrial environment.

Service

Surveys and investigations have been carried out, or other services performed, for fifteen firms and organizations. The topics covered in the surveys and investigations include the following: recruitment of staff, staff selection, staff training, working-conditions and lighting, incentives (modification of a bonus scheme), social amenities and facilities, selection and training of personnel officers, and labour relations.

Vocational Examinations

During the year 543 vocational examinations have been administered, including various recruits for Government positions, Traffic Inspectors, and technicians for R.N.Z.A.F. and Army intakes. The majority of these examinations have been carried out individually. They have involved in all cases an intelligence test, appropriate tests for special aptitudes, and a personal interview.

The Occupational Clinic commenced in June, 1946. It was established to assist persons worried by or maladjusted to their jobs, and has functioned mainly in the evening after office hours. The fifty-five interviews have involved some twenty individuals.

The Division co-operated with Mr. J. Caughley, of the Education Department, in advising the Adjutant-General in the establishment of the psychological testing of Army recruits. Preliminary experiments were carried out in the Central Military District. The Army has now appointed its own psychologist, but the Division continues to act in an advisory capacity.

Education and Information

The Division considers the dissemination of information about industrial psychology and personnel management to be one of its chief functions. In the furtherance of this aim, lecture courses have again been held in Auckland, Christchurch, and Lower Hutt, and twelve other addresses have been given during the year to various bodies and groups.

Information has been supplied to inquirers on a wide range of matters, including bonus schemes, profit-sharing, factory layout, the colouring of workrooms, selection tests, personal records, seating, recreational facilities, accident records, labour turnover statistics, pilfering, music at work, &c.

A quarterly bulletin has been circulated, as in previous years.

LEATHER AND SHOE RESEARCH

Director: Mr. P. White

Leather Research Association

Quality of Sole Leather.—The results obtained in the field trials during the year indicate that the wear life of a sole bears a definite relation to the amount of hide substance per unit area—*i.e.*, per square centimetre. The conditions of wear vary so considerably that it is to be expected that exceptions will occur. Many of these apparent exceptions, however, may be capable of explanation, provided a full history of their wear is available.

Comparisons in actual wear between different types of leather have been based on the relative loss of hide substance worn from soles. Judged on this basis, there was, on the average, surprisingly little difference between the contrasted soles worn as a pair, no matter what the tannage or the stage of processing at which the leather was taken. Should this conclusion be confirmed by a larger-scale trial, then the length of life of a sole will bear a direct relation to the amount of hide fibres in the sole to be worn away. An implication of this conclusion is that normal processes in tanneries do not affect appreciably the wear life of a piece of sole leather. They can affect the quality of a sole—*i.e.*, the number of days' wear per unit thickness. This conclusion only affects wear value and does not in any way imply that the other qualities, as selling features, are not affected by the different tanning processes.

The results of another field trial have shown that, judged on the basis of loss of hide substance, vegetable-tanned sole leather which has been impregnated with wax will give about 20 per cent. longer wear than ordinary vegetable-tanned sole leather. An investigation into the practical difficulties is being carried out.

Finishing of Upper Leather.—During the year some of the fundamental properties of some of the water pigment finishes being used have been examined and results of practical value have been obtained with regard to fastness to wet and dry rubbing.

Curing of Calf-skins.—In recent years trouble has been experienced with the curing and storage of calf-skins. By suitably altering the processing of the skins during tanning, the effect of the trouble is removed. The evidence available is very conflicting, sometimes indicating bacterial action and sometimes chemical action due to impurities in the salt. Stored skins after being treated with brine containing sodium pentachlorphenate were in most cases appreciably better than those stored the previous year without this bactericide, and the suggestion was made that the amount of sodium pentachlorphenate be increased and that, in addition, sodium fluoride be also added.

General Work.—The close contact between the laboratory and the tanneries has been maintained during the year by the usual periodical visits and by analysing and testing liquors and leathers during the processes of production.

Shoe Research Association

Fitting of Shoes.—The Shoe Research Association has co-operated with the Standards Institute and others in designing a suitable measuring instrument for a survey of children's feet, and has examined some of the results of the preliminary survey.

The results of this examination indicate that valuable information will be obtained from the complete survey which can be applied advantageously in the construction of lasts.

Leather for Insoles.—An investigation has been commenced on the types of leather most suitable for insoles from this aspect—that is, the type of leather which will most readily respond to the impression of the foot. So far the results indicate that the most suitable type of leather from this aspect has also the very desirable features of porosity to perspiration, which ensures comfort of the foot in another important direction.

Effect of Perspiration on Leather.—Work has been continued on the very complex problem of the cracking of upper leather during wear associated with the action of perspiration. Conditions of wear vary so much not only from person to person, but also with the individual person, that as yet it has not been possible to interpret analytical results obtained from analyses of cracked leathers not only on account of the above variables, but also due to other factors such as the fit and structure of the shoe and porosity of the leather.

Drying-chambers.—The pilot drying-cabinet mentioned in the 1946 annual report aroused a great deal of interest, which has resulted in the introduction of drying-cabinets in many factories.

A trial drying-cabinet using infra-red rays for the edges of soles after inking was constructed from results obtained in the laboratory.

Factory Problems.—The interest which has been aroused on such problems as factory lighting, colour schemes, and drying is reflected in the individual requests for further information on these subjects. Apart from these problems, the number of other problems—viz., 145—submitted for investigation has been above the average. The number of shoes damaged in wear by a strong acid submitted during the year for a report as to the cause of damage has been above the average, indicating that the public need education on the need for greater care in handling strong acids or containers.

Pelt Research.—The value of the work carried out in previous years has again been fully emphasized in dealing with the problems raised during the year. These have been mainly in connection with plant layout and adjustments of existing processes to meet the requirements of changes brought about by economic factors associated with post-war conditions. Changes in processes may have disastrous repercussions in very unexpected ways unless the fundamental principles underlying these processes are fully appreciated.

MANUFACTURERS' RESEARCH COMMITTEE

Secretary - Executive Officer: Mr. R. T. Wright

The Committee is representative of the industries and principal manufacturing towns of New Zealand. Meetings were held quarterly during the year.

Service to Industry

The committee has maintained its policy of ensuring that the maximum scientific and technical service is made available to industry from the resources of the Department, and of avoiding competition with the facilities and service available from consultant analysts and appropriate private firms. No scientific officers have been appointed by the Committee, but especially through its representatives on the Technical Advisory Committee of the Dominion Physical Laboratory and on the Advisory Committee of the Auckland Industrial Development Laboratories the Committee has maintained close contact with the substantial volume of work being undertaken for industry.

Auckland.—The Committee has been so impressed with the value to sound industrial progress of the work of the Auckland Industrial Development Laboratories that it has recommended the continuation of the Laboratories on a permanent basis. The Laboratories have satisfactorily undertaken over 300 industrial jobs, notably an investigation into the variable speed spinning of wool on ring spinning frames, and the design and manufacture of precision optical parts for industrial use.

Canterbury.—In view of the success of the Auckland experiment, and as part of its long-term programme, the Committee has recommended that a similar organization for servicing industry in the South Island should be established in Christchurch, using as a nucleus the wartime Defence Development Section. A tripartite arrangement involving the Canterbury University College, the manufacturers' associations in Canterbury, Otago, and Southland, and the Department has been proposed, with an advisory committee representative of these three parties and the Committee to guide the activities.

Otago and Southland.—To facilitate close and regular contact with the manufacturers in these districts, the Committee has recommended the appointment of a capable liaison officer, and necessary steps in this direction are being taken.

Details of projects undertaken on behalf of industry are included in the reports of the appropriate laboratories, and were also included in a report submitted to the annual conference of the New Zealand Manufacturers' Federation. During 1946 the Dominion Physical Laboratory dealt with over 1,000 separate jobs for more than 270 individual manufacturers (see page 57).

The Dominion Laboratory has now inaugurated a fuel-efficiency service similar to that in the United Kingdom (see page 55), and this service has been actively sponsored by the Manufacturers' Research Committee. Chemical and chemical engineering problems have been solved for various industries using the special knowledge and equipment possessed by the Laboratory (see page 55).

Research Associations

The Committee has encouraged the formation by industries of co-operative research associations (see page 25). Members of the laundry, dry-cleaning, and dyeing industry have decided to form a research association. The New Zealand Manufacturers' Federation has been recommended to ensure that all its industrial groups explore the possibilities of appropriate research associations and research facilities.

Publicity and Information

The resources of the Department's Information Bureau and overseas offices have been freely placed at the disposal of manufacturers, and every endeavour has been made to ensure that the information supplied has been adapted to cover specifically the particular details of the inquiry.

During most of the year the Secretary-Executive Officer was associate editor of the *Industrial Bulletin.*

Suitable material has been supplied for the official publication of the Manufacturers' Federation, and press publicity for departmental and committee activities has been arranged.

As a result of a close association established with the Federation of British Industries Industrial Research Secretariat and the United Kingdom Ministry of Fuel and Power, details of the Conference on Industry and Research arranged in March, 1946, and *Fuel Efficiency News*, bulletins, and films supplied have been made available to manufacturers.

Under the auspices of the Committee, a striking display entitled "Progress through Science," giving some indication of the assistance to industry given by four of the fourteen Divisions of the Department, was included in the Government Court at the New Zealand Industries Fair organized by the Canterbury Manufacturers' Association in August, 1946.

Addresses by the Committee's Secretary-Executive Officer or by scientific officers of the Department (especially the Fuel Technologist) have been organized in various centres in collaboration with manufacturers' organizations and the Institution of Engineers.

The Committee has given consideration to matters of wider interest, including the problem of corrosion, efficient use of power and heat (especially electric power), post-apprenticeship courses for the training of toolmakers, use of waste by-products of industry, problems of food preservation and processing, and industrial design, and it has laid down its policy of avoiding competition with industry and of ensuring the transference of applied scientific work to industry. The Committee is also deeply concerned that the application of science in local industry is being hampered through loss or lack of suitable trained and qualified personnel. Appropriate recommendations have been made to the Hon. Minister and the Council of Scientific and Industrial Research.

Close association with the Industrial Psychology Division has been maintained throughout the year.

N.Z. FERTILISER MANUFACTURERS' RESEARCH ASSOCIATION (INC.)

This new Research Association, which has been incorporated from the outset, comprises at present only the four superphosphate-manufacturers of New Zealand, but provision is made for the admission to membership of other fertilizer-manufacturers.

The members of the Association are anxious to ensure that the financial basis for operation is satisfactory from the start, and the first year's subscriptions, together with the Government contribution, have already been placed to the credit of the Association.

Close collaboration is being maintained with the Soil Bureau of this Department and with the Soil Fertility Station of the Department of Agriculture to ensure that the activities of the Association are co-ordinated with the activities of the Government organizations.

The principal object of the Association is " To promote research and other scientific work in connection with the manufacture, use, and availability of fertilizers and other materials acting beneficially on growth so as to increase production, improve animal and plant health, and develop the primary industries of New Zealand."

The work envisaged is as follows :—

Examination of the chemical and physical condition of raw materials and finished products.

Examination of the processes of manufacture.

The mixing and blending of fertilizers.

Packaging of fertilizers, and the problems connected therewith.

Preliminary tests of fertilizers and their effect on plant-growth in relation to soil types, this to be confined to short-time pot and plot experiments. Extension of this work to be carried on by the Soil Fertility Station.

The effect of fertilizers on the germination of seeds.

Problems connected with the distribution of fertilizer.

In addition, the Fertiliser Manufacturers' Research Association may concern itself with certain agricultural accessories such as the manufacture of stock-licks, insecticides, &c., which are normally products of certain of the companies.

The selection of a suitable site for the location of the Association's laboratory is actively engaging the attention of the Management Committee, which will later give consideration to the appointment of necessary staff.

NEW ZEALAND POTTERY AND CERAMIC RESEARCH ASSOCIATION (INC.)

The keynote of the first year of the Association's life has been one of steady preparation, and the way in which the advantages of scientific research can best be applied to the local ceramic industry is gradually becoming clear.

Organization and Staff.—The Association has become incorporated under the Incorporated Societies Act, 1908, with its registered office in Wellington. The New Zealand Manufacturers' Federation being unable to maintain secretarial services, arrangements were made with the Manufacturers' Research Committee for its Executive Officer to become secretary of the organization.

The part-time director of the Association has resigned, but has consented to direct the activities of the Association pending the arrival of his successor. A ceramic chemist was appointed in May, 1946.

Visits to Works.—Frequent visits have been made by the research staff to the works of member firms to get first-hand knowledge of works' practice and of the types of problem requiring scientific study. Opportunity has also been taken to inspect the various clay deposits of interest to the industry. A most valuable feature of these visits was the establishment of happy relations with the management and technical staff of the various firms.

Equipment.—Equipment essential for immediate requirements has been ordered. The availability of furnaces covering the low-, medium-, and high-temperature ranges is an essential for ceramic research, and the necessary steps have been taken to see that these are obtained.

Accommodation.—The building being erected adjacent to the Dominion Laboratory will remedy the position with regard to accommodation, the absence of which has seriously hampered the work of the Association staff. In the meantime, use is being made of facilities provided by the Dominion Laboratory and of a concrete air-raid shelter. With the completion of the fitting-out of the new premises, the Research Association will be satisfactorily housed.

Conference of Ceramic Chemists.—In August, 1946, a conference of pottery-work's chemists and the Research Association staff was held in Wellington to discuss a programme of research. A decision was made to concentrate attention on a fundamental study of the main clays being used by the industry. This work has been pushed forward and is reaching the stage where reports on various aspects of the work can be supplied to the industry in the form of technical papers. It is hoped to make such a conference an annual event.

Differential Thermal Analysis.—During the year an apparatus for the differential thermal analysis of hydrous silicate minerals has been assembled and preliminary work carried out on the application of this method of research to New Zealand clays.

Since this apparatus has been in use, a number of clays have been examined qualitatively, and a complete mineralogical examination of eight important New Zealand pottery clays is under way. This will be supplemented by chemical, x-ray, and petrographical examinations, and the correlation of data from these with quantitative thermal analysis.

Free-quartz Determination.—Preliminary work on a differential thermal method for estimating free quartz in clays has been completed. The method, which is based on the small heat effect which accompanies the change low quartz⇌high quartz at 575° C., is both rapid and accurate and promises to be a useful addition to our methods of research on clays.

Clay Beneficiation.—The possibility of improving the quality of certain of our natural white-burning clays by elutriation or other treatment was given consideration and an apparatus constructed in which the clay is separated electrophoretically from a clay dispersion. As a method of purifying clays it is not of great value, though it may have decided advantages in the dewatering of clay suspensions. During the course of this work an apparatus was constructed for the measurement of the particle-size distribution of clays by means of which the extent of clay beneficiation could be readily followed.

Base-exchange Properties of Clay.—The methods of determining the base-exchange characteristics of clays were investigated. The preparation of clay for this work necessitated the use of dialysed clay, for which a novel and convenient electrodialysis apparatus was constructed.

Radiator Bars.—The development of methods of testing the efficiency and durability of locally made electric-radiator bars was carried out.

Affiliation with Overseas Associations.—Affiliation with the British Refactories Research Association was finalized during the year, and inquiries made as to possible affiliation with the British Pottery Research Association. Contact with overseas research institutions of such high standing will be invaluable to our local association.

NEW ZEALAND WOOLLEN-MILLS' RESEARCH ASSOCIATION (INC.)

Director: Professor F. G. Soper

During most of the year the Director was absent in Great Britain and North America, where he met leaders in various wool research organizations. These contacts have proved, and will continue to prove, very valuable, both in avoiding unnecessary duplication of work and in facilitating communications and inquiries. A textile research officer and textile research chemist have recently arrived from Great Britain to take up their duties.

Special attention was directed whilst overseas to the question of disposal of wool-scouring effluent and to new processes and chemical auxiliaries. A report on these activities, together with a supplementary report on the organization of wool research in Great Britain and North America, has been circulated to members.

During the Director's absence, Mr. R. V. Peryman was in charge of research and service to mills. A bulletin was prepared and circulated to members, and six progress reports sent out. A range of technical service problems has been dealt with, including tests on batching-oils, scoured wool, washing fastness, and stains. Further tests have been carried out using Gammexane against carpet-beetle, using cops of woollen yarn containing 10 per cent. of batching-oil. Sufficient success has been achieved to warrant larger-scale mill trials when Gammexane is available in quantity.

Control work on unshrinkable finishes has been continued, some 200 samples of fabrics being tested. Further assistance has been given to two members in starting up their dry-chlorination plants, and four such dry-chlorination plants are now operating in New Zealand. Negotiations for a registered certification trade-mark for dry-chlorinated goods are proceeding. For two members using the wet-chlorination process, mill trials were carried out of improved procedures which demonstrated that some improvement of this method was still practicable.

Arising from the need (mentioned in last year's report) of a more accurate knowledge of the pH of dye liquors, particularly in metachrome dyeing, five mills have now installed pH meters. These are manufactured in New Zealand, and were tested and fitted with accessories by the Research Association before installation in the mills.

The mill tests on the manufacturing trial of hairy wool and on the combing trial of exported scoured wool have been completed. Some further laboratory work is required before reports can be finalized. Progress on this side has been slowed up by insufficiency of staff.

RADIO RESEARCH

The wartime Radio Propagation Committee and Radar Technical Committee have continued their activities in a peacetime capacity by the re-establishment of the Radio Research Committee early in 1946 with wider representation to include the three defence Services, civil avaition, and fuller representation from the Universities. The Chiefs of Staff also agreed to recognize the Committee as the technical Defence Committee on Radio and Radar Research. The functions of the Committee comprise the promotion and co-ordination of radio and radar research throughout the Dominion and to collaborate and assist the Universities in original research within these spheres. Such research undertaken by the Department comes within the purview of the Committee for consideration and recommendation as to policy and programme.

Radio Division, Dominion Physical Laboratory.—The Radio Division has been established on the Committee's recommendation, comprising Radio, Radar, and Electrical-Electronic Sections (see Dominion Physical Laboratory report, p. 59).

Ionosphere Activities.—As part of its wartime activities, the Department established six (6) ionosphere recording-stations in New Zealand and Pacific islands, with an analysis centre at Christchurch. These stations are part of a world network for the collection of data used in the prediction of optimum radio communication frequencies. The Committee recommended the permanent operation by New Zealand of stations at Lincoln (Christchurch), Campbell Island, Kermadec Island, Rarotonga, and Suva (Fiji) (the last on behalf of the British Government), with the analysis centre at Christchurch. The ionosphere work is now a permanent scientific service of the Department.

Seagrove Radio Research Station.—The Committee has considered and recommended for implementation a proposal submitted by the Professor of Physics, Auckland University College, for the establishment by the Department of a radio research station at Seagrove, Auckland, for fundamental research into the nature of radio waves in long-distance transmission to and from New Zealand. The researches have direct application

for increasing the efficiency and improving the design of radio equipment operated by the Post and Telegraph Department and the National Broadcasting Service and, in addition, would contribute to fundamental knowledge on the propagation of radio waves.

Radar Propagation Research.—The Committee considered and recommended for implementation researches into the effects of rainstorms and other meteorological effects to be proceeded with at the conclusion of the Canterbury Project in December, 1947. The researches are of international significance, as the world-wide effects of weather on radar are fundamental to the design of standard radars for civil use, particularly on ships.

Development of Radars for New Zealand Coastal Shipping.—Proposals submitted by the Dominion Physical Laboratory for the development of specialized radars applicable to New Zealand coastal shipping for assistance in coastal navigation were considered and recommended for implementation (see page 60).

Grants to University Colleges.—The Committee considered and approved two grants to Canterbury University College for ionospheric research being conducted by students proceeding to honours degrees. Effect has been given to the Committee's approval.

Other radio research matters considered by the Committee and upon which action has been taken include assistance in solar and auroral research in the relation of these phenomena to radio; use of amateur radio operators for the collection of certain radio phenomena, and ionosphere absorption research.

TOBACCO RESEARCH

Officer in Charge: Mr. Thompson

During the past year four meetings of the Tobacco Research Committee have been held.

The past season has been in the main a dry one. The spring was late, and early summer cold. January, February, and March were dry and warm, with sunshine above the average, bringing about a rapid ripening of the leaf, and kilns were taxed to capacity. The Station crop was irrigated once during January. The yield should be above the average of medium-bodied leaf. The 1945–46 crop was a record, 18,517 lb. being harvested from 13 acres.

The research work this season, as in the past, has been a co-operative effort carried out jointly by officers of the Cawthron Institute and the staff of the Research Station. The Research Station has concentrated on the field side, which has included all types of fertilizer investigations, variety trials, seed-production work, plant-breeding, and disease investigations.

Soil Sterilization

In addition to the Station requirements, a total of 200 cubic yards for fourteen growers was steamed during the past season. The total amount of seed-beds steamed showed a considerable increase on previous seasons on account of the operation of a private soil-sterilizing plant. Many of these beds were direct sown with seed, showing that growers are becoming aware of the advantages of bed-sown over pricked-out seedlings in the control of mosaic.

Fertilizer Experiments, 1945–46 Season

A brief summary of the main results is as follows:—

There was a general increase in yield resulting from the extra complete fertilizer up to 1,400 lb.

Where the percentage of nitrogen in the fertilizer was varied, the plots receiving the least nitrogen (2 per cent.) gave the lowest yield: nitrate of soda is the best form. Potash produces little difference in yield, but high potash produced clean and uniform leaf of good texture and body.

Magnesium had a beneficial effect on both yield and quality. Reserves of phosphate have been built-up in the soil as a result of previous heavy fertilizer applications and additional applications have little effect.

Varieties

In a trial of varieties, Harrison's Special 215 maintained its position as a high yielding variety. It was equalled in yield by an introduction from the United States of America, Special 400, which, in addition, produced a higher proportion of bright leaf. Another American variety, Special 401, in its first year of trial gave promising results. Delray, a Canadian variety, produced a good-quality leaf, but was disappointing in yield. On land infected with the black root-rot disease, Harrison's Special, Special 400, and Special 401 appeared to have a fair degree of resistance.

The results of the 1946–47 experiments will not be available until after the leaf is graded, but the following observations were made on the crop in the field. Once again a dry summer was experienced and little fertilizer was lost through leaching. Results were very similar to those of previous years. In a new cover-crop experiment the tobacco following ryecorn appeared to be the most satisfactory crop. Cover crops of legumes produced rank green leaf. Where different heights of topping were tried out, low topping resulted in earlier maturity. A trial of varieties confirmed the results of last season, a new American variety, Special 402, also being promising.

Seedling-bed Experiments

Steam once again proved the most satisfactory for the control of weeds and the growth of plants in the seedling beds. A calcium cyanamide-urea mixture closely approached steam for the control of weeds and was greatly superior to other chemicals. Formalin, Chloropicrin, and D.D. gave insufficient control of weeds. Several proprietary weed-killers destroyed the tobacco along with the weeds.

Chemical Composition of Tobacco with different Fertilizer Treatment

Chemical analyses of the cured leaf from the 1944–45 season has been completed. In this season the amount and distribution of the rainfall were satisfactory, so that no irrigation of the tobacco was required. The nitrogen contents are much higher and the sugar contents appreciably lower than in the previous season, which was much drier.

Intake of Plant Nutrients

A comparison of the intake of plant nutrients in the case of tobacco grown on a sand (Tobacco Research Station) and a light-phase silt loam (Riwaka) has been made over three seasons. During the past season the tobacco on the heavier soil type was slow in the early growth stages and maturity of the leaf was much delayed.

Ageing Experiments

Moisture tests have been carried out at periodical intervals on tobacco stored in both Wellington and Motueka. The tobacco is held in cases under commercial conditions of leaf storage. The tests were made on the tobacco at different positions in the cases.

Soil Analyses

Nitrate and ammonia nitrogen were determined in representative samples of soil, taken from different locations at the Research Station, on the 11th and 22nd of February. One of the interesting features of the results obtained was the higher nitrogen contents of the plot where lupins had been ploughed in during the spring. This high nitrate figure is in keeping with the dark-green colour of the tobacco on the lupin plot during February.

Disease Investigations

This work has comprised surveys of tobacco-seedling beds and gardens in different parts of the district for mosaic, verticillium wilt, black root-rot, and angular leaf-spot. In addition, experiments have been continued concerning the control of mosaic, black root-rot, and sclerotinia in seedling-bed experiments, and a wide range of tobacco varieties has been tested for resistance to black root-rot and verticillium wilt.

Mosaic Disease

Surveys were made of mosaic in the seedling-beds of thirty-nine growers during October and November. On the whole, little mosaic was in evidence, but the low night temperatures which prevailed during the spring of 1946 tended to retard symptom-development. There were only four cases of severe infection in the seedling-beds.

During January a survey was made of mosaic incidence in the gardens of twenty-nine growers in different parts of the district. The average percentage of mosaic infection for the whole of the tobacco-growing areas was 14 per cent., as compared with 12·4 per cent. in the previous season. The Dovedale - Stanley Brook area showed a decline in mosaic incidence, but other areas showed increases varying from 2 per cent. to 6 per cent. The field surveys again showed much higher mosaic figures for pricked-out plants compared with bed-sown plants.

Some outstanding results were obtained in an experiment to demonstrate the spread of mosaic following the handling of infected plants.

Black Root-rot

Surveys of this disease have been made in seedling-beds of a large number of growers. Black root-rot was identified in twenty-two cases, of which twelve were severely infected. In five cases infection was so serious as to justify rejection of all seedlings for field planting. In a number of instances infection in the seedling-beds was confined to the edges of the bed, causing stunting of the seedlings. So far, the experiments established to control black root-rot in the seedling-beds by using chemicals have not proved successful. Calcium cyanamide plus urea was tried this season, but little improvement was effected.

Resistance of Tobacco Varieties to Black Root-rot.—Some twenty-eight varieties or lines of tobacco were tested to ascertain their degree of resistance to the disease. The results showed that a number of varieties were resistant, but some in the susceptible group show a much higher degree of resistance as field plants when soil and air temperatures are higher.

Verticillium Wilt

(*a*) *Seedling-bed and Field Surveys.*—An examination was made of seedling-beds of those growers who had infection last season. No verticillium symptoms were seen.

Two field surveys were made during the season and an extension of infection was noted in three new fields surrounding initial cases of infection. Arrangements are being made by some growers to grass down infected fields for two or three years.

(*b*) *Resistance of Tobacco Varieties to Verticillium Wilt.*—Tests were conducted in seedling-boxes under glasshouse conditions of the resistance of twenty-eight tobacco varieties or lines to verticillium wilt. Three varieties—viz., Wills' Harrison's Special, Ambalema, and Kelly—showed good resistance.

Collar-rot (Sclerotinia)

Experiments to control collar-rot in seedling-beds have been continued. The following chemicals in spray form were used to ascertain their value in controlling collar-rot in seedling-beds: Shirlan A.G., Fermate, Bordeaux, F.D., and Dinoc. Best results were obtained with Fermate and F.D., but these chemicals did not give complete control. Bordeaux and Shirlan were not successful when applied as sprays to the seedlings. Where the chemicals were watered on to the seedling-beds, Fermate, followed by Shirlan, gave the best results. Calcium cyanamide plus urea applied to infected soil well before the sowing of tobacco-seed appeared to give some benefit in the control of the disease.

Seed-production and Plant-breeding

The demand for tobacco-seed continues to increase, 50 lb. being supplied last season, compared with 42 lb. the previous year. An excellent season allowed a satisfactory reserve of seed to be built up. The present season has also been a good one for maturing seed. Five commercial varieties were grown, in addition to a number of

miscellaneous lines. Plant-breeding to obtain a mosaic-resistant type is continuing. Some resistant lines appear to be quite promising flue-cured types and will be put under field trials next season. Breeding to produce black-root-rot-resistant varieties is continuing. Meanwhile, Harrison's Special 215 and Special 400 provide a reasonable degree of resistance.

Fire-cured Tobacco

Last season's crop of fire-cured tobacco was very promising, both in the field and when cured. A further area grown this season made good growth and is at present being cured. This includes twelve additional varieties received from Kentucky which are being tested under local conditions.

Kilns and Curing

Following last season's experience, further modifications were made to the experimental kiln. Shortage of staff prevented the full range of experiments as planned being carried out, but much additional information was gained, which will be added to when the leaf has been graded.

Soil Survey of Tobacco Lands

Work carried out by Cawthron Institute

During the past year detailed soil mapping has been continued on the alluvial soils of the Wai-iti and Upper Motueka rivers. The Wakefield-Belgrove sector of the Wai-iti Subdivision has been completed, and tobacco soil maps have been prepared for this area and made available to the tobacco companies and the Tobacco Research Station.

In the Wakefield-Belgrove sector, some 4,110 acres of alluvial soil were mapped and divided into categories based on their suitability for growing flue-cured tobacco.

Although tobacco-growing is increasing in acreage in the Wai-iti Subdivision, the soils are patchy and those more suitable for tobacco are distributed in small areas, presenting difficulties in the economic development of flue-cured tobacco culture. Partly on account of the small acreage of suitable soil available for tobacco to individual farmers, Burley tobacco, which is air-cured, is grown more extensively than in other parts of the Nelson District.

Soil mapping on the alluvial soils of Tapawera has been completed, but the preparation of tobacco soil maps must await the completion of mechanical and chemical analyses of representative soil samples. The only area of tobacco soil which now requires mapping is that of the Stanley Brook Valley. No base maps exist, but when aerial photographs become available detailed soil mapping will be carried out in this valley.

Distribution of Tobacco in 1945–46 and 1946–47 Seasons

Locality.	1945–46 Acreages.	1946–47. Acreages.
Riwaka-Motueka district	1,838½	1,999
Motueka Valley district	518	590½
Ngatimoti and Orinoco district	195	228½
Dovedale-Thorpe district	320½	312½
Stanley Brook - Tapawera district ..	256½	234
Wai-iti district	275½	339½
Waimea district	61½	51
Moutere Valley	92	160½
	3,557½	3,915½

WHEAT RESEARCH INSTITUTE

Director: Dr. O. H. Frankel

Wheatgrowing

Areas and Yields of Varieties.—In the harvest of 1946, Fife-Tuscan increased further by 3·4 per cent. and Cross 7 by 2 per cent., mainly at the expense of Tuscan. The percentages of the main varieties were as follows: Cross 7, 67·3 per cent.; Fife-Tuscan, 11·9 per cent.; Tuscan, 9·4 per cent.; Dreadnought, 5·7 per cent.; Tainui, 2·5 per cent.; Hunters, 1·4 per cent. According to the sowing estimates for 1946–47, Fife-Tuscan increased its area by 3 per cent. to 14·9 per cent., Cross 7 reduced it by 2·3 per cent., with the other varieties remaining more or less the same.

Wheat-breeding

New Varieties.—A decision has been reached to distribute two new varieties which have been under test for a number of years. The first, as yet unnamed, is 78,01, from the cross Tuscan × Tainui. This wheat has a baking-quality about as good as that of Cross 7, matures slightly earlier, and is a little taller than Cross 7. In twenty-eight accurate trials extending over the last six years it gave an average yield increase over Cross 7 of 3·8 bushels per acre, equalling 8·4 per cent. This represents, at a mean yield of 33 bushels per acre, an increased return of about £1 per acre.

The second wheat, 140,014, from the cross Cross 7 × Tainui, has now been named "Hilgendorf" wheat, after the late Dr. F. W. Hilgendorf, first Director of the Wheat Research Institute and pioneer of wheat improvement in New Zealand. Its special feature is its excellent baking-quality. Without exception it has been markedly superior to Cross 7 in every trial, and to Marquis wherever the two were grown together. In fourteen trials which were tested for protein content, the new wheat had an average protein content of nearly 2 per cent. more than Cross 7. In a trial at Lincoln against high-quality wheats from New South Wales which command a premium, our wheat was distinctly better than the strongest New South Wales wheat, Pusa 4.

This wheat does not seem to be suited for light land, but on medium to good land it has yielded the same as, or slightly less than, Cross 7. To have it widely grown may require a premium for quality. This and the best ways of using this wheat are being explored.

New Breeding Lines.—Some of the new lines under test are giving excellent promise of increased yields. Two lines yielded about 20 per cent. more than Cross 7 both at Lincoln and at the Tai Tapu Substation. Others gave both good yields and superior baking-quality.

The total number of plots at the Lincoln Station was 17,878, and at Tai Tapu 1,394.

Cereal Chemistry, Milling, and Baking

Eighty per cent. Extraction Flour.—Towards the end of April, 1946, the Government announced that from 1st May the rate of flour extraction in New Zealand mills must be raised to 80 per cent. and so use less wheat in making the amount of flour needed.

As the extraction rate is raised, even with the best techniques, the flour becomes less capable of making the well-risen loaf consumers expect, and the whole attention of the Christchurch laboratory was given to assisting the millers and bakers to minimize this undesired effect on the quality of the flour and bread.

This assistance was in the nature of advice to millers and bakers, the design of a special machine, additional testing-work, and the sending of technical officers to help in adapting mills.

That the change in the bread was scarcely noticed in many districts is largely to be attributed to the skill and energy displayed by the millers, but the leaders of the milling industry have stated that a major help to them was the centrifugal detacher designed by the Institute. This machine is mentioned in last year's report, and was

designed to extract vitamin-rich flour from certain pollard streams so as to improve the nutritive value of flour. Acting on the Institute's advice, millers have used it to extract practically all the flour that usually goes into pollard. Other means to this end were also used, but many millers found that they could not reach the desired extraction rate without the detacher, especially since they could not get additional machinery of the usual kind.

Production of the machines was arranged by the Institute, on behalf of the Flourmillers' Society and with the help of the Defence Development Section of the Department in Christchurch. Within a few months almost all mills had the machines installed.

Analyses showed vitamin content of the flour was considerably increased. The rise in vitamin B_1 from 1·8 to 3·1 p.p.m. is considered by the Nutrition Research Department to have given the average consumer the full requirement.

The increase in extraction left little margin in the baking-quality of the flour, and millers made full use of the testing service of the Institute. The wisdom of this became the more apparent when, in February, it showed that imported wheat was giving inferior flour at 80 per cent. extraction. In consequence, it was possible to warn bakers of the need for special care and to issue advice to them.

A close collaboration was maintained with the Wheat and Flour Controller in order to assist him in distributing the flours to best advantage.

Chemical and Research Work.—In addition to routine chemical examination of the 80 per cent. flour, the chemical staff began a study of the factors which lead to its darker crumb.

Extension Work

Short Courses for Servicemen.—The first of a series of refresher courses in baking for returned servicemen was held in September. These courses were arranged in conjunction with the Rehabilitation Department, which gives the men an allowance and travelling-expenses.

Wheat Review.—The Institute has published this illustrated eighty-page booklet containing articles on many aspects of the wheat industry and of the work of the Wheat Research Institute.

Visits Overseas

The Chief Executive Officer attended an inter-State conference of Australian cereal-breeders and geneticists held at Roseworthy College, South Australia, in August.

At the request of the bread-manufacturers of New South Wales, the Chief Chemist spent the month of March in Australia to consult with Dr. D. W. Kent-Jones, th eminent English cereal chemist, who had been brought to Australia by the New South Wales bakers.

CAWTHRON INSTITUTE

Director: Sir Theodore Rigg

The following reports relate to land-utilization, chemical work, and tomato investigations carried out by the Institute. Other work is published under the headings "Tobacco Research" (see p. 31), "Fruit Research" (see p. 18), while entomological work is included in the report of the Entomology Division (see p. 73).

Land-utilization

Maps showing the present use of land in the Wakefield-Belgrove sector have been prepared, indicating some 102 acres of tobacco, 78 acres of hops, and 7 acres of small fruits and tomatoes.

Soil Conservation and Rivers Control

Considerable time has been devoted to the classification of hill land and to the establishment of a tentative boundary between land suitable for agriculture and that required for reafforestation. This work has now been completed for the Waimea County. A study of the proposed boundary shows that, in addition to the 340,000 acres now included in State forests and reserves, a further 184,000 acres of poor hill land must be retired from agriculture and included in the afforestation category.

At the request of the Nelson Catchment Board, observations on the value of subterranean clover and green-manure crops have been continued with a view to the prevention of soil erosion and the conservation of soil fertility. Assistance has been given to the Department of Agriculture in the layout of field experiments, and estimations of soil nitrogen have been made on lupin and subterranean-clover plots.

Chemical Work

The mechanical and chemical analyses of soil samples in the Wai-iti and Tapawera surveys have been continued. The soils of the Wai-iti Subdivision have been completed, and good progress has been made with those from the Tapawera locality. At Tapawera, sands, sandy loams, and silt loams predominate, suggesting that a considerable acreage will be suitable for tobacco culture.

Other work is reported under appropriate headings in this report.

General

At the request of the State Advances and other Government Departments, visits have been paid to several properties required for soldier settlement. Many requests from Nelson farmers relating to the use of lime and fertilizers have been received and the necessary assistance has been given.

Tomato Investigations

(*a*) *Use of Steam, Formalin, and Chloropicrin.*—In view of the good results obtained in the previous season with chloropicrin on outside tomato soils, this chemical was included in the tests for the treatment of glasshouse soil.

The results showed the great value of both steam and chloropicrin in improving the growth and yield of tomatoes on an old tomato soil. The result from chloropicrin was not significantly different from that obtained with steam treatment. In both cases the yield of tomatoes was improved by at least 3 lb. per plant.

(*b*) *Tests on New Tomato Glasshouse Soil.*—The erection of a new glasshouse on an area of outside tomato soil enabled tests of steam and soil disinfectants to be enlarged over the previous year.

Yields from the new glasshouse were considerably higher than those from the old glasshouse, but the percentage increases in yield obtained from the use of steam, formalin, or chloropicrin were very similar to those obtained in the old glasshouse.

Effect of Cocoa-bean Husks, Compost, etc., on Tomato Yield

Tests of the value of different materials for improving the textural and plant-food status of Nelson tomato soil, which in the case of the Institute glasshouses contains a high percentage of clay and silt, have been continued.

Steamed compost which in the 1945–46 season gave an increase of 1·25 lb. per plant over the corresponding control showed only a small and non-significant increase of 0·2 lb. per plant in the second season.

The use of sawdust was associated with a marked decrease in yield which, however, was not so great as in the 1945–46 season.

The beneficial effect of cocoa-bean husks (included in the experiment for the first time) in improving yield of tomatoes on the Institute soil was confirmed in three parallel tests which gave an average increase in yield of 0·4 lb. per plant.

Effect of Different Rates of Watering on Tomato Yield

As found in previous years, the heaviest rate (51 gallons per plant) of watering gave the highest yield, 10·0 lb. per plant. This was followed by the standard rate (35 gallons per plant) with 8·8 lb. per plant. The lowest rate (25 gallons per plant) gave 8·2 lb. per plant under similar steam and fertilizer treatment.

Tomato "Cloud"

The Dreadnought variety was grown under different conditions in the Institute glasshouse.

The percentage of "cloud" averaged over the whole of the house was 11 per cent., compared with 3·8 per cent. in the previous season. As treatments were the same, the difference must be attributed to the season.

"Cloud" was least in evidence on the unsterilized plots. Steam sterilization and the use of compost or cocoa-bean husks tended to raise the percentage of "cloud." Heavy supplements of potassic manures or the use of charcoal had little effect on the incidence of "cloud."

Heavy watering of the plants was associated again with a marked increase in the percentage of "cloud," confirming the results obtained in three previous seasons.

Tests with Steam and Soil Disinfectants on Outdoor Tomato Soil

Chloropicrin, steam, formalin, and D.D. have been tested for the treatment of outdoor tomato soil. The plants were retarded in growth during the early summer by exceptionally cold weather.

For the Kondine variety, results in the 1946–47 season confirm the value of chloropicrin for the treatment of outdoor tomato soil. Both steam and 2 per cent. formalin treatment gave improvement in yield, but the results were not as good as in the 1945–46 season.

The chemical, D.D., did not effect any improvement in yield, due possibly to soil conditions.

Over a period of three seasons steam sterilization of the soil and treatment with chloropicrin have given outstanding results in growth of plants and in yield of tomatoes.

Effect of Soil Amendments on Outdoor Tomato Soil

Tests with various soil amendments have been continued during the past season. Outstanding improvement in growth of plants and yield of tomatoes was obtained with sheep manure and cocoa-bean husks used at the rate of 30 tons per acre. Coarse sand at the rate of 300 tons per acre likewise appeared to be beneficial. Charcoal, and particularly sawdust, tended to lower the yield of tomatoes.

Tomato "Hard-core"

Investigations have comprised records under a great variety of conditions, including effect of fertilizers, of steam and soil disinfectants and of soil amendments on the incidence of "hard-core."

The use of chloropicrin, sheep manure, and cocoa-bean husks gave great reduction in the amount of "hard-core." This reduction in "hard-core" was associated with improvement in the growth of the plants and also with yield of tomatoes. Other treatments which had a beneficial effect in reducing "hard-core" were treble dose fertilizer, steam treatment, and the use of extra potash and nitrogen. Sawdust, charcoal, and sand gave no improvement in "hard-core" over the control plots.

MINERAL-DEFICIENCY WORK

(*a*) *Serpentine-superphosphate Investigations.*—The same pots that were used last year for experiments with Sherry River soil were again given the same fertilizer treatments and sown to Western Wolths grass.

(*b*) *Plant-tissue Tests.*—As part of the fundamental work concerned with the evaluation of plant-tissue-test methods, petioles of single leaves from the same position on tomato plants of a similar appearance as possible grown on plots of a given fertilizer or soil-amendment treatment have been analysed. Very great variations in concentration of any particular constituent have been revealed. This work was done fairly late in the season and, although it confirms results obtained last season, requires to be extended to cover the earlier stages of growth of the plants.

The great variations found from plant to plant show that before these tissue-test methods can be used in fertilizer and nutritional studies a large amount of work must still be done to find out how many plants must be sampled on a given plot for inter-comparisons to be made of the effect of fertilizer and cultural treatments if reliable results are to be obtained.

(*c*) *Nutritional Deficiencies.*—In December, 1946, a chlorosis of the leaves of the tops and side shoots of indoor tomato plants on the unsterilized and formalin-treated plots developed to an appreciable degree. Steam-sterilized or chloropicrin-treated plots did not show this symptom. Painting the leaves with a solution of ferrous sulphate (0·25 per cent.) gave some improvement in colour, but no response was obtained from the use of a manganese sulphate solution at the same concentration.

A chlorosis of similar appearance developed in the same month on outdoor tomato plants on soil which had been treated in the early winter with sulphuric acid to lower the pH value. This chlorosis responded to iron treatment also, but the best results were obtained with a mixed iron, manganese, and zinc solution.

RESEARCH WORK AT AGRICULTURAL COLLEGES

Grants were made by the Department during the year to Canterbury and Massey Agricultural Colleges for a number of projects which are reported below.

CANTERBURY AGRICULTURAL COLLEGE

ANIMAL HUSBANDRY

Professor I. E. COOP

Pig-breeding.—The breeding programme of the Tamworth and Large White pigs has continued in the process of evolving a breed of pigs possessing the desirable qualities of each parent breed. Progeny testing of sires is being used in selecting the boars for breeding. Further Large White blood has been introduced from a line of proved carcass-quality pigs obtained from Ruakura.

Sheep-dipping Trials.—The new insecticides D.D.T. and Gammexane have been tested in their effect on keds and lice. The trials with D.D.T. have proved disappointing. The D.D.T. was used both as a solid dispersion and in suspension dissolved in benzine, and in both cases failed to control lice, and was not as good as derris or Gammexane in controlling keds. On the other hand, Gammexane proved to be very effective in the small-scale trials against both keds and lice. Here again it was used in both the fluid and powder forms, both being equally effective. It has also been tested on a larger scale, when a flock with a very heavy ked infestation was cleaned up in one dipping. The difficulty of obtaining lice-infested flocks has not yet permitted large-scale trials of Gammexane against lice.

Growth and Development of Corriedale Sheep.—The growth and development of Corriedale sheep raised at the Kirwee Experimental Farm on high and low levels of nutrition since birth are being studied. Their rates of growth are being followed and their development studied by killing and dissecting the carcasses of representative sheep at regular intervals.

Soil and Fertilizer Research

Soil Fertility.—A long-term project designed to study the interaction of the soil and various crops, including wheat as a major crop, has been established. The project includes four different crop rotations designed to produce divergent levels of soil fertility, four different cultivation treatments, and eight manurial treatments. The layout adopted is one of fractional replication recommended by the Statistics Department of the Rothamsted Experiment Station.

Copper Deficiencies.—Unsatisfactory growth of onions on an area of peat soils near Christchurch was reported in November, 1946. Pilot spray trials using various trace nutrients were applied and a marked response to copper was obtained. No other treatment gave any response.

The effect of copper deficiency was subsequently observed as affecting a range of market-garden crops grown over a wide area of this soil type, and further trials have been laid down.

Since the problem is one of considerable economic importance, it is proposed to expand the work and to undertake analyses of soil samples and of plant materials.

Lime and Liming.—A series of projects on lime and liming were started during the year. These include studies on the lime status of paddocks with known history on the College farm, investigations on the physical properties of ground limestones in relation to flow and distribution, and the efficiency of bulk-lime distributors.

A comprehensive set of samples of rock and of the ground product, representing thirty-one commercial limeworks in the South Island, was collected. Further samples are being obtained from certain works at intervals as a check on the variability of the product.

The lime content and sieve analysis of the ground samples has been determined, and the separate determination of calcium and magnesium has been commenced.

Entomological Investigations

Mr. L. Morrison

Insect Pests of Wheat Crops.—Several years' work on the susceptibility of wheat varieties to attack by Hessian fly (*Mayetiola destructor*) and Argentine stem-weevil (*Hyperodes griseus*) has shown conclusively that certain of the standard varieties which are commonly grown show distinct differences in susceptibility to damage. A special study of the Hessian fly has been in progress during the past year. With the co-operation of officers of the Department of Agriculture, samples of wheat from early-sown crops and samples of wheat straw from previous seasons' crops which had not been burned or ploughed under were collected from various wheat areas throughout Canterbury.

An examination of these samples has shown that there is no autumn infestation of wheat by Hessian fly taking place in New Zealand, as occurs commonly in the United States of America. No matter how early wheat is sown—and some of the crops examined were from volunteer seeding—there is no infestation by Hessian fly until September or October the following spring. Two generations of Hessian fly are produced during the year, the first causing damage from October to December, the second attacking from December to February and producing pupæ ("flax seed" stage) which lie dormant until the following spring.

All wheat-stubble samples were infested with over-wintering "flax seeds," the percentage stalks infested varying from 2·1 to 19·6. Further investigation of the over-wintering problem is being pursued, and samples of wheat dressings (third, offal from weed riddle, and cavings) from areas where wheat is threshed by mill are being collected in order to investigate the "carry over" which may occur where such offal is dumped instead of being burned.

Bumble-bees and Red-clover Fertilization.—Correspondence with Britain and the United States of America regarding the possibility of arranging for introductions of long-tongued bumble-bees known to frequent red clover has revealed that it would appear arrangements can be made for the collection in the Northern Hemisphere of fertilized queens during the months of September and October for despatch to New Zealand.

Subterranean Clover Investigation

Mr. J. W. Calder

The permanent subterranean clover investigation area of 72 acres at Ashley Dene has maintained the high production with an average carrying-capacity of 2·36 sheep per acre for the 1946–47 season.

The improvement in the productivity of the land since the investigation was commenced in 1939–40 is well shown by the following comparison :

	Sheep per Acre.
Average carrying-capacity for the first three years	1·55
Average carrying-capacity for the last three years	2·505

This is on land which, prior to the introduction of subterranean clover, supported approximately three-quarters of a ewe per acre under a costly system of short-rotation pastures and considerable cultivation for winter and summer forage crops.

The four individual fertilizer treatments under investigation were continued. During the past two years the treatments which had an initial application of 1 ton of lime in 1937 (C and D) were showing evidence of declining production in comparison with the treatment which had received 5 cwt. of lime every other year (treatment A). The lime status of the soil was determined, and the results indicated that the soil in all treatments other than the one receiving 5 cwt. of lime every other year (A) was low ; as a result of this, a fresh application of 1 ton of lime per acre was applied during the winter to treatments C and D.

The carrying-capacity in terms of sheep per acre of the four fertilizer treatments is given below :—

Treatment.	Average First Three Years.	Average Last Three Years.	Season 1946–1947.
A : 1 cwt. super. alternately with 5 cwt. lime	1·3	2·57	2·36
B : No lime—2 cwt. super. annually	1·2	2·08	1·85
C : 1 ton lime 1937, 2 cwt. super. annually, 1 ton lime 1946	1·7	2·55	2·54
D : 1 ton lime 1937, 2 cwt. super. annually, 1 ton lime 1946, ½ cwt. potash annually	2·0	2·80	2·69

Treatment A is maintaining its high standard of production in relation to the cost of the fertilizers used. Treatments C and D are higher in production, but the cost, also, is considerably higher. Increased production on subterranean clover pasture on light land in Canterbury can thus be secured by a small application of lime and super. in combination.

Farm Machinery Research

Mr. A. W. Riddolls

Effort has been concentrated mainly on the development of a truck-mounted grass-seed stripper, based on an earlier invention for harvesting the large areas of rye-grass, brown-top, and crested dogstail which are allowed to seed every year and which cannot be economically headed with the header-harvester. The principle of the machine is simple, the stripper being mounted on the front of a truck which is driven through the crop at about 15 m.p.h., stripping the seed, which is collected in trays. Hitherto the stripper had been unsuccessful. Experimental work showed that it had been constructed on incorrect lines. As a result of further work an improved machine, which worked most successfully in the recent harvest, has been designed, the high speed at which the work is done making the harvesting of very light seed crops economical. The machine is now at a stage where it can be put into commercial production. An important feature is the light, cheap construction and absence of moving parts.

A successful experimental machine was developed for the removal of stones from the surface of fields to allow the use of harvesting and haying machinery.

Some experimental work was done on a truck-mounted weed-cutter and pasture-topper in the form of a large blade mounted on the truck, the speed of the truck causing the knife to cut. Although very successful in stiff-stemmed weeds such as thistles, the choking of the knife when attempting to top grass paddocks could not be overcome.

A hydraulic drawbar dynamometer for testing the draught of implements was designed and constructed and is now in use.

An experimental spraying-boom was constructed for adapting a tractor-drawn orchard spray for spraying field crops.

Microbiology

Dr. I. D. Blair

Ear Blight and Frost Damage.—*Fusarium graminearum* and *Fusarium avenaceum* have been identified as the predominant fungous cause of ear blight. Natural air-borne infection of spikelets contributes to a much lower degree of ear blight compared with brown foot-rot resulting from stem decay.

Frost damage in the late spring of 1947 caused severe grain losses in North Canterbury when frosts of 12° were recorded in mid-November. Experiments on low-temperature effects on wheat ear development have continued during a second year, primarily for the purpose of defining frost-damage symptoms in contrast with those associated with fungous infection.

Eyespot Disease (Cercosporella herpotrichoides).—An area with a severe eyespot-disease record over four seasons has been set aside for development as a trial ground. Among results for the 1946–47 season no significant differences in infection in standard varieties were recorded, although there was evidence that some varieties were more susceptible than others to ultimate straw break as a result of tiller infection. Among soil treatments it was found that ploughing-in 1 ton per acre of straw caused a sharp reduction in eyespot infection in both autumn- and Spring-sown crops. Other cellulosic materials, including stable-manure, poultry-run litter, and green manure, reduced infection, while organic nitrogen effected no improvement compared with control. In glasshouse plots no *Cercosporella* colonies were isolated from plants grown from seed collected from diseased plants in the previous harvest. Diseased plants were collected in the field at weekly intervals, and throughout the growing season spore production was found to be very slight.

Effect of Erysiphe graminis.—Spore suspension inoculation of glasshouse-grown plants were made at two weeks, two months, and four months after emergence. Observations were made on leaf infection, height of plant, grain per ear, and weight of grain per plant, and it was found that only those plants inoculated in mid-season—viz., after three months' growth—revealed significant detrimental effects of mildew infection.

Efficiency in Commercial Seed-wheat Dusting.—The efficiency of dust coverage is being studied, using an inoculated culture plate technique. Progress results concerning samples submitted by ten commercial firms indicate that the wheat-seed-disinfection practice, costing approximately £13,000 per annum in Canterbury, is being most inefficiently applied. The percentage of efficient dusting in many samples has been recorded as nil, and in few instances was the figure over 75 per cent. efficient dusting. No differences were found in the ability of standard varieties to retain standard dry dusts, and it has been concluded that wherever adequate mixing of dust and seed is provided all standard varieties exhibit an equal dust adhesion. It has been found that wide variations exist in the characteristics of commercial dusting-machines and in the care and supervision of dusting operations, and as a result of this work improvements have been initiated by several seed firms.

Occurrence of Smut Infection.—Sample lines of wheat from all districts have been certrifuged and aqueous suspensions examined microscopically for *Tilletia* spore load. The study indicates that for practical purposes control of *Tilletia* smut has been achieved.

Crop-disease Survey.—Most noteworthy problems during the past season in Canterbury included wheat take-all (*Ophiobolus graminis*) and frost damage to ears, rye-grass blind-seed (*Phialea temulenta*), tomato wilt (*Phytophthera cryptogea* and *Fusaria* spp.), and lettuce mildew (*Bremia lactucae*).

New records include *Septoria pisi*, causing leaf spot in peas, and *Kabatiella caulivera* causing stem scorch of red clover.

Soil Microbiology.—The soil-type distribution of *Actinomyces* and *Azotobacter* species is under investigation, the latter having been found abundantly in about half of the soil samples examined, but no correlations have been noted between soil reaction and occurrence of these bacteria.

Seed Disinfection of Peas.—In field sowings of Massey peas over an eight months' period at two-weekly intervals, no significant improvement in emergence resulted from any dust treatment during the sowings September–March. August sowings showed the benefit of dusting, notably by Spergon. Used crank-case oil, in comparison with standard dusts, during all sowings resulted in a field emergence equal to the dusting treatments. Field soil conditions for the September–March growing period apparently differed to a considerable extent from those occuring in the glasshouse studies reported in 1946, where a significant improvement in germination resulted from the dust treatments at the moisture levels of 50, 70, and 90 per cent. saturation.

Potato Blight.—Spray costing field trials, using a four-row boom attachment, have continued for a second growing season, again under conditions of practically nil blight infection. Costing data indicate that the treatments incurred an expense of approximately £2 per acre and in effect reduced the total tuber yield by about 1 ton per acre. The trial will be continued to include a season of epidemic severity.

Rye-grass Blind Seed.—Seed examination of farmers' samples for pre-harvest infection has continued, and during the past season the disease has been as severe as in any previous year. In the seed-treatment trial it was found that hot water for thirty minutes at 50° C. prevented apothecia formation and the treatment did not impair field germination compared with control. Agrosan and Ceresan dusts failed to check apothecia formation, and after a period of storage, seed so treated germinated lower than the control. A trial area of 1 acre has been established and surface-sown with diseased seed. On this area an investigational programme is being developed.

Wool Metrology Laboratory

Mr. A. E. Henderson

Survey Investigations.—Wool survey was carried out on a number of properties in both Islands. All wool-survey data accumulated since 1940 are being analysed.

Early Shearing.—Further visits have been made to properties in both North and South Islands where pregnant ewes have been shorn prior to lambing. The controlled trial laid down in North Canterbury has given the following results :—

Wool.—Early-shorn fleeces (ten months' growth) averaged 8·9 lb. and realized 24¾d., while late-shorn fleeces from the control mob weighed 10·6 lb. and realized 22d. in the same sale. The early-shorn fleeces were all sound, while the late-shorn mob showed a marked break with a tendency to cotting.

Fat Lambs.—In the first draft, 147 lambs were picked from 150 early-shorn ewes, whereas only 91 were ready from a similar mob of ewes shorn in November. Grades and weights for the lambs and other relevant information on the behaviour of the two mobs are not yet to hand. The trial is being continued.

Progeny Tests.—The Laboratory co-operated in the past season with six sheep-breeders in sire progeny tests, and reports have been made to these breeders.

Intensive Investigations.—Samples have been collected from sheep on varying planes of nutrition. A study is being made in an attempt to determine (*a*) the period at which the break occurs, and (*b*) the extent of the break under the various conditions.

Preliminary work has been done on moisture relationships in slipe wools. Attempts are being made to find a satisfactory means of bringing about a normal regain. Results so far indicate that the problem is of considerable economic importance.

An analysis of greasy-wool production for 1944–45 has been made and a report is being prepared.

Problems on the standardization of greasy-wool counts are being studied.

MASSEY AGRICULTURAL COLLEGE

Nutrition Experiment (Pasture Grazing Trials)

Mr. E. A. Clarke

Manuring Trials.—The seventh year of this trial has now been completed and the results to date analysed. The main effect of the different manuring treatments on a basic rye-grass - white-clover sward has been on the carrying-capacity. The effect of lime is most marked and deterioration of the pastures in the control plots continues. In so far as thrift and productivity of ewes and lambs are concerned, there are still no measureable differences which can be attributed to manuring treatments.

The stocking of these plots with experimental sheep has been discontinued for the time being, but manuring treatments and careful pasture management with sheep are being continued. When treatment differences are more marked, restocking with experimental sheep can be undertaken.

Trials of the Carrying-capacity of Short-rotation Rye-grass (H1) Pedigree Rye-grass.—Pasture establishment on all plots has been excellent and production has been sustained at a high level. The considerably higher production of the short-rotation rye-grass pastures in the late winter and early spring of the first year has not been repeated this year. The pedigree rye-grass plots have since carried more stock at all times of the year, except for a short period during the late spring. The slight superiority of the short-rotation rye-grass pastures at this time may have been due to the exceptionally cold and wet conditions obtaining.

Differences between set stocked and rotationally grazed plots are still not clearly defined in terms of carrying-capacity, but a slight superiority has been noted in the quality and grading of the lambs off the set stocked plots.

Mutton and Wool Improvement (H. Goot).—The analysis of data accumulated by the fleece testing and recording department in the course of its progeny-testing work in commercial Romney Marsh stud flocks has been continued. The main object of these investigations is to obtain a real understanding of the problems confronting the breeder and the difficulties of fitting progeny tests into breeding practices, as well as testing certain sheep-recording systems.

The following papers have been published in the *New Zealand Journal of Science and Technology* :—

"Hairiness in Wool—III: Growth of Hairiness in New Zealand Romney Marsh Lambs."

"Hairiness in Wool—IV: Relationship between Fleece Hairiness and Fleece Weight in New Zealand Romney Marsh Sheep."

"A Note on Progeny Testing."

Research on Hairy Sheep (N-type)

Dr. F. W. Dry

Further breeding experiments have advanced our knowledge of the inheritance of this hairy type. The studies of N-type, so extreme in character, with several features of ordinary sheep magnified, have added to our understanding of the fleeces of both hairy and non-hairy sheep.

With the aid of a special grant for fur-work, new-born skins were secured as trial furs, in view of their use for this purpose suggested by a New Zealand firm. Other firms are now interested in this development. The position is that fur is regarded as possibly giving support to the growing of carpet-wool.

During his visit to New Zealand early in 1946, Professor A. F. Barker emphasized the merits of N-type wool for carpet-manufacture. A New Zealand firm has made trial carpets and is proceeding to breed the sheep on a small scale. Interest in the use of the wool for carpet purposes has also been shown by the representatives of overseas firms.

Propagation Research

Dr. J. S. Yeates

A. *Long-range Investigations*

CO_2 as an Aid in Rooting of Cuttings.—Very definite and positive results have been obtained showing that with cuttings of carnation Otaki Pink better rooting was obtained when the cuttings were supplied with an excess of CO_2. The concentration was raised to approximately 2·5 per cent. at about 8.30 a.m. and 4.30 p.m. each day. The light was approximately three-quarters of the strength of full light from the sky at any time.

Another series of experiments was designed and demonstrated (*a*) that an increased dry weight of the cutting occurred, (*b*) that the effect of CO_2 was extra to that produced by rooting hormones applied at the base of the cutting, and (*c*) the effect of sugar applied at the base of the cutting is additional to that produced by (*a*) and (*b*).

B. *Short-range Investigations*

Rooting of Azalea mollis.—Of the cuttings rooted in the previous year, some hundreds of the most vigorous were boxed up, but less than 5 per cent. survived the winter. During the past summer further work was done on the rooting of cuttings, but in view of the above difficulty we have made initial tests of methods of grafting.

Rhododendrons.—Considerable attention has been given to various methods of propagating these plants—different methods of grafting, rooting of cuttings, and media for the growing of seedlings.

Rooting-hormones.—Continual experiments are under way to test the effects of different hormones, proprietary and otherwise, on the rooting of a wide range of cuttings. The recently published work of Van Overbeck, in which application of sucrose, arginine, and indole-butyric acid aided rooting, prompted tests of the method on cuttings of azalea and of daphne. So far no success has been attained.

Attempts were also made to promote better rooting of *Coleus* cuttings by spraying the parent plants with weak solutions of the weed-killer 2-methyl-4-chloro-phenoxyacetic acid. A wide range of concentrations was used and cuttings were taken at different intervals after spraying. Although more rapid rooting was promoted by these treatments (some cuttings had roots before removal from the parent plant), after a period of some weeks cuttings from unsprayed plants were the most advanced.

Drainage Research

Mr. A. W. Hudson

Experimental Work.—Continuous records of outflows were obtained from experimental mole drains pulled at three different depths and from tile drains "backfilled" in five different ways. Records from the mole drains continue to confirm the belief that shallow moles are more effective initially, but that they deteriorate more rapidly. Information over a further period will be necessary from the tile drains to determine whether limited increases in efficiency from tile drains blinded with straw, stones, &c., will justify the expense involved.

Investigation of the Value of the "Roteho" Tile-trench-digging Machine for Practical Farm Draining.—In September, 1946, this machine, imported by Massey College with the aid of a grant from the Department of Scientific and Industrial Research, was demonstrated (some 1,700 people attended), and has since been in continuous operation draining land on which ex-servicemen are being settled. Experience with it indicates—

(*a*) That for satisfactory and efficient utilization a machine of this type should be under the ultimate direction and supervision of an individual trained and experienced in drainage operations.

(*b*) The machine is likely to reduce costs of tile draining only if operated in conjunction with an efficient organization.

(*c*) Its main attribute lies in the fact that it will increase the output per man per hour approximately eightfold, and that it will facilitate drainage operations by enabling the work to be carried out under dry conditions, when hand labour would be out of the question.

The introduction of the "Roteho" has, without doubt, been fully justified both from the point of view of the work it is doing at the moment and the fact that it has created considerable interest in the question of mechanical ditching for tile draining. This interest is certain to be followed by an increase in the use of machinery for draining wet land.

A full report on the "Roteho" and its cost of operation has been prepared.

A bulletin on farm drainage is in preparation.

Research on the Internal Parasites of Sheep

Mr. J. H. Tetley

(*a*) Time has been devoted mostly to research on the seasonal incidence of parasites on pasture, with attention paid to possible fluctuations due to weather. This has been carried out chiefly upon lambs raised away from pasture in order to keep them free from parasites.

Animals have been put out on ordinary pasture and killed after a defined time, when the contents of the digestive tract are taken for examination. All the species of parasites formed in the stomach and intestines are dealt with.

(*b*) Apparatus has been built for work on the free-living stages of nematode parasites, beginning with the stomach worm, *Haemonchus contortus*. In the past, work has largely been confined to that part of the life-cycle which is spent inside sheep. What happens on the pasture has mostly been inferred. The parasites will now be studied by direct observation in controlled conditions in the laboratory.

Biochemistry Department

Dr. C. R. Barnicoat

Wear in Sheep's Teeth.—As part of a survey, ewe fairs have been visited in the Waikato, Gisborne, and Hastings districts. Observations have again been made on mouths of several hundred sheep (tagged and numbered) in the Taihape and Manawatu areas.

Too many Romney ewes' mouths tend to be undershot. Such mouths wear down quickly, particularly on country naturally "hard on teeth." Width of tooth is another fact: broad teeth last better than others.

District differences are not only caused by pasture deficiencies, but also by climatic differences and management factors. Soft succulent grasses in high-rainfall areas carry long, though not necessarily good, teeth. Close grazing naturally wears teeth down, but whether because of grit or the fibrous nature of the short feed is not yet clear.

Recording work is being continued, and chemical work on the composition of teeth has commenced.

Milk-supply of Romney Ewes.—A digestibility trial with the feed mixture used in last year's feeding experiments (high and low plane of nutrition in relation to milk-supply) has been carried out. No other experimental work was undertaken last season.

Vitamins in Meat (W. A. McGillivray).—Chemical methods for estimating water- and fat-soluble vitamins have been standardized and initial observations made with lambs fed on two extreme types of diet—indoors on hay and concentrates and outdoors on grass. The water-soluble vitamin contents of typical New Zealand lamb organs and muscle are of the same order as those reported elsewhere.

BRANCH REPORTS

APIA OBSERVATORY, WESTERN SAMOA

Director: Mr. J. W. Beagley

Since the reversion of the control of the geophysical work at the Apia Observatory to the Department of Scientific and Industrial Research in December, 1945, a determined effort has been made to reduce the arrears of work and at the same time rehabilitate the Observatory. Modern buildings suitable for tropical conditions, modern equipment, adequate scientific staff trained in Observatory work, and congenial living-conditions for European members of the staff have been made the objectives in the plans for its scientific rehabilitation.

Buildings

Plans for a complete new office block to accommodate both the geophysical staff and the Meteorological Section, Air Department, were drawn up and submitted for approval to the Department of Scientific and Industrial Research and the Director, Meteorological Services. The main office building is in a state of disrepair. Repairs have been carried out on other Observatory buildings.

Instrumental

During 1946 a member of the Dominion Physical Laboratory installed the horizontal seismograph recording-clock which has been redesigned, and carried out other instrumental repairs.

Time Service.—At the beginning of the report year the electrical circuit of the synchronome block was altered to overcome erratic behaviour of the impulse mechanism, which had been troublesome for over twelve months. A new wireless receiver was installed for the reception of time signals. Early in 1947 the Davison chronometer, which had not been giving a satisfactory performance, was sent to New Zealand for repairs.

Terrestrial Magnetism.—The Gauss house was completely rewired and a new lighting circuit installed to eliminate loss of record due to power failures. A new circuit to be used for calibrating the variometers was designed in conjunction with the Dominion Physical Laboratory and is being constructed there. The torsion weight of the magnetometer was sent to the Carnegie Institution, of Washington, to have the scale re-etched and treated for tropical use.

Seismology.—Because the seismological equipment is unable to meet modern requirements for research in this branch of geophysics, consideration has been given to the installation of up-to-date instruments. Approval has been obtained for the construction of a Wood Anderson seismograph by the Dominion Physical Laboratory. Owing to the unsuitability of the lithographic formation at Mulinu'u for sensitive seismographs, a new location which would be satisfactory was sought. The use of a site which will enable the instrument piers to be set on rock was granted by the Administration of Western Samoa.

Tide Gauge.—This instrument has given an indifferent performance and required frequent attention and adjustments to maintain satisfactory recording. The float well has been descaled. The recording-clock is being replaced by the United States Coast and Geodetic Survey. The annual check of the level of the staff with reference to local bench marks was carried out by the Lands and Survey Department.

Recordings

The observational and recording programmes have been maintained. Absolute magnetic observations were made each week and scale values determined on alternative days. The measurement of hourly values is well forward. International Magnetic Character figures and the "K" indices of geomagnetic activity have been supplied monthly to the Department of Terrestrial Magnetism, Carnegie Institution, of Washington. Descriptions of magnetic disturbances recorded have also been sent to this institution for publication in the *Journal of Terrestrial Magnetism and Atmospheric Electricity*. Some progress has been made in overcoming the arrears of annual report work, and the years 1941–46 inclusive are almost ready for publication. The mean values of the magnetic elements at Apia for the last three years, obtained from autographic records, are as follows:—

Year.	Declination.	Horizontal Force.	Vertical Force.	Inclination.
1944	11° 08·0 E.	34,857·1γ	−20,653·9γ	−30° 38·9
1945	11° 11·41 E.	34,861·7γ	−20,651·3γ	−30° 38·5
1946	11° 13·70 E.	34,834·1γ	−20,637·9γ	−30° 38·7

Until the end of September, earthquake recordings were obtained from the vertical seismograph only. Many shocks that should have been recorded were lost, either through lack of sensitivity of the instrument or because of failure of the driving mechanism. Since the return of the recording-clock of the horizontal seismograph this instrument has been operated again. Because of the large number of local shocks experienced the pens are frequently thrown out of adjustment.

Measurement of tide-gauge charts is up to date and the hourly heights have been forwarded periodically to the United States Coast and Geodetic Survey. The tidal waves resulting from the Unimak earthquake of 1st April, 1946, were very marked in Apia Harbour and were well recorded on the tide gauge.

Meteorology

This branch of the work is still being performed by Air Department.

General

Office and Library.—The filing system was overhauled and a new method of letter numbering introduced. The addition of steel filing-cabinets has also made an improvement which was badly needed. A more satisfactory system of keeping office accounts was instituted.

AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: Mr. J. B. Brooke

Although this is the second annual report of the Auckland Laboratories, it is in reality the first report covering a full year's operation, and as such is indicative of the settled policy of the Laboratories and, to a lesser degree, the progress made by the branch since its inception.

The broad general policy of immediate scientific and technical assistance to industry has been followed as the guiding principle of this section, and it has been most gratifying to note the increase in the number, variety, and perhaps complexity of the industrial problems in which assistance has been sought.

It will be of interest to note that, of the 406 jobs undertaken during the year, 302 have been industrial, or an average of 75 per cent.

The Advisory Committee to the Laboratories has met regularly throughout the year and, in addition to assisting the Director in furthering the activities of the branch, has brought forward in report form a number of constructive recommendations of interest to all branches of the Department.

PROJECTS HANDLED

Monthly reports of all work handled have been forwarded both to the Manufacturers' Research Committee and to the Department. The following projects were of particular interest :—

The production of several types of manipulating endpieces for bronchoscopy. An operation for the removal of a screw from the lung has been performed successfully in Auckland several times within the last year, using special equipment made by the Laboratories to the requirements of the operating surgeon.

The design and prototype construction of alternative forms of industrial heating to supplement coal gas and electricity. Considerable work has been carried out on the design of burners, regulators, and generating equipment, and several emergency installations have been made.

The design and construction of a remote-indicating wind direction and force indicator for superphosphate-works.

An investigation into the performance of a variable-speed ring-spinning frame for woollen fibre. This project, which is covered by A.I.D.L. Report No. 1, was completed early in the year and the results obtained circulated through the Woollen-mills Research Association through the generosity of Mr. L. W. Tattersfield.

The design and construction of acid etching-machines for photo-engraving

The design and installation of electrical tank-level indicators to ensure safe and continuous operation of sulphuric-acid plants in a chemical-works.

The design and development of dies and jigs for forming plywood chair-backs, and assistance in the development of the finished article.

The design of a continuous paint spraying, dipping, and drying plant for pressed-steel articles. Infra-red dull emission lamps are used as a drying medium, and a large range of speeds and heat input is available.

An investigation into uneven performance of a carding-engine for a woollen-manufacturing firm was made by recording speed variations throughout the machine, using the equipment developed for the ring-spinning investigations.

A soil-shear-testing machine was designed and constructed for the Auckland City Council for experimental use on earth-dam design and construction.

An increasing number of pressure gauges, temperature indicators and recorders, humidity-controllers, and other industrial instruments were checked, repaired, and recalibrated. Many special tools and gauges, particularly those requiring ground threads or formed relief, were designed and produced, most of this work being handled in collaboration with the Dominion Physical Laboratory. A number of mechanical tests of various materials and manufactured articles were carried out, either to check their compliance with specifications or to give further design data from which the final manufactured product could be improved.

It is hoped to increase the mechanical testing facilities greatly during the next few years.

Optics : Repair, Replacements, and Design.—Equipment has been set up for the polishing, grinding, and cutting of glass and design of optical instruments. In conjunction with the range of optical glass now in stock, most types of lenses and prisms can be made. Orders fulfilled during the past year included the manufacture of spherical and cylindrical condenser lenses ; eyepiece components ; objectives for telescopes, binoculars, and microscopes ; prisms for binoculars ; inspection lenses ; lenses and prisms for hospital instruments ; bubbles for levels and theodolites ; spherical mirrors.

Also included were the engraving of graticules and the repolishing and rebalsaming of lenses and prisms.

General Physics : Measurements and Calibration.—With the limited equipment and standards at present available it has been possible to carry out quite a number of useful measurements, including refractive index and specific gravity of tomato-pulp, moments of magnets, refractive index of prisms, inspection and checking of balances, calibration of a Simmance gas-recorder, manometers, pressure gauges 0–1·000 lb./sq.in., and thermometers.

Investigations and Development.—Some of the investigations which have been successfully completed are as follows: efficiency of fireplaces, composition of natural gases, plate-glass stains, polishing-compounds, and impurities of carbide samples.

Frost-prevention and Frost-fighting.—Preliminary work has been done on this project in conjunction with the Dominion Physical Laboratory, and at the present time a detailed survey of temperature and air-flow condition is being carried out on the State experimental orchard at Earnscleugh, in Central Otago. It is hoped to experiment locally with several designs of orchard-heaters, and probably an artificial wind machine.

Molecular distillation of fish-oils.—This industrial project is still under the technical supervision of the branch, and its successful operation under commercial conditions has given practical information which will assist in the design of the stills now in the process of development by the Dominion Physical Laboratory.

Air-conditioning of Commercial Greenhouses.—Several houses have been equipped with units to give temperature and/or humidity control.

Electroplating.—Seven cases of assistance to nickel, cadmium, silver, and chromium-plating firms have been handled, in conjunction with the Government Analyst. It is hoped to install small experimental plating-baths in the near future to facilitate process checking. Equipment for measurement of thickness of deposit is in the course of preparation.

BIOMETRICS SECTION

Officer in Charge: Mr. I. D. Dick

This being the first annual report of the Biometrics Section, opportunity has been taken to trace briefly the course of biometric and statistical work done in New Zealand prior to 1946. The late Dr. F. W. Hilgendorf first applied statistical methods to agricultural experience in New Zealand, and an article in the *New Zealand Journal of Agriculture* (*Vol. 26*, p. 354) records his analysis, the first recorded in New Zealand literature.

Hilgendorf's example was quickly followed by Messrs. M. J. Scott and A. W. Hudson in that order, and the latter, when Crop Experimentalist to the Department of Agriculture, used statistical methods in wheat, turnip, and potato trials, several of his papers appearing in the *Journal of Agriculture*. Both the Wheat Research Institute and the Fields Division of the Department of Agriculture still maintain and develop the example set by Hilgendorf and Hudson.

Both Hilgendorf and Hudson lectured on the elements of statistical method as applied to field trials at Canterbury and Massey Agricultural Colleges respectively. The next impetus to statistical research in New Zealand was the appointment of Dr. J. T. Campbell to Victoria University College. Dr. Campbell was trained in statistics at Edinburgh under A. C. Aitken, and it was through his activities and the growing realization amongst departmental officers that the present officer in charge of the Biometrics Section was appointed in 1939. Unfortunately, war conditions effectively prevented organization of the Section till 1946.

Reasonable progress has been made throughout the first year, although it will be another four years or so before the Section is operating really effectively. Work has proceeded along four major lines—the collection of an adequate library of technical literature, the recruitment and training of staff, the exploration of methods of handling extensive collections of data, and, finally, research and consultative work.

Arrangements have been made for an officer of the Section to study at Cambridge under Dr. Wishart for a further year on full pay. Another officer has been recently awarded a Shirtcliffe Fellowship by the New Zealand University. The Section has other mathematical graduates in view.

The third major activity was the exploration of possible methods of coping with the long and arduous computations which the Section is frequently requested to perform on extensive collections of data. Attention was turned to the possible use of a punched-card system, and accordingly the Section obtained possession of Powers-Samas equipment

from the Government Statistician. After considerable experimentation it has been found that, using this equipment, computations could be done in one-tenth to one-twentieth the time required for the same work using the latest fully automatic calculating-machines. The Section's gratitude for considerable assistance in this project is due to Messrs. Butchers and Woods, past and present Government Statisticians, to Mr. Woodford, late of the Census Office, and to Mr. Dainty and Mr. Bartlett, of Messrs. Powers-Samas, Ltd.

The research activities of the Section have been largely centred on the punched-card technique mentioned above and theoretical work on experimental designs appropriate to work on identical twins, particular care being given to modifications required in the event of one or two animals being lost to the experiment through disease, &c.

Investigations under way deal with the accuracy of sampling methods used in estimating the production of milk, fat, and solids-not-fat over a complete lactation; of estimating the daily variation of a cow's performance; and the accuracy of dairy experiments. An attempt is also being made to devise a suitable method for calculating the heritability of the shape of the lactation curve.

Advice has been afforded to many branches of the Department and other bodies. Examples are Plant Diseases Division, Grasslands Division, Soil Bureau, Dominion Laboratory, and State Forest Service.

DEFENCE DEVELOPMENT SECTION*

Director: Acting-Professor T. R. POLLARD

The major portion of the programme for 1946 was the construction of four radar height-finders for the Meteorological Services of the R.N.Z.A.F. The work done by this Section comprised the whole of the mechanical structures, together with the thyratron-controlled Ward Leonard sets. The mechanical structures are completed and are being erected in the Canterbury University College grounds for testing. The first thyratron-controlled Ward Leonard set is practically complete, and it is expected that final tests will take place shortly and thus allow the first unit to be despatched to its destination, which, tentatively, is Fiji.

Other work undertaken by this department during the year is the construction of a number of stroboscopes for other Government Departments and industry, the overhaul and calibration of shock therapy machines for the mental hospital, the design and development of an electronic wheat-counting machine for the Wheat Research Institute, and the design and development of a high-frequency electronic sewing-machine for the Latex Rubber Co. A prototype model has been supplied to this company and is being used by them for the welding together of thin polyvinyl chloride fabrics. Six electronic moisture-testers were designed and developed in conjunction with the Wheat Research Institute. These were supplied to industry for the checking of moisture content of wheat crops. They have been very successful, and recently repeat orders have been received for a further number. It is likely that their use will extend into fields other than those of wheat. Tests are being made at the present time to see if they are adaptable for linseed. A special ionization chamber was made up for the Dominion X-ray and Radium Laboratory.

A considerable amount of work has been done for the science and engineering departments of Canterbury College. It has been possible to design and manufacture for these departments apparatus which has been required urgently for the abnormally large classes, thus saving a considerable amount of overseas funds.

A certain amount of maintenance and construction work has been carried out for the Canterbury Project.

A great deal more work could have been undertaken, but the very limited staff made this impossible.

In the ionosphere section, routine recordings of ionosphere data have been continued at four stations, and analysis, coding, and despatch to overseas predicting centres has been satisfactorily maintained.

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* See p. 23 *re* future activities of this Section.

DOMINION OBSERVATORY

Acting-Director: Mr. R. C. Hayes

Time Service

Control of Clocks.—The method of controlling the standard clocks has been the same as in previous years. Transit observations of the planet Venus were made on two days in October for checking the clocks.

Time Signals sent out.—The time-service arrangements continued as previously, except that special time signals sent out twice daily through ZLW for war purposes in the South-west Pacific were discontinued after 31st January. The errors of the main ZLW signals exceeded 0·25 seconds on several occasions during the year, but exceeded 0·5 seconds (0·68 seconds) on one occasion only, in December. Towards the end of the year there was a general tendency for signal errors to increase, owing to increasing solar activity interrupting reception of check signals from abroad. It is expected that improvements in the radio receiving-apparatus and the reinstallation of the free pendulum will overcome this difficulty to a large extent. The ZLW signals failed completely on two occasions, both due to faults outside the Observatory. There were eight partial failures during the year, four being due to causes outside the Observatory and four to battery trouble at the Observatory.

During the year, 1,874 telephone requests for correct time were received, as compared with 1,686 in 1945. The greatest number of calls were received in July.

Public Clocks.—The Government Buildings clock was checked daily at 9 a.m. and regulated when necessary. The maximum errors recorded during the year were 50 seconds fast and 28 seconds slow. The largest uninterrupted run of the synchronous electric clock was from 1st January to 3rd March (62 days). The maximum errors observed during that period were 67 seconds fast and 48 seconds slow. Power cuts caused frequent stoppages of the clock during winter months.

Seismology

Summary of Seismic Activity in New Zealand in 1946.—The chief seismic event during the year was the disturbance in the Lake Coleridge region on 26th June. The main shock originated about ten miles north-north-west of Lake Coleridge at a depth of approximately twenty miles. It was felt in most parts of the South Island, and reached intensity M – M VII + in the epicentral area. The instrumental magnitude was 6. A very large number of aftershocks occurred, mostly originating west of the initial shock, with some apparently beneath the main range of the Alps.

On 12th February a shock occurred with centre in the vicinity of Pipiriki at a depth of seventy to eighty miles. It reached intensity VI + at Wanganui and was felt extensively in both Islands.

On 17th August a shock reported felt at Opotiki originated near Mayor Island, in the western Bay of Plenty; and in October two minor shocks occurred in the Auckland region.

During the latter part of the year there was some increase of activity in the submarine region east of the North Island.

In 1946, 302 earthquakes were reported felt in some part of New Zealand, 87 being felt in the North Island and 219 in the South Island. Four of these were felt in both Islands. The excessive number in the South Island was due to after-shocks of the Lake Coleridge earthquake on 26th June. The maximum intensities reported were M – M VI + in the North Island and VII + in the South Island. Non-instrumental reports of earthquakes are furnished by Post Office and lighthouse officials and by a number of private observers.

Seismograph Stations.—All the seismograph stations were in operation continuously throughout the year. A plan for the development of further stations is being put into effect.

North Pacific Earthquake of 1st April, 1946.—This earthquake caused sea-waves which did severe damage in Hawaii and were observed and recorded on parts of the New Zealand coast. With the co-operation of the Marine Department, records have been collected from tide gauges which recorded the waves.

Requests continue to be received from time to time from persons and institutions abroad for copies of New Zealand seismograph records, in connection with special studies of particular earthquakes.

Strong-motion Accelerometer.—In September a three-component Wenner accelerometer from the United States was set up in the Observatory basement. This instrument is especially designed for vibration work in connection with building-construction.

Geophysical Investigations

Papers on the following subjects have been published in the *New Zealand Journal of Science and Technology*:—

(*a*) "The Seismic Geometry of a Volcano such as Ruapehu."
(*b*) "Note on a Table of Distances from South Pacific Observatories."
(*c*) "Note on Wood-Anderson Records of Mine Explosions at Wellington."
(*d*) "Effects of Surface Relief on Anomalies of Vertical Magnetic Intensity."
(*e*) "A Further Table of Direction-Cosines, for Latitudes 41°–90°."
(*f*) "Some Theoretical Aspects of Anomalies of Magnetic Declination in New Zealand."

A table of distances from seven South Pacific observatories has been completed and will be issued as a Dominion Observatory Bulletin.

A paper on "The Relation of Microseisms to Weather Conditions in New Zealand" is in preparation.

Internal reports have been made on a magnetic reconnaissance at Thames, possibilities of magnetic survey in the thermal district, methods suitable for seismic studies in the volcanic zone, and the scope for wave and beach studies in New Zealand.

General

Maitenance of Equipment.—The maintenance and repair of the clocks, seismographs, and other equipment was carried out by the Dominion Physical Laboratory.

Gravity Determination.—Pendulum observations were made in the Observatory basement by a member of the staff for a determination of the absolute value of gravity.

DOMINION LABORATORY

Director: Mr. W. A. Joiner

The total number of samples for the year was 25,103, as compared with 25,640 in 1945. With the increasing amount of industrial work undertaken and the extensive investigations that are sometimes necessary, the number of samples examined bears little relation to the amount of work being done.

During the year all the more senior members of the staff were constantly consulted on chemical matters by Government Departments and by commercial firms requiring information or assistance. Many industrial problems were brought to the Laboratory by the secretary of the Manufacturers' Research Committee. Chemists of the Laboratory staff served on a large number of committees, more especially on committees of the New Zealand Standards Institute.

The greatest hindrance to the work of the Laboratory at the present time is the serious lack of accommodation, and the temporary buildings now being provided will go only a small way towards meeting the present needs of the Laboratory.

The table printed below shows the number of samples examined during the year by the Dominion Laboratory and its branches :—

Contributor or Department.	Dominion Laboratory, Wellington.	Auckland Branch.	Christchurch Branch.	Dunedin Branch.
Agriculture	20	23	368	3
Air	329	39	..	..
Army	13	12	7	..
Broadcasting	2	..	..	..
Customs	242	2	1	18
Education	4	..	..	..
Food Controller	..	..	..	12
Forestry	8	8	..	..
Government Printer	13	..	..	..
Health	4,211	5,602	6,747	1,985
Housing	160	28	5	..
Hydro-electric	94	..	..	..
Industries and Commerce	28	..	1	..
Internal Affairs	2	..	..	..
Internal Marketing	13	103	154	9
Labour	..	..	..	6
Lands and Survey	..	3	..	..
Local bodies	155	1	213	235
Main Highways Board	55	..	..	..
Marine	..	1	9	..
Mines	101	5	1	5
Native	24	..	..	..
Navy	9	12	..	..
Plunket Society	264	65	48	7
Police	42	245	124	15
Post and Telegraph	39	29	4	2
Prisons	104	..	..	..
Public Works	231	15	31	17
Railways	26	3	40	131
Scientific and Industrial Research—				
Dominion Laboratory	20	..	..	3
Coal Survey	535	..	..	..
Dominion Physical Laboratory	41	..	..	..
Geological Survey	183	..	..	6
Plant Research Bureau	14	..	..	..
Botany Division	11	..	..	..
Plant Diseases Division	97	610	..	..
Soil Bureau	6	..	..	..
Unclassified	15	12	1	56
Standards Institute	8	..	..	..
State Advances Corporation	57	93	8	..
Miscellaneous	636	123	111	71
Total	7,615	7,034	7,873	2,581

The activities of the Laboratory are briefly summarized below.

Rocks, Minerals, and Clays

Rocks for analysis included samples of limestone, marl, phosphate rock, chalk, arkose, diatomite, and serpentine for use in the manufacture of serpentine-superphosphate.

Minerals, for which in most cases highly accurate complete analyses were made for the Geological Survey, included monazite, garnet, titanite (sphene), thorite, clinochlore magno-morenosite (a new mineral), biotite, phlogopite, feldspar, norite, and hornblende sphene. Owing to the small amounts available of such minerals it is frequently necessary to use micro-methods, and for this purpose a micro-balance is being obtained.

Quantities of radio-active elements present in beach concentrates were determined, and much time was devoted to the development of more accurate methods for the determination of uranium and thorium.

Other investigations included studies of brickmaking clays and manufacture of bricks, bentonite, diatomite as a filtering agent, boron compounds used in salt glazing, cement used for hydro-electric dams, Fuller's earth, glass-sand, and whiting from Oxford chalk.

Food and Drugs

Milk.—The numbers of samples examined were: Wellington, 3,731; Auckland, 4,922; Christchurch, 5,104; Dunedin, 1,946.

In the Wellington District the milk is of good quality, especially in the city. More reductase tests should be taken in the outlying districts.

In Auckland the supply is not so satisfactory. A large number of improperly pasteurized milks came from a particular plant during a relatively short period. Due to lack of proper chilling facilities, raw milk sold in Hamilton during warm weather was of poor quality. Watered milks amounted to 58.

As mentioned in the report for last year, some of the milk supplied to Christchurch is low in solids other than fat. There is urgent need for further investigations of this and for improvement at some farms.

Of 1,350 milk samples received from the Dunedin area, 7 per cent. were deficient in fat, 10 per cent, were deficient in solids other than fat, and 6 per cent. were stale. Deficiencies in fat and other solids were more frequent than last year. Stale milks were less in evidence, but the number of watered milks increased eightfold. Samples examined for efficiency of pasteurization showed an improvement, but the position is not yet staisfactory.

In the combined Otago-Southland area added water was detected in no fewer than 59 samples. This is 3 per cent. of the samples received. From Invercargill 7 per cent. of the milk samples were watered, and of the few samples tested for efficiency of pasteurization, nearly half were improperly pasteurized.

Attention was drawn in last year's report to the unsatisfactory condition of the milk supplied in the Otago and Southland Provinces (including the Dunedin City area), and it must be repeated that the position is still far from satisfactory and calls for early attention by the authorities concerned.

Waters.—Regular examinations were made of water-supplies throughout the Dominion, mainly from the health aspect, but an increasing number of analyses of water for use in steam boilers is being made. This work was in the past done mainly for Government Departments such as the Railways Department, but is now being extended to waters used in industrial boilers. A few swimming-bath waters were examined. Industrial effluents were tested for their effect on stream pollution.

Analyses of food and drug samples other than milk revealed the following: "Almond-meal" made from posionous ground apricot kernels; "almond-paste" with no almond; bacon contining boric acid and excessive nitrite; ice-cream not meeting the regulations in milk-fat; sausages with insufficient meat; minced meat and sausage-meat with excessive amounts of sulphur dioxide; milk-shakes not conforming to regulations for milk-fat, and many other similar analyses.

Organic

Research was carried out on New Zealand woods and an investigation was made of the extractives and of acid hydrolysis of one species.

In an effort to overcome the tainting of butter by boxes made of *Pinus radiata* timber, special coatings were applied to experimental boxes for packing butter.

A considerable number of questions on problems related to adhesives and plastics was handled.

Samples which were received for analysis and investigation included chlorinated oil, wetting and detergent agents, rubber hose for use in aircraft oil-lines, pressed-fibre wallboard, strawboard, lanolin, sun-flower seeds for oil-production, and plastic materials.

Toxicology

Poisons detected in police exhibits included arsenic, barbitone, barium carbonate, carbon monoxide, chloroform, disinfectant, mercuric chloride, nembutal, petroleum distillate, phenobarbitone (three cases), sodium cyanide and sodium salicylate.

Arsenical weedkiller was responsible for two accidental deaths and arsenical fly-poison for one.

Arsenic was found in the viscera of a poisoned dog.

Urine and blood from the victims of traffic accidents were examined for the presence of alcohol.

A laxative compounded by an amateur with fatal results was found to consist of about equal parts of Epsom salts and mercuric chloride (corrosive sublimate) which was supplied by mistake for mercurous chloride (calomel).

Death occurred through a mistake in administering 300 grains of sodium salicylate in mistake for glucose.

Oil, Bitumen, and Tar

The samples examined numbered 416, and included 264 samples of aviation fuel. Other examinations included lubricating-oils (including aero and Diesel lubricating-oils), anti-corrosion oils, dashpot relay oils, Diesel fuels, spray oils, tanning-oil, turbine oils, transformer oils, regenerated lubricating-oils, used oils, varnish-thinners, crude petroleum, and turbo-fuels for jet aircraft.

The desirability of revising existing specifications for lubricating-oils was examined.

A rich-mixture supercharged C.F.R. engine for the determination of the knock rating of aviation fuels has been ordered to supplement the engine already in use.

Highways work has included the routine analysis of tars, bitumens, bitumen emulsions; road oils; cut-backs, and tar primers. Various New Zealand tars were examined for suitability for use as road-making materials.

Building-Materials

(See Building Research report, p. 7.)

Physical Chemistry

The main work in spectrochemical analysis was the examination of metals. The type of work has changed since the war ended. There were very few examinations of metals for compliance with specifications, but spectrographic examination of metals was frequently required in the investigation of faults or failures. Much of this work was directly for industry. It included tin from tinning pots, badly annealed copper tubing, gold too brittle to work, aluminium alloy for permanent mould casting, bronze for propeller shafting, zinc ingot, and platinum wire. The preliminary spectrographic examination of alloy steels is proving useful, as it frequently eliminates the need for chemical analysis.

Spectrographic and chemical determinations of the corrosion product from steam-turbine blades was against the presence of appreciable residues from sea water, which had at first been suspected.

On 0·2 mg. of a black deposit from an electric meter it was shown that it was mainly platinum, with some iridium. It was suggested that on this alternating-current circuit, silver or silver-alloy contacts might be more suitable.

Only two investigations were made of organic material: samples of dried yeast were examined for traces of metals and citrus leaves for the cause of chlorosis.

In the only example of forensic work which arose during the year it was desired to prove whether a red spot on a tire was due to paint similar to the red paint contained in a tin. The material (half a millionth of an ounce) recovered from chemical tests was examined spectrographically, and it was found that tests on the material from the spot agreed with tests made on paint from the tin.

The quartz spectrograph with photometer accessory was used for the determination of vitamin A in fish-liver oils and for the determination of transmission curves for visible light of colorimetric filters.

In the early part of the year the x-ray crystallographic apparatus was installed and put into operation. A considerable amount of work with the apparatus was done by an officer of the Soil Bureau, who used the powder cameras for the examination of the clay fractions of soils. The main work for the Laboratory was an examination of pigments of basic lead sulphate.

Some assistance was given to industrial firms on electroplating problems. Reports were prepared on nickel, silver, and chromium plating.

Metals and Corrosion

The most notable feature of this work was the marked increase in the amount of work undertaken for industry. Of the 158 samples analysed, 54 were received through the Manufacturers' Research Committee from industrial concerns.

Analyses were made of cast iron, carbon steel, alloy steel, brass, tin, solder, type-metal, welding-materials, other metallurgical materials, and corrosion specimens. In many of these, metallographic examinations by microscope methods were made to determine their structure. This was considerably aided by the use of the Vickers projection microscope which was installed during the year.

Laboratory trials were made to determine suitable conditions for electrolytic polishing of nickel-silver articles being produced in New Zealand. The process was followed through to the production stage and recommendations were made for the finishing of the electroplated article by electrolytic polishing.

Weld metal was analysed and examined metallographically for homogeneity of structure in connection with the construction of hydro-electric plant on the Waikato River.

Cast-iron pots used for hydrochloric-acid manufacture developed holes. This was shown to be due to the poor quality of the castings. Regions where slag inclusions occurred were attacked rapidly by the acid mix.

Assistance was given to firms tinning copper and steel.

Corrosion problems included mould metal, brass refrigerator tubes, boilers, telephone-cable sheaths, and action of hot mineral waters on alloys used for brazing copper service pipes.

Coal Survey

The Coal Survey Laboratory co-operated with the field staffs of the Geological Survey and the Mines Department in a continuation of the physical and chemical survey of the coal resources of the Dominion.

Samples, including coals, mine airs, and other gases, were received from mine headings, outcrops, and boreholes throughout New Zealand, and special investigations proceeded in the Westport, Reefton, Greymouth, Kaitangata, Mataura, and Ohai districts. Analyses of coal and residues from boiler tests were made for the Fuel Efficiency Service of the Chemical Engineering Section.

Other matters considered included an investigation of the efficiency of household grates, the storage of bore cores at central depots, the explosibility of coal-dusts, waxes in lignites and peats, material being sold to the public as "coal-saver," and the investigation of machinery used in Germany for the making of binderless briquettes. A scheme was prepared for the regular sampling of coal from all producing mines.

The following *Coal Survey Reports* were issued:—

161: "Reefton Coalfield Analyses."
163 and 170: "Proposed New Colliery at Rewanui: Estimated recoverable Coal, Geological Structure, and Analyses."
164: "Briquetting of Mataura Coal in Australia."
165: "Burning Low-grade Coal in Steam-raising Equipment in Australia."
166: "Gasification of Low-grade coals, Australia."
167: "Shale-works, Glen Davis, Australia."
168: "Analyses of New Zealand Coals."
169: "Pike River Coalfield: Reconnaissance Report."
171: "Sampling Scheme for New Zealand Mines."

Chemical Engineering

In collaboration with the Plant Chemistry Laboratory and the Plant Diseases Division, equipment on a pilot-plant scale for the production of penicillin and other antibiotic substances was designed for installation at the Plant Chemistry Laboratory.

With the staff of the Leather Research Association, a small batch-type dryer was designed for eather articles used in the manufacture of boots and shoes.

Technical advice was given to the Internal Marketing Division on dehydration problems, and further technical supervision was provided at the Motueka apple-dehydration factory. The sliced-apple sulphiting equipment was installed early in the 1946 season, and the principal task for the year was completing the reorganization of the apple-processing line prior to drying.

The survey of conditions in tobacco-kilns at the Tobacco Research Station commenced in 1945 was continued during 1946 with a careful survey of airflow, temperature, and humidity in a modified kiln. A design was completed for a cabinet in which a small sample of tobacco-leaf could be cured under carefully controlled conditions of temperature, humidity, and air flow.

For the measurement of low rates of air flow in the tobacco research work, a heated-sphere anemometer designed by the University of Illinois was constructed and calibrated in a wind-tunnel built at the Laboratory and proved very satisfactory for the measurement of air flows of the order of 6 ft. per minute. Similar anemometers made by the Dominion Physical Laboratory were also calibrated.

Plans of a revised design of commercial-size seed-dryer were made available to five firms in Otago and Southland. Technical assistance was given to the firm which had a seed-dryer in operation.

In collaboration with the Fruit Research Officer, experimental work on the recovery of apple-juice from waste material produced at the apple-dehydration factory at Motueka was commenced.

An experimental tray dryer designed in the Laboratory for use in investigational work on the drying of various products was installed. Tests were carried out in collaboration with the Fruit Research Section, Department of Scientific and Industrial Research, for the Government of Fiji to find the optimum conditions for drying bananas.

To provide for industry a service covering all aspects of steam-generating, a Fuel Efficiency Service similar to those initiated by the British Ministry of Fuel and Power in Great Britain and by the Commonwealth Coal Commissioner in Australia was inaugurated. Boiler trials on 16 plants were conducted during the year, including a number in the Wellington District, and some 30 plants, including potteries and brickworks, were investigated in the Otago-Southland district. Considerable savings of fuel are anticipated as a result of recommendations made in each of these reports, and it is considered that by the full adoption of methods such as are being recommended a 20 per cent. saving of coal used for industrial purposes in New Zealand, amounting to 100,000 tons per annum, could be made.

General Investigations

This section of the report includes work done in various sections of the Wellington Laboratory and some of the work done in the branch laboratories.

Additional work for the Police Department included the following: samples of opium; earth, clothing, shoes, &c., in a murder case; wash from illegal stills; paint from a motor accident; fragment of mirror on accused person; obliterated numbers on bicycles; analyses of "tonic wine"; instruments, pills, &c., in alleged abortion cases.

Work on timber-preservation was continued, and involved the analysis of a large number of solutions and treated wood samples.

An interesting case of corrosion of pipes was proved to be due to the activity of the sulphate-reducing bacterium, *Vibrio desulphuricans*. This type of corrosion is now thought to be more widespread than was previously supposed, and further studies are in progress.

A complete survey of all certified plant therapeutants on the market was undertaken. Samples of lime-sulphur, colloidal sulphur, spraying-oils, lead arsenate, and nicotine sulphate obtained both from distributing agents and from orchards were analysed. The results showed that the requirements of the certification scheme are being fully adhered to by manufacturers and that orchardists are being adequately protected in the quality of the spray materials they use. Several samples of D.D.T. dusting-powders were examined with a view to acceptance for certification. In collaboration with the Plant Diseases Division, a series of samples of cabbages grown at Auckland and treated with D.D.T. to control white butterfly and diamond-back moth were examined for the amount of D.D.T. residue contained on the cabbage when prepared for market. The results showed that it should be possible to market cabbages having a residual D.D.T. content of not more than 7 p.p.m.

Bacteriology

Owing to difficulty in obtaining suitable staff, bacteriology is practically confined to the Christchurch Branch, where this kind of work has increased. For the Health Department, potable water, pasteurized milk, milk-shakes, and miscellaneous foodstuffs were examined. For the Department of Agriculture, many milk samples were examined in connection with animal-diseases. Egg-pulp produced at Christchurch and at Timaru was regularly examined. Industrial work included several problems relating to mould growths.

Gas-testing

The gas-supplies of the four main centres and of most of the other main towns of the Dominion were regularly examined for calorific value, pressure, and freedom from sulphuretted hydrogen. Many thousands of meters were tested and stamped. Owing to coal shortages and staff difficulties, gasworks in general had a trying time, but with a few exceptions maintained a satisfactory supply.

Library

The amount of work in the Library again increased considerably.

An effort was made to increase the subject-index information by indexing all the articles in the most important journals as they are received. The usefulness of this has already been appreciated.

As in former years, a wide variety of inquiries was dealt with, including twenty-eight arising from abstracts in the *Industrial Bulletin*.

Papers published in Scientific Journals by Members of the Staff

"The Chemical Analysis of Clays—I: Determination of R_2O_3 and Alkalies." J. J. S. Cornes. *N.Z. J. Sci. & Tech., 27, (Sec. B)*, (1946), 307.

"Cementstone at Feldwick." J. J. S. Cornes and R. Willett. *N.Z. J. Sci. & Tech., 28, (Sec. B)*, (1946), 101.

"Equipment for the Sulphiting of Apple Slices." G. Maskill Smith. *N.Z. J. Sci. & Tech., 28, (Sec. A)*, (1946), 284.

"Fluorine in New Zealand Waters"—

I: North Island Waters—*continued*. G. Chamberlain. *N.Z. J. Sci. & Tech., 28, (Sec. B)*, (1946), 154.

II: South Island Waters. C. F. Denmead. *N.Z. J. Sci. & Tech., 28, (Sec. B)*, (1946), 158.

DOMINION PHYSICAL LABORATORY

Director: Dr. E. Cooper

The year has been a busy one, considerable assistance having been given to a large number of New Zealand manufacturing concerns in the form of tests on materials and equipment, the design and supply of special measuring-apparatus, replacement parts for machinery and small precision tools, and investigations into manufacturing difficulties. In addition, the Laboratory has spent approximately 50 per cent. of its time on work along similar lines for Government Departments. The Laboratory is anxious to devote more energy to the development of New Zealand's natural resources—for example, this year has seen considerable progress on the construction of a pilot plant for fibrating wood with the object of making mouldable wood fibre, further work has been done on the design of more efficient plant for the concentration of vitamin in fish-oil, and a start has been made on the problem of extracting titanium from New Zealand ironsands. These latter types of work are entirely dependent on the supply of experienced research staff.

The Laboratory has performed work in one category or another for 271 separate firms and institutions throughout New Zealand, indicating the extent to which industry is utilizing laboratory facilities.

Work is organized in three main groups—general physics and instrument testing, electrotechnology, and engineering.

Physical Laboratory (General Physics, Testing of Materials, Instrument Development and Calibration).

Major projects which have been worked upon during the past year by this section are :—

(1) *Timber-impregnation.*—Vacuum pressure impregnation of *Pinus radiata* with water-soluble forms of synthetic resins has been carried out.

(2) *Physical Properties of Rock taken from the Site of the Proposed Cobb River Dam.*—The State Hydro-electric Department has requested the Laboratory to undertake the measurement of certain physical properties—density, compressive and shear strengths, modulus of elasticity in compression in the dry and wet conditions—of rock extracted from various parts of the site of the proposed Cobb River Dam.

(3) *Investigation of the Physical Conditions accompanying Frosts in Central Otago.*—Fruitgrowers in Central Otago are faced each spring with threats of serious damage to crops from frosts, mainly of the radiation type. Several different kinds of attempts to combat such frosts have been tried abroad, but until more is known about local conditions it is not possible to advise as to the most favourable method of application. Accordingly, an extensive programme of observations has been organized for both autumn and spring conditions, and upon this it is hoped to be able later to devise means to mitigate the frost hazard.

(4) *Thermal efficiency of open-hearth fires in State houses.*

(5) *Examination of the Conditions affecting the Moulding of Plywood.*—A firm engaged in moulding plywood in various forms using pressure and heat in a single process experienced difficulty in producing stable and unwarped mouldings. An officer from the Laboratory visited the factory to inspect the process and conditions of manufacture and made certain recommendations concerning the moisture content of the timber and the glue-spreading technique.

(6) *The Use of Radio-active Elements as Tracer Materials.*—Plans are in hand to keep a physical check on all such material coming into the country and to co-ordinate and control its distribution.

(7) *Measurements of the Efficiency of Dairy Water-heaters.*—Various makes of dairy water-heaters have been supplied by their agents to the Laboratory for the determination of their efficiencies.

(8) *Heat-insulation of Houses and Mould in Houses.*—Reports on this work have been included in the Building Research report, p. 7.

Instrument Tests and Calibrations

Testing of materials was done over a wide field and included the following tests: casein glue (18), fabrics (46), thermal conductivity of building-materials on 12 in. guard-ring apparatus (10); thermal transmittance of walls, ceilings, and floors in houses (4); pumice and concrete blocks (24); catgut (29); wallboard materials (4); rubber hose (2); plywood (5); resistance to impact of wood (215); electrical conductivity of railway ballast (12); electrical insulating-boards (4); dielectric strength of varnishes (14); efficiencies of batteries (8); also on rubber adhesives, wool, paperboard, asbestos-cement, roofing-sheets, electric plugs and sockets, and field tests on a roofing-slab.

More than 700 different instruments were calibrated and/or adjusted, the main items being indicating thermometers (168), radiosondes (185), and vacuum gauges (104).

Development work was done on equipment designed and constructed for industrial use or by the Laboratory.

STANDARDS LABORATORY

With the co-operation of the Director, National Physical Laboratory, Great Britain, the officer responsible for the planning of the New Zealand Standards Laboratory was enabled to proceed to the National Physical Laboratory for training and discussions in July of this year.

No major work of setting up standards has proceeded since it was considered that waste of effort might ensue until the discussions with the National Physical Laboratory were completed. The standardizing-work this year has covered the calibration of analytical masses, hydrometers, platinum - platinum rhodium thermocouples, sub-standard lamps and photometers, various electrical meters (including sub-standards resistors and potentiometers), gauges, and tools for New Zealand metal industries. In addition, this Laboratory has conducted tests on accumulators, the performance of low-temperature resistors and electromotive cells for use with balloons, radiosondes, and measurements of the rollers and pathways associated with the spillway and intake gates of the Karapiro Dam. The routine intercomparison of the Laboratory sub-standards has been done, and special mention should be made of the kind collaboration of the National Standards Laboratory, Sydney.

DESIGN AND DRAUGHTING SECTION

The following are the major projects on which this Section has been engaged during the past year:—

In September, 1945, a high-vacuum, short-path, molecular still designed earlier was installed at the factory of an Auckland firm. Following this installation, a second still was requested which was to incorporate any improvements suggested from the operation of the first still. The design for the second still is now practically complete and includes many improvements which facilitate manufacture and operation.

A stirred-oil bath for standard pyrometry calibration was designed. New features are a proportional controller to maintain temperatures up to 300° C. constant to ± ·05° C., and improved oil-circulating system.

A simple pyrometer has been designed and manufactured to determine the surface temperature of hot bodies up to 500° C.

Considerable work is being done on vacuum equipment. Included in this work are high-vacuum oil-diffusion pumps of various sizes, equipment necessary to measure the speed of these pumps, leak-detection apparatus, and vacuum gauges.

At the request of the Air Department, designs have been prepared of equipment to demonstrate the functioning and inherent errors of the gyroscopic aircraft compass.

Thermocouple equipment has been designed to measure the temperature midway along the inside of a full-scale rotary cement-kiln.

The Soil Conservation Board have asked for a river-stage recorder which may be used on any river in New Zealand without requiring major adjustments. It was also desired that the high installation costs of conventional recorders be avoided. The design of the instrument is almost complete.

Electrical Electronics and Acoustics Laboratory

In addition to the development of special electrical and electronic apparatus and the testing of electrical materials, the activities of this Laboratory included at first the calibration of electrical meters. Early in the year, however, the electrical standard equipment was taken over by the Standards Laboratory.

The principal work of the Laboratory has been the development of electronic apparatus for research and industrial applications. The work included circuits for piranti-type vacuum gauges for different degrees of high vacuum; dielectric gum-detector for preventing ungummed cigarette-papers from being included in packets; rapid electrical heating of grass for killing enzymes; design of ultra-violet-light scanner and integrator for recording the total radiation of ultra-violet light from the sky; investigation into the design of a crystal clock type of frequency standard; bridge coil oscillator and detector; wool medullometer for grading wool; portable electronic recording circuits suitable for use with resistance-type strain gauges; supersonic methods of measuring the thickness of concrete blocks and pipes; dielectric heating-equipment for sealing Pliofilm bags; calibration of various types of hearing-aids; circuits for reverse D.C. relays; electronic seed-moisture meters; absorption meter; D.C. high-voltage supply; modification of echo-sounding equipment; testing of various electrical water-heating systems; apparatus for determining the magnetic susceptibility of rocks; magnetograph calibrator; adjustment and repair of magneto-meters.

Tests of materials included attenuation tests on polyethylene cable; comprehensive tests on several different types of polyvinylchloride-covered cables for use in automobiles, and comparison with imported cables; testing of insulation boards to B.S.S. 737; moisture proofing and testing of balloon cable; dielectric constants and loss factor of fish-oil.

Radio and Radar Laboratory

Projects completed

Loran Developments.—One of the three equipments required for establishing a local Loran chain was manufactured and installed, the original purpose being to extend the existing Pacific cover to New Zealand. The Pacific chain was, however, discontinued by the United States Forces, and the New Zealand equipment was then used as the basis of a training system for the R.N.Z.A.F. Owing to Air Force staff difficulties, the requirement finally lapsed and the project was terminated.

General.—Other completed projects include the design of voltage-regulating transformers; the testing, repair, and calibration of radiosondes; the development of 3 cm. wave-length power-measuring gear; and the fitting of marine radar in inter-Island steamers.

Projects in Progress

Design and Construction of Micro-wave Meteorological Radar.—Four sets of equipment operating on 10·7 cm. wave-length are being constructed for the Meteorological Service (Air Department). One set is almost complete, and the remaining three are expected to be completed by December, 1947. The first set will be installed at Whenuapai, the second at Suva, and the others at Palmerston North and Taieri or Invercargill.

Cosmic-ray Investigations.—An automatic radiation-recorder, using Geiger-Mueller tubes in coincidence and running from battery supplies, has been made and will be used for preliminary work in the Wellington area.

Further equipments are in development, one suitable for recording short-interval changes at a ground station with small statistical error, and a second for observing radiation at heights up to 35,000 ft. The particular interest of the latter is the investigation of the anomalous condition of meson radiation at 15,000 ft. which has recently been reported in the Northern Hemisphere.

Radio Communication in Mountain Areas.—Tests have been conducted on behalf of the Tourist and Publicity Department using two-way radio-telephone equipment which showed that successful communication could be achieved over distances as great as twenty-three miles in mountainous country, and equipment is approaching completion.

Marine Radar.—Routine inspection and maintenance of marine radar has proceeded during the year; the list of vessels visited includes "Rangatira," "Wahine," "Waikemo," "Hinemoa," "Rakaia," "Lautoka," "Rangitikei," "Rangitata," &c.

Transmission of 3 cm. and 9 cm. Radio Waves in Tropical Areas.—The efficiency of microwave radar in tropical areas is seriously affected by rainstorms owing to absorption of energy by the rain and to interference caused by energy reflected back to the receiver from the rain. Equipment developed and used in England for measuring the absorption has been received and will be used in the Auckland area, where rainstorms can approach tropical intensity. Observations of reflection from the rain will be made simultaneously, using 3 cm. radar.

Prediction of Transmission of Radio Waves.—Studies have been undertaken in an effort to improve the reliability of predictions of radio circuit operation. Data derived from the analysis of circuit performance records and observations of phenomena associated with changes of performance will be correlated. Observations are available from various sources on sunspots, solar noise, magnetic storms, earth currents, ionosphere conditions, and aurora.

The Canterbury Project

The Canterbury Project is a long-term investigation in radio meteorology to determine the effect of the Canterbury Föhn wind (nor'wester) on the propagation of ultra-high-frequency radiation in the troposphere. The influence of the sea breeze is also being investigated. The results of the experiments will be of world-wide application, and the United Kingdom has taken an active part in assisting with personnel, material, and finance. The United States of America has contributed a quantity of meteorological equipment on loan.

The bulk of the personnel and equipment arrived at headquarters area of the project at Ashburton Aerodrome in May, 1946, and there followed a period of installation and organization work which was not concluded until mid-September. The United Kingdom party of six arrived in June, followed shortly by their equipment.

Full operations commenced towards the end of September, but since that date there has been a phenomenal paucity of north-west conditions, and only a meagre quantity of data has been collected this spring and summer. By late November it was apparent that the investigation would have to be extended to the end of 1947 to ensure the collecting of sufficient data to answer the various problems involved.

The quality of the data obtained in field observations has been of good standard, and improvement in techniques as the summer progressed has resulted in the maximum of useful information being obtained in an operational period with the facilities available. Final analysis of a large section of the results is being undertaken by Telecommunications Research Establishment in the United Kingdom, and they have expressed themselves gratified with the data furnished to them to date.

The results obtained during the spring and summer allow no more than a few tentative and very general conclusions to be made at present, but they indicate that, with a normal season next spring, ample data should be obtained to ensure a satisfactory solution to the problems. When conditions are not favourable for work on the main project, the party is engaged on a subsidiary research programme related to current radar and meteorological problems.

Engineering Laboratory

Precision Moulding Technique.—Investigations have been started on the production of non-ferrous castings by the investment process.

Photoelastic Investigation of Knee-joints.—In order to widen the available knowledge on the stresses set up in a rigid frame structure, photoelastic models have been made up for analysis. Particular reference is being made to the type of haunch.

Mobile Drilling-rig.—Designs have been completed and all arrangements made for the supply and manufacture of drill rig.

Dynamic Balancing-equipment.—After some unsuccessful experiments with various designs for which experimental pilot plants were made, a design was finally decided on and completed involving a mechanical pick up which resonates and excites a strobe lamp through a vibration pack.

S Curves for Tool Steel.—The recent advances made in the heat treatment of tool and die steels have made it necessary for a full survey of all steels used in New Zealand and of the use of the recently published time-transformation (S) curves. Heat treatment under these conditions consists of quenching the hot steel into a salt-bath furnace held at high temperatures. The hardness of the steel depends upon the temperature and the time held in the bath. This method eliminates stress cracks due to quenching.

Sand-testing Equipment.—In order to undertake the control of moulding and care of sands in New Zealand foundries, equipment has been built to test the moisture content, grain fineness, permeability, and tensile and compression strengths of sands. It is proposed to make a thorough investigation of the moulding properties of New Zealand sands as soon as staff permits.

Recording-equipment for dynamic stress and production of wire-strain gauges.

Experimental pilot plant for wood fibration, using waste wood.

Electrolytic polishing.

Weld Tests and Metallurgical Investigation of Welding Technique: Welding of Rock-drilling Tool Bits.—A general research was carried out on the metallurgy of welds. Particular reference was made to the heat-treatment effect of each run of weld. The crystallographic structure so obtained was allied to the time transformation (S) curves for the steel. Results obtained from these experiments were used to study the reclamation of tool bits by welding the tips up to normal size.

Investigation of die-casting technique.

Strain-hardening of Metals.—Investigations into the hardening effect of metal due to the application of load (work-hardening) and the results of this upon the ultimate tensile strength, ductility, &c., of the steel sample.

Portable X-ray Equipment.—Designs have been completed for making the 250 kV. x-ray plant portable so that it can be conveyed per trailer to any part of New Zealand. A 15 kW. trailer-borne power plant acquired as reparations will further extend the use of the equipment to remote parts of the country where electric power is not available. It is proposed to include with the x-ray trailer, equipment for measuring strain in metal structures by electrical means. With the double unit it will be possible, therefore, to examine bridge and similar structures.

Ironsands.—Equipment is being built and experimental work started in an endeavour to separate iron, titanium, and vanadium from Patea ironsands.

The following routine work has been dealt with (the Engineering Laboratory is the official test-house for the Civil Aviation Department in matters relating to materials testing): calibration of pyrometers and thermocouples (45 separate applications for assistance); metallurgical and strength tests on welded metals (78 separate applications); strength tests on miscellaneous metal components covering steel bar, steel plate, bolts, 115 aircraft rocker-arm bolts, knives, concrete blocks, aircraft spar attachment plate, aircraft metal links, disc-harrow blades, aircraft engine push-rods, crane hook, aircraft engine exhaust-valves, aircraft fittings, toggles, chain slings, washers, rivets, aircraft-propeller oil-line, aircraft counter-weight bearings; aircraft glue samples; milling-machine cups; melting-points of Seger cones; x-ray examination of castings and welds; 28 applications for metallurgical examinations of metals and examinations of heat-treatment procedures and foundry practices; hard chroming of steel tools (5); crack detection in die; concrete chimney section.

Fine-instrument Workshops, including Glass-blowing, Glass-grinding, and Electrical Instruments

The Fine-instrument Workshop has been engaged on the finer types of instrument construction and repair work, and the following analysis shows the number of instruments of different types dealt with: cameras (5); surveying-instruments (81); meteorological instruments (43); optical instruments (4); clocks, chronometers, stop-watches (47); seismographs (4); drawing-instruments (6); and miscellaneous measuring-instruments (53). The equipment at Apia Observatory was overhauled by this section during the year.

The Electrical Instrument Workshop has dealt with the following instruments: ammeters, voltmeters, multi-test meters, valve-testers (98); pyrometers, pyrostats, and recorders (26); galvanometers (29); other electrical instruments, including light-meters and exposure meters (26).

The glass-working section has suffered through not having a qualified glass-blower, but has handled the repair of 50 pieces of laboratory equipment.

Precision Workshops, including Tool-room and Instrument-construction

Tool-room (including Machine-shop, Grinding-room, Heat-treatment Room, and Sheet-metal Shop)

The Tool-room has handled some 800 separate requests for the manufacture of tools, and each request may have involved the construction of several items. The following analysis gives some idea of the number of tools dealt with: gauges (52), heat-treatment (3,432 pieces), taps (226), dies (61), chasers (61 sets), hobs (8), cutters (117), grinding following heat treatment (297), grinding alone (35), reamers (50), mandrels (6), collets (7), and miscellaneous (213).

Under miscellaneous are included replacement parts for factory production machines which might otherwise be idle until replacements could be imported. It also includes the repair and putting into service of production machines. A great deal of precision work has been done which, prior to the acquisition of this Tool-room, would have been sent overseas or accomplished by makeshift or expensive means. The following are brief descriptions of some special items which will illustrate the complexity and precision of the work done by the Tool-room: spindles and bearings for Broadcasting Service recorders; crown stay-taps for Railway Workshops (these were unobtainable in New Zealand and lack of them was seriously hampering boiler repair in Railway workshops); a milling-machine lead screw for a Hutt Valley engineering firm; special tools were designed and made for an Auckland firm engaged in the manufacture of musical instruments (flutes); special bent-nut taps were made in high-speed steel and thread ground for a firm engaged in the manufacture of nuts; circular-form tools for the manufacture of tongue and grooved wooden flooring; thread-rolling wheels for the manufacture of tooth-paste tubes; hobs for use in manufacture of washing-machines; a number of small broaches for a firm manufacturing vacuum cleaners; a seed-packing machine serviced and put into operation; glass rolls for polishing leather reconditioned for an Auckland tannery; a number of circular cutters for a firm engaged in steel-tube manufacture; parts for electric-lamp-manufacturing machines have been made (these parts were otherwise unobtainable in New Zealand, and the finish and performance of the parts made at the Laboratory have been highly praised by the firm concerned); a jet-control shaft for a turbo alternator for the Waimea Electric-power Board; Deep-hole-drilling tools have been designed, made, and used successfully in making parts for electric-lamp machines mentioned above; a dividing-plate was drilled for a dividing-head for a local engineering firm; a number of coil-formers and mandrels for a firm manufacturing loud-speakers; large shell-reamers for reconditioning motor-car engines; mattress-stitching machines have been repaired and serviced for two mattress-manufacturing firms; rollers for cardboard-box-making machines; a firm manufacturing builders' hardware has been assisted by the making of a shaving-die, and also a ninety-six-pin mould for brass injection moulding of window-stay latches; the Returned Servicemen's Re-establishment League has been assisted by the provision of tools for cutting micarta and stainless steel.

Instrument Workshop

This Workshop was set up during the year in a separate room, after having operated for some months as a group in the Tool-room. The following are some of the more interesting jobs handled during the year and give an indication of the variety of the work :—

Portable manometer for measurement of velocity and static head in air ducts; a fabric abrasion machine for testing motor-car upholstery fabrics; a foot-measuring instrument for use by Standards Institute in New-Zealand-wide survey of dimensions of children's feet; a balance for quick measurement of specific gravity of rubber and other materials; equipment for rotating deflection coils round cathode-ray indicators of meteorological radar sets synchronous with aerial; radio frequency coaxial line and components for radar equipments; a form of periscope for viewing the pantograph of an electric locomotive from the cab while the locomotive is in motion.

In addition, the following apparatus, which is described under "Design," was built: molecular still, diffusion pumps, leak-detecting apparatus, surface pryometer, portable potentiometer, and electron microscope.

FATS RESEARCH LABORATORY

Officer in Charge: Dr. F. B. Shorland

The Fats Research Laboratory was established in Wellington on 1st April, 1946, to conduct researches on fats of animal, vegetable, and marine origin, emphasis being laid on the nature of the fats themselves rather than on their characters as foodstuffs. Fats in the form of butterfat, tallow, wool-fat, linseed-oil, fish-oil, and whale-oil represent a considerable proportion of the actual and potential wealth of New Zealand, and it is felt that the projected researches will enable a more complete utilization and development of these raw materials. Up to the present time the main attention of the Laboratory has been focused, in close collaboration with the Dairy Research Institute, on the nature of the fats in dairy products, especially butter, although some attention has been devoted to various other fats of direct interest to New Zealand industries.

Butterfat Investigations

The physical properties of butter, such as texture, are associated with the complex range of fatty acids present (fatty acid composition) and their mode of combination (glyceride structure), while the keeping-quality and aroma are largely dependent upon the minor constituents of the unsaponifiable and phosphatide fractions. The elucidation of these aspects of butterfat composition will undoubtably provide a much more complete understanding of the nature of butter than has hitherto been possible.

For the present the work has been concentrated on the development of technique, using one sample of butterfat with a view to testing the accuracy of the methods used in anticipation of a comprehensive survey of the composition of New Zealand butterfats commencing this spring. The lines of investigation in progress may be divided into the following :—

Fatty Acid Composition of the Glycerides.—A series of eight analyses of a sample of butterfat showed that the standard deviation of the molar percentage of the saturated acids (C_4–C_{18}) varied from 0·5 for C_{10} to 1·8 for C_{16}, while that of the unsaturated acids (C_{10}–C_{20}) varied from less than 0·1 for C_{10} to 2·6 for C_{16}.

A single analysis of each of two samples revealed significant differences in total C_{16} + C_{18} unsaturated acids and in total saturated acids, but the differences observed between the individual acids were not significant.

Methods of analysis involving methanolysis or ethanolysis with sulphuric acid catalyst were not found to be more expeditious than the more conventional method involving separation of the volatile acids by steam distillation and esterification of the

non-volatile acids after resolution into solids and liquids. In addition, it was found that methanolysis and ethanolysis resulted in a considerable lowering of the iodine values of the C_{18}, and especially the C_{20}, unsaturated acids.

Glyceride Structure.—Studies on glyceride structure have been confined to the determination of the amount of fully saturated glycerides by oxidation of the unsaturated glycerides with permanganate in acetone solution. A series of eight determinations yielded an average value of 39 mols. per cent. of fully saturated glycerides, the standard deviations being 1·9 mols. per cent. The fully saturated glyceride content of this butter exceeds the value expected from the saturated acid content by some three or four units. This may mean either that this butterfat has an unusual glyceride structure or a more complete recovery of the fully saturated glycerides than previously obtained by other workers.

Characterization of Acids of Butter Glycerides.—The assumption has generally been made that the monoethenoid C_{18} acids of butter are comprised solely of oleic acid. Preparation of pure monoethenoid C_{18} fractions of butterfat and of olive-oil by fractional crystallization at low temperatures from acetone and methyl alcohol showed that, while olive-oil readily yielded oleic acid (m.p., 12·8–12·9°), butterfat gave a fraction, which melted indefinitely some three or four units lower, indicating the probable presence of one or more isomers. The probable presence of one or more isomers of oleic acid in butter is of distinct interest in increasing the random distribution of the acids and providing a lower melting-point fat than would be the case if the monoethenoid C_{18} fraction were composed solely of oleic acid.

A concentrate of C_{20} unsaturated acids, which form a minor and little-known fraction of butterfat, was prepared by fractional distillation of the methyl esters. By spetroscopic isomerization it was found that approximately half the total fraction was monoethenoid, one-third diethenoid, and the remainder mainly tetraethenoid, the di- and tetraethenoid acids being mainly in a conjugated form prior to isomerization.

Phosphatides and Unsaponifiable Constituents.—Studies of the phosphatide fractions which separate with the serum during the dehydration of butter by centrifugal separation showed that the C_{18} and C_{20} unsaturated acids were much more highly unsaturated than those present in the whole butterfat. The phosphatides were also found to contain nearly seven times as much as C_{20} unsaturated acids as found in normal butterfat, from which it also differed in the absence of lower saturated fatty acids. The unsaponifiable constituents, including principally cholesterol, were found to be concentrated to the extent of 2·11 per cent. in the serum glycerides, as compared with 0·65 per cent. in the dried butterfat. Investigations on the nature of the unsaponifiable fractions is continuing.

Fish-oil Investigations

Molecular Distillation.—During the course of the year, using fish-liver oil containing 34,000 I.U. per gram of vitamin A, some 77 lb. of distillates of average concentration of 200,000 I.U. per gram, but ranging up to over 300,000 I.U. per gram, were prepared using a still of novel design for which a patent has been applied. Arising from this work, vitamin A concentrates are now being produced commercially in New Zealand to meet the keen demand overseas for this product.

Eel-oil.—The results of a survey of fresh-water eels made in collaboration with the Marine Department during the war have now been assembled. It has been found that the oil content of both the long- and short-finned species increases with age up to as much as 23 per cent., the migrant eel containing as much oil as the largest size of immature eel. The oil content of the immature eel was found to be largely concentrated in the tail, while in the case of the migrant the oil was found to be much more uniformly distributed. The data thus collected has application, in connection with the eel-canning industry, which has already produced some 80 tons of canned product for UNRRA. It is hoped that this industry will continue and that the eel-oil-extraction plant at Lake Ellesmere will soon be in production. In regard to this project, technical advice has been provided.

Miscellaneous

In connection with the utilization of horse flesh in Auckland, considerable supplies of horse-oil have become available. The composition of this oil is under investigation, and tests are being carried out to determine its drying properties for use in association with linseed-oil. Neatsfoot-oil is being investigated to test its suitability as a diluent for vitamin oil concentrates.

From time to time advice has been sought in connection with the vitamin A content of fish-liver oils and a number of determinations have been made. The accumulated material from earlier work on shark-livers is slowly being worked up as part of the survey of New Zealand fish-liver-oil resources. Work is also proceeding on the phosphatides of linseed-oil and on the constitution of the hexadecatrienoic acid recently isolated from rape.

GEOLOGICAL SURVEY

Director: Mr. M. Ongley

During 1946–47, field geologists have been mostly engaged on urgent jobs, but have regionally surveyed and mapped parts of Motatau in North Auckland, Waitotara-Wanganui, d'Urville Island - Dun Mountain, and the so-called "mineral belt" of Nelson and the type locality of the Maitai Series, Moeraki-Oamaru type of the classic Oamaru sedimentary beds, Monowai, the most western continuous sedimentary beds of Southland. White Island was examined by two officers from 7th to 14th January and also visited again later.

The coal situation has demanded continuous work in the coalfields at Greymouth, Reefton, Ohai, and Wangaloa and occasional work at Kamo, Tatu, Retaruke, Burke's Creek, Pike River, Mount Davy, Paparoa, Blackball, and Elliotvale.

The limestones of Southland and the limeworks have been examined in detail, maps and a report having been prepared. The bulletin on the auriferous lodes of Reefton has gone to the editor. The natural gas at Greymouth has been reported on.

Problems in water-supply are becoming more and more urgent and require more investigation. If the geology of the district has been already done, it is easier to report on water-supply, but in many places scraps of evidence have had to be hastily searched for. Districts reported on include Opua, Whangarei, and other parts of North Auckland, several parts of Auckland City and suburbs, Wairakei, Otahuhu, Mangatainoka, Blenheim, Picton, North Canterbury, Canterbury Plains, Goodwood, Southland, and Stewart Island. Hot-water supplies have been reported on for Helensville, Wairakei, Rotorua, and Maruia.

The activities of Ruapehu volcano have been investigated and shown to be waning normally. Not enough work has been done in New Zealand volcanology to predict what will happen.

Ironsands have been surveyed, mapped, and reported on at Wanganui and Waitara, and duplicate collections of 100 samples have been deposited at the Geological Survey.

Samples of all clays near Wellington have been collected, and samples have been also collected as required from North Auckland, Oamaru, Benhar, Hyde, &c.

Bentonites were sampled at Blue Slip, Oaro, Kekerangu, and Waipara. Those at Kekerangu were surveyed and mapped in detail.

Stone-quarries and outcrops have been reported on from many places, including North Auckland, Piako, Waikato, Bluff, &c.

Dredge concentrates, building-stones, gem-stones, numerous rocks, and minerals, &c., have been examined.

Dam-sites have been reported on by the geologists at Waikato, Waikaretaheke, Cobb River, Picton, Waitaki, Clutha, and are kept under examination. The sites along the Waikato have been continuously studied geophysically.

Data for engineering problems have been searched for at the dam-sites, Ohope Beach, Manawatu Gorge, Rimutaka, and Wanaka.

A geological bulletin on "The Geology of Te Kuiti Subdivision" and a geological memoir on "An Outline of Late Cretaceous and Tertiary Diastrophism in New Zealand" have been published.

The palæontological work included examining the material collected by the field geologists and others, reporting on collections (including the "Golden Hind" material), Campbell Island, Otahuhu well, and field-work in Oamaru, Wangaloa, and Wanganui. The systematic report on the stages of the Upper Cretaceous and Tertiary strata has been published in the *Journal of Science and Technology*.

During August, 1946, the Chief Palæntologist attended the A.N.Z.A.A.S. meeting at Adelaide, where he was brought in touch with many current problems in geology and palæontology.

The bulletin and reports have been illustrated by many maps and sketches, the work of the draughting staff.

INFORMATION BUREAU

Officer in Charge: Mr. D. Cairns

Technical Information.—Major inquiries, answered either by officers of the Bureau or by reference to the appropriate divisions, have totalled 160 in the last six months. A wide range of more minor requests has been dealt with.

N.Z. Journal of Science and Technology.—Considerable arrears of publication have been overtaken and it is expected that the *Journal* will shortly be up to date. A consolidated author and subject index for volumes 1–25 which has been prepared is now in the press. It is hoped from now on to publish such an index at the end of every five volumes. The circulation of the *Journal* has been much increased over the last year, due to the inauguration of many new foreign exchanges and the renewal of old relationships as normal postal services are resumed.

Bulletins.—The following bulletins have recently been published, are in hand, or are in the press. Photolithographing of some bulletins is being undertaken by the Lithographic Department of the Government Printing Office to ease pressure in the letterpress sections:—

No. 93: "Investigation of the Clarendon Phosphate Deposits," by R. W. Willett. 5s.

No. 94: "Soils and some Related Aspects of Agriculture in Mid-Hawke's Bay," by I. J. Pohlen. 5s.

No. —: "Soil Erosion in New Zealand—Part I: Southern Half of North Island," by L. I. Grange and H. S. Gibbs.

No. —: "The Epidemiology of Nematode Parasitism in Sheep—Part I," by J. H. Tetley (to be photolithographed).

Industrial Bulletin.—Published jointly with the Department of Industries and Commerce, the *Bulletin* is primarily for the use of manufacturers. Abstracts and reports have been supplied throughout the year.

Library.—During this year there has been a large increase in books, pamphlets, and periodicals coming into the library. This is a result of renewal of exchanges and an increase of material from the Scientific Liaison Officers, together with the building-up of a reference section. An effort is being made to adopt standard library routines to make this information more readily available. All books are classified by Universal Decimal Classification, pamphlets are filed under subject headings, and card system of loans has been introduced. Training has been given to branch librarians whenever possible.

Technical Records.—Five thousand technical reports were received from overseas and index lists circulated to Universities, Government Departments, and to industry through the *Industrial Bulletin*.

Publicity.—A considerable number of articles have been prepared for both local and overseas journals and for the press. A departmental publicity booklet is nearing completion.

Miscellaneous.—Reflex photographic copying and translation services have been initiated, and an extended service will be available in the coming year.

War History.—A start has been made on the war history of the Department and several sections are completed and in hand.

MAGNETIC OBSERVATORY, CHRISTCHURCH

Director: Mr. H. F. Baird

Terrestrial Magnetism.—Magnetographs at Amberley operated satisfactorily. To cope with increased magnetic disturbance usual with the approach of another sunspot maximum, some magnetographs during the year were suitably desensitized. Now, for the first time, we can record a very wide range in magnetic storms. Although more frequent this year, these storms have not been extremely large, but many disrupted radio and telegraphic communications, often during auroral displays. Collection of data on associated effects in magnetic activity, auroræ, cosmic radiation, and ionosphere conditions proceeded so as to help solve or bypass difficulties in means of communication. By concomitant exchange of such data, New Zealand made a reasonable contribution towards world-wide endeavours which aim to explain the, as yet, unknown origin of the earth's magnetism and some of its instabilities. In this same spirit Dr. H. H. Howe, of the United States Coast and Geodetic Survey, as a member of the Byrd Expedition, specially visited Amberley to compare the instruments at Amberley against those used by him earlier in the Antarctic. For this reason all four Byrd expeditions sent scientists to Amberley.

Magnetic Resurvey.—At the request of the Marine Department, magnetic stations were put in at Omapere and Port Jackson in order to improve navigation charts. To check the rate of natural slow persistent changes, eight stations were reoccupied over the North Island, but only one in the South Island, at Henley. Plans for needed stations in the thermal area were discussed in the region with the Department's volcanologist.

Staff.—All members of the staff formerly with defence Forces have resumed duties and are again attending University. Set-backs due to loss last year of trained staff to Apia Observatory are being offset by recent transfer of cadets and a senior computer.

Recordings.—Volunteer observers in Canterbury have given very valuable reports on the increasing number of auroral displays ruling with the approaching sunspot maximum. The cosmic-ray meter operated satisfactorily when essential supplies were available either locally or from its owners in the United States of America. Climatological data typical of city household or factory sites were extended by daily observations throughout the year. The year 1946 proved the wettest one on our records, which began in 1902. Much use continues to be made by the public of climatological statistics. After forty-five years of continuity, earthquake-recording at Christchurch ceased temporarily on 18th March, 1947. The building over the recorders vitiated records, so it was decided to remove the seismographs to a disused military laboratory near Glentunnel. It was hoped that an inland site might be sufficiently free from natural ground unrest to prove suitable for more modern recorders, but already Glentunnel has proved very disappointing. Other areas, especially on hard rock, are available for testing before the instruments are again housed at Christchurch in a new cellar with no detrimental superstructure.

METEOROLOGICAL BRANCH

This Branch remained under the control of the Air Department during the year and its activities are reported in the annual report of that Department.

NUCLEAR PHYSICS SECTION

The reconnaissance survey of the Dominion's resources of uranium and thorium has proceeded to a point where an indication can be given of the possibilities of recovery should these minerals become of high commercial value. In the case of the recovery of tailings from certain dredges, it has been found that in order to effect complete

recovery of uranium the work of the dredges would have to be slowed down and the output of gold thus reduced. Consequently, effort has been devoted to new and important methods of separation of the heavy minerals from such tailings and from certain sands.

An officer of this Section has spent some considerable time in Australia studying methods of flotation and separation of heavy minerals, and, as a result of this and also of other investigations elsewhere, equipment is in process of assembly so that such separation can be carried out more efficiently. It seems reasonably hopeful that small-scale production could, if necessary, be carried out in future.

Equipment.—During the year a number of light portable gamma-ray counters were produced. Laboratory-type counters were constructed and work commenced on beta-ray counters. Equipment was made available to outside laboratories for biological and chemical research and for geophysical prospecting.

Geological and Mineralogical Work.—Routine work continued on the testing of samples selected by members of the Section and those sent in by the Geological Survey, other Departments, and members of the public. Valuable experience was gained in bore-logging by radioactive methods. These appear to have special usefulness also in coal-seam estimations, since coal is in general very inactive compared with surrounding strata. Considerable work has been done on chemical methods of estimation of uranium and thorium.

PLANT CHEMISTRY LABORATORY

Director: Dr. J. Melville

Chemical Laboratory at Agronomy Division, Lincoln.—In order to extend to forage crops the work which is being done on pasture plants at Palmerston North, a laboratory is being established at the Agronomy Division, Plant Research Bureau.

Vitamin Analyses.—Due to alterations in the Food and Drugs Act, which now requires that any product which is advertised as containing one or more vitamins must have the minimum vitamins content quoted on the label, various commercial firms have asked for analyses of the B group vitamins. A survey of the vitamin B content of various cuts of meat has also been made at the request of the Food Committee with results which are in substantial agreement with those reported from other countries. The survey emphasizes the high content of thiamine, riboflavin, and nicotinic acid in liver and kidney.

The technique for microbiological assays has been greatly simplified by the introduction of freeze-dried cultures and media. Continuous subculturing of the organisms with its attendant difficulties is no longer necessary, while sufficient media for a year's analyses can be prepared in one operation.

Pasture Growth Studies.—In collaboration with Grasslands Division, studies of the factors influencing pasture-production are being continued. One phase of this work started from the observation that no synthetic mixture of fertilizers gives yields of herbage comparable with those obtained from the droppings of grazing animals. Since it has been established that herbivorous urine contains considerable concentrations of plant hormones, an investigation of the effect of these materials on fertility and the growth of pasture plants is in progress. The nitrogen cycle in pasture is also being investigated on a collaborative basis in order to delineate more clearly the effect of clovers and of the grazing animal, and to determine the place of artificial nitrogenous fertilizers in grasslands management.

Hormone Weed-killers.—A successful trial of these new weedicides has been conducted in Ashburton County on a cocksfoot crop which was badly infested with nodding thistle. Control of the weed by both dusts and spray was entirely satisfactory.

Trials have also been carried out which demonstrate the extreme care which must be observed in washing the last traces of these weed-killers from spraying equipment before using them for other purposes. Failure to take these precautions has already resulted in serious loss among susceptible plants.

Antibiotics.—The fabrication of the pilot fermentation plant and ancillary units is suffering serious delays through shortages of essential materials. Work has therefore been confined to the culture of antagonistic organisms in static and shaken cultures on a small scale. Considerable experience has been gained of the behaviour of the organisms and of the environmental conditions necessary for antibiotic production.

The microbiological section, which deals with this work, has also been called on for help by industry and by other research institutions.

Nitrogenous Metabolism of Green Leaves.—During the year considerable progress has been made with the problem of the treatment of plant tissues for analysis. It is already clear that no one preparative procedure is adequate for all analyses, and that for active metabolites, such as the soluble sugars and the simpler nitrogenous compounds, no drying method gives results which agree with fresh preparative methods.

A very full study of the ammonia and glutamine content of green leaves from a wide variety of sources and under widely varying environmental conditions has led to the conclusion that there is present an ammonia-yielding material which is even more labile than glutamine.

PLANT RESEARCH BUREAU

Chief Executive Officer: Mr. F. R. Callaghan

Reports from the five Divisions appear below:—

AGRONOMY DIVISION, LINCOLN

Acting-Director: Mr. R. A. Calder

Field Crops

Wheat.—To provide nucleus stocks for certification purposes, reselected lines of the following varieties were grown from hot-water-treated seed: Dreadnought, Solid Straw Tuscan, Hunters II, Tainui, and Jumbuck.

Oats.—Reselected stocks of Gartons Abundance and Algerian were increased for distribution under certification and small areas of Onward and Duns were grown for reselection.

The following recent introductions were compared with Abundance and Onward: Binder, Royal Scot, Spitfire, 10/3 (Resistance × Grey Winter received from Great Britain), and three Aberystwyth varieties, S. 84, S. 147, and S. 172.

Additional hybrid material is under observation.

Barley.—To provide nucleus stocks for a proposed barley certification scheme, increase areas of the following malting varieties were grown: Spratt Archer, Plumage Archer, Chevallier, Research, and Kenia.

Of the feed types, Wong, Prefect, Campton, and Smooth Awned Cape were propagated to provide seed for further trial and Newal was increased for distribution; due to severe bird attack, no seed was obtained from Wong.

Breeding-work is being maintained; this has for its objective the development of a high-yielding, high-quality malting type which might be suitable for heading.

Ryecorn.—Selection work has been undertaken on material from Great Britain and Australia.

Garden Peas.—The demand for reselected stocks of garden peas, which are grown under contract for merchants, has increased steadily over the past few years and extended areas of the following varieties were grown: Greenfeast, Onward, William Massey, Pioneer, Little Marvel, and Greencrop. A Dutch strain of Harrison's Glory, which is the type of Marrowfat pea most popular in Great Britain, was also multiplied.

Several recent introductions were grown for observation.

A comprehensive breeding programme is in operation, efforts being directed towards the development of a high-quality early variety, a Greenfeast type resistant to pea-mosiac and an improved variety for canning at the green-pea stage.

Field Peas.—The main interest in field peas at present is the development of an improved Partridge type, and 260 selections derived from a cross between Partridge and Black Eyed Susan were grown for further observation and selection.

The selection of a blue pea with a higher yield than Blue Prussian but with a smaller seed than Mammoth Blue has been commenced.

Rape.—A nucleus area of a club-root-resistant strain developed by the Plant Diseases Division, Auckland, gave a high seed yield. Further trials are planned.

Kale.—The nucleus areas of Giant and Medium-stemmed chou moellier had to be discarded due to severe damage by frost.

Small increase areas of the hybrid lines chou moellier × thousand-headed kale, chou moellier × winter cabbage, and chou moellier × spring cabbage were similarly affected and had to be resown.

Swedes.—An increase area of Dryland swede (Grandmaster × Sensation) was grown in Central Otago, and further trials were carried out both at the Division and by the Department of Agriculture. It is still considered a suitable type for Canterbury conditions.

Additional crosses were made between Dryland and Superlative.

Lucerne.—Sixty-two introduced strains grown for comparison with Marlborough and Strain B, a pedigree strain developed at the Division, revealed that under the conditions of the trial none is as good as the pedigree strain, which will be distributed as certified New Zealand lucerne.

Potatoes.—Breeding-work is being maintained, although nothing of an economic importance has yet been isolated, apart from one line, a cross between Katahdin and *S. andigenum* which appears to have some degree of resistance to the mosaic viruses.

Linen Flax.—Nucleus seed of Liral Crown (half an acre) and Stormont Gossamer (1 acre) was grown for the Linen Flax Corporation.

Twenty-eight reselected lines of Stormont Cirrus were grown, and the best are being tested for fibre content and quality at the Linen Flax Research Section, Washdyke.

Pure lines of three Russian varieties that have proved immune to rust are being multiplied as rapidly as possible, and varieties from America and one from West Australia are under observation in this connection.

Linseed.—Special attention is being given to rust-resistant varieties. Golden Viking and Rio, which performed well in field trials last year, are in process of reselection. Certain varieties from Tasmania are also very highly resistant or immune to rust, and these will undergo reselection and increase for trials.

Lupins.—Sweet lupins, which in grazing trials have given better fattening results than rape, have proved disappointing in yield of green feed per acre on farms under Canterbury conditions. The reasons for this are being investigated. Present indications are that sweet blues are not inherently less productive than bitter blues, but that their relative yield is greatly reduced by damage due to hares, birds, and thrips. Thrips, in addition to direct damage, are suspected of spreading pea-mosaic in the crop, and this disease is more lethal to lupins than to peas.

Four selections of *L. angustifolius* and two of *L. luteus*, obtained from Germany recently, are under trial.

An area of Sweet White flowering lupin, a selection from Sweet Blue, was grown to provide seed for extended field trials.

Maize.—Thirty-six double hybrids, mainly from Wisconsin, Illinois, and Iowa, were grown in a replicated yield trial near Gisborne in 1945–46. Results showed that the later varieties were superior to the earlier ones in yield, though growth was much slower than in America.

Herbage Species

Seed-production.—Nucleus seed of the following grass and clover species was increased on behalf of the Grasslands Division: perennial, Italian and short-rotation rye-grass, and Montgomery red, broad red, and white clover.

Grasslands Section.—This substation of the Grasslands Division serves to determine the behaviour of various grasses and clovers under Canterbury conditions.

Vegetable Crops

Vegetable Research.—A Vegetable Research Section has now been established and trials of vegetable strains and varieties have been extended. These trials are furnishing seedsmen with information on their stocks as well as ascertaining the extent to which present supplies are meeting the public requirements. Broccoli, spring cabbage, and Savoy crops are being paid particular attention.

Selected lines of certain vegetables are being increased and trial areas to ascertain the most suitable conditions and technique for seed production have been laid down in various parts of the country.

Weed Control.—Extensive trials have been carried out with the new hormone weed-killers, and detailed reports are in course of preparation.

Many annual and biennial and some perennial weeds are readily killed by them. Californian thistle, with its deep and extensive root system, is a much more difficult problem, and much work will have to be done before any recommendations can be made regarding optimum rate and time of application.

Cereals and established pastures and lawns are not apparently much affected, though the growth may be checked to some extent. Peas are very severely injured, even at low rates. Linen flax and linseed are not obviously injured by aqueous solutions, but are very severely damaged by oil emulsions. Possible damage to fibre in linen flax is being investigated, and until these investigations are completed the use of hormone weed-killers on linen-flax must be considered risky.

BOTANY DIVISION

Director: Dr. H. H. Allan

An Assistant Director took up duties towards the end of the year.

Advisory

Some 2,000 specimens have been examined and reported on, including several weeds not previously recorded. Among these were ball mustard (*Vogelia paniculata*), ditch celery (*Apium nodiflorum*), and English fleabane (*Pulicaria dysenterica*), all potentially serious weeds. Numerous inquiries have been replied to concerning hemlock (*Conium maculatum*), which appears to be often confused with the comparatively harmless wild carrot (*Daucus carota*), though the bristly fruits and other characters of the latter make it readily distinguishable. Kikuyu grass has been found to be well established about Croixelles Harbour, apparently the first recorded occurrence in the South Island. Advice has been rendered concerning the eradication of primrose willow (*Jussiaea diffusa*), which is giving increasing trouble in the drainage area of the Waikato River.

Herbarium

The valuable collection of the late Dr. Wm. McKay, of Greymouth, donated to the Division by the will of the late owner, has been incorporated. This collection is rich in material from Westland. Algal contributions have also been received from Mr. V. J. Lindauer. The important monograph on New Zealand lichens published by the late Dr. A. Zahlbruckner, of Vienna, and based on large collections forwarded by this Division, has been received. The lichen herbarium is being reorganized in the light of this treatment. Inquiries for herbarium material and offers of exchange have been received from various European herbaria damaged during the war.

Vegetation Surveys

Further work has been done on the Molesworth-Tarndale area, and a report is in preparation. Reconnaissance surveys have been made in north-western Nelson, together with herbarium collections. A full report has been issued to the Wairarapa Catchment Board on the vegetation on much of its area. This demonstrates serious deterioration of forest at high levels owing to the damage done by deer and opossums. Suggestions have been formulated concerning treatment and utilization, including some of the badly eroding areas.

Linen Flax

The work of the Division has been completed and a report published, with special reference to the relation of flax quality and production on the different soil types. A final report is being submitted for publication. Fibre quality is linked up not only with soil type, but also with seasonal conditions. Lodging appears to be related to large thin-walled fibres.

Seaweed

Agar.—From June, 1942, to December, 1946, 381 tons of agar seaweed have been collected, including 175 tons from Hokianga, 157 tons from Bay of Plenty, and nearly 45 tons from East Cape district. The total for 1946 was 109 tons. Certain beds yielded more in 1946 than in any previous year—*e.g.*, 8, 18, 7, 21, and nearly 30 tons in successive calendar years—indicating that with care at least the present average could be maintained indefinitely. Intensive canvassing by the Internal Marketing Division in southern Hawke's Bay has resulted in 10½ tons being sent in to Hastings in four months from that district, which in the previous four years had yielded only a little over 2 tons, although surveys had indicated that it had rich possibilities. The factory is now using weed about as fast as it is collected and is producing 1,000 lb. of agar a week, of which about 75 per cent. is exported. Production could be doubled if more weed comes to hand.

A review of supplies of weed up to June, 1945, was published in *N.Z. Journal of Science and Technology, Vol. 27*, pp. 311–7.

General.—Renewed interest in collecting carrageen (Irish moss) about Wellington resulted in various requests for advice and instruction; more than 3 tons of high-quality carrageen have been harvested. Some inquiries related also to a project to use New Zealand brown seaweeds for extraction if alginates. Field work has been done in Taranaki, Castlepoint, and Collingwood districts. Summarizing data accumulated during surveys of commercially valuable seaweeds, a paper is being prepared on the marine algal provinces of New Zealand. A fine collection of samples, literature, and notes on Japanese seaweeds and their uses have been received from Mr. K. J. Mitchell.

Peat and Pollen

A paper has been published dealing with the peat work done on the Hauraki Plains. A further series of samples has since been taken and is under study, including pollen content. Nearly 300 slides have been added to the reference collection. The preparation of a key to fern spores is well advanced. Atmospheric pollens, for hay-fever problems, have been studied at three stations in Wellington, and field studies continued. The only long and heavy pollen shower recorded during the season was that of grass pollen from November to February. The most abundant tree pollens likely to cause hay-fever in Wellington are those of species of cypress and the native coprosmas. Observations were made on many other species with hay-fever potentialities.

Tussock Grassland

Vegetation and Flora.—A general survey is being made of the whole Molesworth area, along with more detailed projects:—

(*a*) Quadrats and transects have been set up in places, with and without grazing by stock and rabbits, for recording actual changes with time in representative samples of plant cover—*e.g.*, good tussock, poor tussock, sorrel, scabweed, and the vegetation of gullied slopes. Records of changes following clipping and burning of tussock are also being kept. Conclusions to date are that, even with full protection of opened-up tussock, changes are very slow in individual plants and natural seedling establishment is poor.

(*b*) *Scabweed.*—Five species of *Raoulia* occur, but special attention is given to *R. lutescens* and *R. australis*. Seeds germinate and young plants establish freely in certain places, but death rate in early stages is high. Growth is always slow, the maximum recorded for *R. lutescens* being about 2 in. per annum in small plants in particularly favourable places. This gives a means of estimating the minimum age of older plants that will be a useful yardstick in the study of adjacent vegetation.

Experimental sowings have been made on open range, in rabbit-free plots, and in prepared nursery ground. The most promising exotic grasses to date are tall-oat grass, bluestem (*Agropyron smithii*), thick-spike wheat-grass (*A. dasystachyum*), and cocksfoot. Native blue-grass (*A. scabrum*) has germinated and grown well. Various hardy strains of lucerne are under trial and show good promise.

Seed-production areas have been established at the Waiwhetu Experimental Area and good harvests secured. Some 700 plants of different forms of native blue-grass are under observation for selection of the best strains.

Wild Life

The stomach contents of 92 opossums trapped in the Orongorongo Valley have been examined for the Wildlife Branch of the Department of Internal Affairs. It has been possible to identify nearly all the material, by far the greater part consisting of leaves of 20 species of trees and shrubs. There were also remains of fruits and seeds from 10 species and flowers from 5 species of plants. The stomach contents of some wallabies, 1 deer, and some quail and chukor were examined and identified. A report was prepared on the weed beds of Lake Ellesmere.

Phormium

The period has been one largely of planning long-term phormium research in consideration of the fact that there is likely to be a serious jute shortage. This Division will maintain liaison with other Divisions of the Plant Research Bureau, with the Soil Bureau, the Plant Chemistry and Dominion Laboratories, and with industry on various aspects of the work.

Work on breeding and selection has continued at Moutoa. The trace-element experiment in connection with yellow-leaf has been examined without promising results and a yellow-leaf incidence survey made. A preliminary paper on yellow-leaf is almost complete. Work has also commenced on the embryology of phormium and on seed storage and germination.

ENTOMOLOGY DIVISION

Director: Dr. D. Miller

Grass-grubs (Odontria spp.)

Researches in the Ashburton area have been inaugurated.

Field surveys for the determination of flight periods of beetles and population fluctuations amongst the larvæ have been carried out. During the period of beetle activity there were indications of possibly two flight periods last season; by the close of January very few beetles were found either on the wing or in the soil. A comparison of the numbers of adult beetles sheltering in ploughed or unploughed land offered nothing from which conclusions could be drawn. The location of the different larval instars in the soil in relation to soil moisture, &c., has been studied.

Detailed studies have been carried out toward the development of a laboratory technique for the handling of adult beetles, eggs, and larvæ in relation to work upon parasites, a search for which is being made in Australia and Patagonia. Insectaries have been prepared and the turf infested with larvæ.

The cultures of the nematode parasite (*Neoaplectara glasseri*) have been maintained.

Experiments with insecticides were also carried out in relation to their influence upon the insects.

Porina Grass-caterpillar (Oxycanus)

Population counts have been made concurrently with those on the grass-grub, and the evidence shows a high population in most of the lighter lands examined, while there seemed to be no sign of the caterpillars in the heavier lands under observation.

On account of the shortage of bran for the poison baits, other materials such as gristed oats, chaff and flour, and sawdust and flour are being experimented with. Also, D.D.T. and Gammexane dusts, as controls alternative to paris green and arsenate of lead, are being experimented with.

Diamond-back Moth and White Butterfly

The larval parasite (*Apanteles glomeratus*) of the white butterfly is thoroughly established in Nelson; collections of it have been made and distributed to officers of the Department of Agriculture who are co-operating in the spread of the parasite into different parts of the country.

In the case of the parasites of the diamond-back moth, these are now well established in the Dominion and supplies are being reared for shipping to the authorities in Australia and Tasmania.

Red-legged Earth-mite (Halotydeus destructor)

This mite is well established in the vicinity of Napier and Wairoa and near Gisborne. It has been under investigation during the past few years, so that when it came into prominence during 1946, control measures could be advocated, and will be put into operation to meet any future outbreaks amongst early vegetable crops, under which conditions the mite can be economically controlled by insecticides, but any attempt to eradicate it would be fruitless. A detailed study of the mite is being continued to ascertain the extent of its possible distribution in New Zealand and to intensify control measures. It seems that its distribution tends to be limited by climatic conditions.

Australian Soldier-fly (Metoponia rubriceps)

The deterioration of pasture land and maize in the Opotiki basin is associated with the presence of an extraordinarily high population of the larvæ of the Australian soldier-fly in the soils.

The larvæ of soldier-flies are not known to be destructive; they feed mainly on decaying vegetable matter as well as being carnivorous, and often occur in very large numbers. In this particular case, however, some, but by no means all, of the larvæ are found attached to the roots of grasses and maize. Work is proceeding in co-operation with the Department of Agriculture.

Crane-fly Larvæ (Tipulidæ)

Unusually high populations of a native species of crane-fly larvæ were studied in areas of damaged pasture in the vicinity of Waimate. There is no evidence yet to show that these larvæ were responsible, since grass-grub and porina caterpillars were also present. However, there is a possibility of crane-fly larvæ being destructive to pastures, and the investigations are proceeding.

Clover Insects

The causes responsible for the comparatively low yield of red-clover seed are being investigated. Although clover thrips are very common on clover throughout the country, there is a possibility of their not being of major importance.

On the other hand, a survey of the humble-bees is being carried out in order to ascertain the species present in New Zealand, and their distribution and relative abundance as a basis upon which to decide what further species should be introduced.

Insects of Stored Products

In the case of the wartime project of cheese-mite control, work during the year has been centred upon the completion of researches into the physical ecology of mites.

Experiments have been carried out with fumigants and dusts for the control of insect pests of stored grains and hides.

Insecticides

Experiments with D.D.T. indicate that this insecticide cannot be used indiscriminately in orchards; its detrimental influence upon bees can be avoided to a certain extent, but its destruction of natural enemies, especially those of woolly-aphis and red-mite, without affecting the pest will exclude D.D.T. from general orchard practice.

Some of the new insecticides have been used according to the recommendations of the manufacturers for the purpose of being in a position to recommend their use in New Zealand.

Wheat-stem Weevil

A search for parasites of this weevil is being continued in the Argentine. Certain species have been located, but no decision is yet possible as to their usefulness under New Zealand conditions.

Timber-borers

Studies of the biology of the resin-beetle (*Ernobius mollis*) of insignis pine and of the common house borer (*Anobium punctatum*) continue, while a comprehensive work on borers of service timbers, and their treatment (based on the results of experiments with wood-preservatives), has been published.

General

Attention has been given to the cause of manuka dying out in South Canterbury, and though an insect and certain fungi are prevalent on the affected plants, the actual cause of death is not yet known.

GRASSLANDS DIVISION

Director: Mr. E. Bruce Levy

Pedigree Strains of Pasture Species

Bred strains of perennial, Italian, and short-rotation rye-grass, and white clover, Montgomery red clover, and broad red clover have been released and accepted into farming practice, but further breeding is being applied to the gradual improvement of these strains. With Italian rye-grass, for example, a strain which is a biennial rather than an annual has been bred, and the persistency of short-rotation rye-grass has been considerably improved since the first pedigree strain was released.

To complete the wide agronomic coverage of the rye-grasses, work is now being done on the production of a high-producing Western Wolths rye-grass and also a long-rotation rye-grass which, like short-rotation rye-grass, is being bred from hybridization between perennial and Italian rye-grass.

Seed stocks are being built up of bred strains of timothy and cocksfoot.

To provide data on the performance of bred strains of the grasses and clovers and of promising types during breeding, broadcast sward trials are being carried out at Palmerston North and the substations at Lincoln and Gore. Collaborative trials are also being carried out on Department of Agriculture experimental farms and hundreds of observational trials have been sown on farms throughout New Zealand. Other bred strains such as the Welsh Plant Breeding Station's strains of perennial rye-grass, white clover, and Montgomery red clover are being fully tested out against our New Zealand pedigree strains.

Sufficient nucleus seed of the more important species is being produced annually to supply stocks for admission into the highest grades of certified seed of the following species: perennial rye-grass, Italian rye-grass, short-rotation rye-grass, timothy, white clover, broad red clover, and Montgomery red clover.

To ensure that the high standards required of certified seeds are being well maintained, 10,780 seed-certification plots have been sown this year, as against 5,600 the previous year.

The value of pedigree strains of high-producing grasses and clovers suited to the varied agronomic needs of the country is rapidly becoming appreciated and must play an important part in raising the level of the primary production of the country.

Blind-seed Disease of Rye-grass

Work in the control of this serious disease is being approached from three different angles: (1) crop management; (2) therapeutics; (3) the breeding of resistant strains.

Some therapeutic treatments using commercial fungicides have been applied to crops of rye-grass infected with blind-seed disease. Dusting with a copper compound has given a 12 per cent. improvement in germination, but further experiments with this and several new therapeutants are required.

The problem of breeding a strain of perennial rye-grass equal to the present pedigree strain but resistant to the disease depends on the possibility of combining the agronomic characters of pedigree rye-grass with the resistance found in some otherwise inferior types. From second-generation progenies produced from crosses of resistant plants to pedigree plants, a number of resistant plants superior agronomically to the original resistant plants but not the equal of pedigree plants have been obtained. Further generations of crossing to plants of pedigree type will be required to prove whether a resistant strain similar in other respects to the pedigree strain can be produced.

Measurement of Pasture-production from Pure and Mixed Swards under Different Manurial Treatments

A comprehensive series of plots has been established to measure the effects of added phosphates and lime on pure swards of grass, of clover, and mixtures of these species. Cross-treatments to measure the effects of the return of animal residues and added nitrogenous fertilizers have resulted in a wide range of productivity and compositions, both chemical and botanical. Substantial evidence is being obtained to support the contention that the effectiveness of added phosphate is influenced by the type of clover present in the pasture. It appears, also, that much phosphate has been, and is being, wasted in actual farm practice.

Trials in Grazing and Management Methods

These are now well established and valuable data is being secured. Demonstrations on the plots have attracted wide attention.

Measurement of Crop Varieties

Yield and feeding value trials have been continued on behalf of the Agronomy Division. Crosses between chou moellier and field cabbage are encouraging enough to merit further breeding-work.

Seed-production Trials

Trials on old cocksfoot pastures in Canterbury have been continued to study the effects of (*a*) added fertilizers and (*b*) mechanical treatments of the stand. The effects of added nitrogenous fertilizer as the basic requirement for high yields and the doubtful value of superphosphate alone are being investigated further.

Various nitrogenous fertilizers at different rates were studied in relation to seed yield of perennial rye-grass and short-rotation rye-grass. Outstanding increases of up to 45 per cent. in seed yield were obtained, as well as a general improvement in quality, where heavy dressings of nitrogen were applied.

Herbage Analyses

Botanical analyses of herbage for the Department of Agriculture and this Division are being made regularly, while plant material for chemical analysis is also being supplied to the Plant Chemistry Laboratory.

Soil Conservation

Te Awa.—Pasture improvement by oversowing and top-dressing, planting of hillside with various types of trees, and debris-dam construction have been the main features of this work.

Botanical analyses reveal that there has been a 20 per cent. improvement in the pasture cover of the hillsides where recently sown grasses and clovers have established. No. 1 white clover is proving extremely valuable on this country. The results indicate that substantial improvements in hill-country pastures can be obtained by the surface sowing of suitable species without tillage or cultivation.

Poverty Bay.—A member of the staff is now stationed in Gisborne to undertake pasture research on areas of eroding country which have been differentially treated with seeds mixtures and fertilizers. Further seedings have been made this year and experimental tree-planting of hillsides has been carried out.

Varying degrees of success in the establishment of grasses and clovers on slips and eroded areas have resulted from the numerous seeding trials made to date. The influence of soil fertility on establishment is quite apparent and top-dressing with artificial nitrogenous fertilizers has been highly beneficial. Work in connection with soil conservation is being conducted in collaboration with the Soil Conservation and Rivers Control Council and appropriate Catchment Boards.

Aerodrome Turfs

Advice in connection with maintenance and management of aerodrome surfaces has been given and applied, and there has been a steady improvement in the condition of the fields since these have been converted from "pasture" to "turf."

The reconversion of some "turf" fields back to "pasture" has been carried out where necessary.

Modifications of management and maintenance methods have been successfully and economically applied to certain aerodromes for civil aviation needs.

Greenkeeping Research

There is a renewed interest in this work and numerous inquiries relative to the technical and scientific aspects of greenkeeping are being dealt with regularly. In January of this year the first post-war greenkeepers' conference was held in Palmerston North.

Pollen for Medical Institutions

The service of supplying grass pollens to medical institutions has been increased, and this season 838 grams were supplied from 10 pasture grasses.

PLANT DISEASES DIVISION

Director: Dr. G. H. Cunningham

I. Plant Diseases Investigations

Tree-tomato Mosaic.—Field surveys have shown the disease is widely distributed throughout areas where the host is grown. Experimental and symptomatic evidence suggest that possibly three viruses are involved. All are transmitted by artificial inoculation and all have a wide but differing host range amongst solanaceous hosts. Two strains are transmitted by insects. This disease is not seed-transmitted.

Rhubarb-mosaic.—This disease has been artificially transmitted from rhubarb to dock and dock to dock. It is also carried from dock to dock by aphides, but so far attempts have failed to transmit the disease back to rhubarb by insects or inoculation.

Lettuce-mosaic.—Prevalent in Auckland and Hutt Valley commercial areas. The virus has been found to be seed-carried, and is also transmitted by artificial inoculation.

Tomato Spotted-wilt.—Investigations have shown this disease occurs on garden peas.

Lily-mosaic.—The virus has been proved to be readily transmitted by aphides.

Pea-mosaic.—Thirty selections of peas produced by the Agronomy Division were tested for resistance. All but three proved to be immune.

Cucumber-mosaic.—Fourteen varieties of pumpkin, marrow, squash, and cucumber were tested for resistance. Seven proved to be resistant to the disease, the others susceptible.

Halo-blight of Beans.—Three and four applications of Bordeaux mixture and copper carbonate gave satisfactory control of the disease under field conditions. Work is in progress in selection of three promising varieties for resistance to this disease.

Grease-spot and Brown-spot of Passion-fruit.—Four sprays of Bordeaux 3-4-50 reduced infection of the former disease to 2·3 per cent. and gave almost complete control of the latter.

Dry-rot of Swedes.—Seed from five commercial varieties of swedes and seven of turnips, grown under supervision of the Department of Agriculture, were tested for presence of this disease, which is seed-borne. All were found to be disease-free.

Head-smut of Maize.—Work has shown that infection from infected soils is the chief source of perpetuation; the disease may be to a slight extent also carried with the seed.

Blind-seed of Rye-grass.—Preliminary investigations with rye-grass grown in pots under glass suggest, as a means of control, use of certain dusts or sprays applied at blossoming to prevent infection of ovaries.

II. Therapeutant Testing

(See also Fruit Research Report, p. 18.)

Improvements in Disease Control

Septoria-spot of Celery.—Comparative tests for control of the fungus were made with the proprietary Cuprox, Coppesan, Copper Sandoz, Dithane, and Bordeaux mixture. All gave control equal to Bordeaux. Dithane showed no trace of plant injury and left no visible residues.

Broad-bean Rust.—Tests were made comparatively with Dithane, Phygon, Fermate, T.M.T., and lime sulphur plus colloidal sulphur. Control equal to that secured with the standard spray, lime sulphur plus colloidal sulphur, were obtained with these new proprietary fungicides.

Downy-mildew of Onions.—Comparative tests were made for control of the fungus with Dithane, Phygon, and Bordeaux mixture. Owing to the dry season, little disease developed; nevertheless, the proprietary Phygon gave evidence of being an effectual fungicide for control of this disease.

Bronze-beetle, on Boysen-berry.—A field trial was undertaken to ascertain whether D.D.T. was more effectual than lead arsenate in control of this pest. Results suggest that D.D.T. may offer a promising control of this pest.

Calendar-beetle of Strawberry.—As soil treatments, D.D.T. and Gammexane were used in an effort to combat the larvæ of this pest, which destroys the roots. Gammexane proved to be highly toxic to larvæ, D.D.T. almost inert.

White-butterfly and Diamond-back Moth of Cabbage.—Field trials are in progress to ascertain dosage rates and periods between applications of D.D.T. for control of these pests. Comparisons are also being made with a D.D.T. oil emulsion and a new insecticide based on chlorinated terpenes.

Late-blight of Tomatoes.—Field trials are in progress to ascertain value as fungicides of Phygon and Dithane at various dosages in comparison with Copper Sandoz, Coppersan, Cuprox, and Bordeaux mixture. Phygon has shown some interesting phytocidal effects, producing fruit injury at a dosage rate of 4 lb. to 100 gallons. Dithane produced somewhat severe foliage injury at the highest concentration and slight injury at the lowest concentration. Copper Sandoz produced leaf injury typical of copper oxide.

Soil-disinfection Studies

Formalin.—Efficacy and residual effects of fresh and deteriorated solutions and paraformaldehyde dust were investigated. No detrimental effects to plants were produced when planting was delayed from one to four weeks, according to dosages applied.

Grass-grub in Lawns.—Comparative tests with different soil fumigants applied as injections and emulsions gave promising results. Work is in progress to ascertain effects in proofing of lawns by use of D.D.T. and Gammexane in comparison with the standard lead arsenate.

Club-root Control.—None of the fumigants tested gave as satisfactory control of the disease as acidulated mercuric chloride.

Growth Responses.—Effects of soil fumigants and steam disinfection were studied in glasshouse and field trials. Five separate and consecutive crops were planted in plots following treatments. Results indicated an improved growth of test crops.

III. Pomology Investigations

(See Fruit Research report, p. 17.)

IV. Timber-preservation Investigations

(See Building Research report, p. 8.)

V. Miscellaneous

Fabric-proofing.—Work has been confined to testing various new chemicals likely to prove of value in proofing canvas and other fabrics against attacks of fungi and bacteria. Two plastic resins (Eronel O.S. and Firefoil) and cadmium naphthenate have been tested against *Stachybotrys atra*. No loss in tensile strength occurred in plastic resin test strips; significant breakdown, however, appeared in those treated with cadmium naphthenate.

Synthetic Plant-hormone-induced Injury.—Symptoms on tomato foliage resembling cucumber-mosaic were produced by 2–4 D. Extremely low dilutions and even vapour seriously injured tomato, tobacco plants, and grape leaves.

Testing of Household Insecticides.—A technique for breeding flies in numbers sufficient for testing therapeutants has been evolved.

Soil-injector.—Apparatus was designed and manufactured for the purpose of injecting into the soil such toxic substances as chloropicrin. It is now being manufactured by a commercial firm for use of nurserymen and market-gardeners.

Tomato-seed.—Following requests from commercial growers, production of seed of the variety Potentate has been undertaken. Seed is free from seed-carried diseases, produced from true-to-type plants, and has been made available in quantity sufficient for growers' requirements.

Lucerne Culture.—Cultures sufficient for 213,270 lb. of lucerne seed were distributed to 1,782 farmers, indicating an increase in sowing of some 2,680 acres over the previous year.

SOIL BUREAU

Director: Dr. L. I. Grange

Erosion Surveys

Manawatu and Taranaki Districts.—The types of erosion occurring in Manawatu and Taranaki districts were mapped, thus completing the survey of the southern half of the North Island, which was commenced last year. The report and maps are now in the press.

Soil Surveys

General Survey, North Island.—Sheets 1 and 3 of the soil map of the North Island were published during the year. Sheet 8 is with the printer.

North Auckland.—The draughtsmen are preparing the soil maps of Whangarei County for publication.

Mid-Hawke's Bay.—A bulletin, "Soils and some Related Aspects of Agriculture in Mid-Hawke's Bay," is in the press and will appear during August.

Hutt and Makara Counties.—The field survey of Hutt and Makara Counties was completed and the distribution of the twenty-nine soil types and ten phases shown on a scale of 1 mile to an inch. The map demonstrates that large areas of uniform soil type occur only on the steep land and that most farms comprise two or more soil types. On the rolling and easy hill land the soil pattern is more complicated. Analyses of soil samples collected during this survey showed a general low phosphate level and a low to medium supply of bases. Examinations were made of the clay minerals and the sand residues, and it was evident from the latter that some minerals were present that had not come from the greywacke, but from volcanic ash deposits blown from central North Island.

Wairarapa Plains.—A soil survey of the Wairarapa Plains was commenced and the mapping of the area west of the Ruamahanga River and south of the Waiohine River completed. The soils are chiefly derived from alluvial deposits, and soil differences are due to depth, texture, drainage, and age of the soil. Considerable areas of soil show evidence of high water-table, indicating the need for improved drainage.

Westland.—In co-operation with the Department of Agriculture, a report on the soils and agriculture of Westland has been prepared and a soil map drawn on a scale of 4 miles to an inch. Analyses show that the older soils are very poor in plant nutrients.

The young soils are low in bases but surprisingly high in phosphate. This is a combination not met with in other New Zealand soils.

Plains and Downlands, Canterbury.—A survey of the plains and downlands of Canterbury on a scale of 2 miles to an inch is almost completed.

On the plains the recent alluvial soils deposited within historic times are chiefly of light texture, except for the Templeton Series, which has a silt-loam texture and is of high natural fertility. The Recent Meadow soils of small total area are found in low-lying areas near the coast. In their natural state they are poorly drained, but when this defect is remedied they become the most fertile soils on the plains. Tussock soils occupy much the greater part of the plains, the most extensive of the younger soils of this group being the Orari soils. Their fertility depends mainly on depth of soil overlying gravel. Of the immature soils, the most important are those of the Aylesbury Series, which are silt loams, pastures and crops on which benefit considerably from the application of lime and superphosphate. Small areas of podzolic soils occurring near the foothills of the Southern Alps are of very low fertility.

The downlands have a thick coating of loess of a fairly uniform silt-loam texture. Four soil types have been mapped :—

Tussock soils—

Timaru silt loam, under less than 24 in. rainfall, moderately fertile.

Clermont silt loam, under from 24–30 in., lower fertility.

Opuha silt loam, under same rainfall but higher humidity, lower fertility, fairly high lime requirement.

Immature podzol : Hurunui silt loam, least fertile, high lime requirement.

Timaru and Clermont silt loams have been cropped successfully, yielding from 40 bushels to 50 bushels of wheat to the acre. Opuha silt loam has been cropped with moderate success in the past, but now yields only about 25 bushels of wheat to the acre. Hurunui silt loam is mostly used for grazing.

Maniototo Plains.—A survey of a part of the Maniototo Plains which it is proposed to irrigate was commenced for the Public Works Department on a scale of 20 chains to an inch. Soluble salt has been found in some soil types. Chemical tests show that it varies considerably both in quantity and type, gypsum, black and white alkali, and common salt having been found. Since a knowledge of the source and occurrence of the salt is essential, a temporary laboratory has been set up at Ranfurly to keep in close touch with the field side of the survey.

Miscellaneous Surveys of several small areas were undertaken.

Soil Chemistry

Chemical work for soil surveys has continued to be the main activity of this division. A district chemist has been attached to each of the five soil districts of New Zealand. These chemists work in close collaboration with the pedologists and deal with chemical problems as they arise.

For the Canterbury plains and downlands survey a large number of analyses have been compiled and collated with field data, and detailed investigations are in progress on selected Canterbury and Wellington soils and on the salt-bearing soils of Maniototo Plains. As this work is an integral part of soil surveys, some of the results are mentioned above under the appropriate surveys.

Clay Minerals.—Good progress has been made in applying x-ray techniques to the study of clay minerals. In addition, a second method, that of differential thermal analysis, has been started, and the two combine to give a reliable picture of the types of clay minerals in different soils. Much of the work this year has been concerned with compiling a set of analyses of type clay minerals for comparison with those from New Zealand soils. Investigations are now being made into the genetic differences in the yellow earth group of soils.

Soil Phosphates.—Work in this subject has been concentrated mainly on the measurement of phosphates absorbed by the soil clays. Difficulty has been experienced in separating the absorbed inorganic phosphates from those contained in soil organic matter.

Soil Corrosion.—There has been much activity in this section of the work. Not only have surveys and analyses been made of the soils of proposed pipe-lines at Thames, Lake Alice, the second part of the Wellington line, and at Cherry Farm, Otago, and advice tendered on protective measures necessary to reduce the corrosion of pipe-lines, but also research is in progress on the correlation between the corrosion of iron plates and analytical tests made on the soil. In this latter investigation considerable assistance has been given by the New Zealand Institution of Engineers, who laid down some thirteen years ago a series of uniform iron test plates. High acidity, low resistivity, differential aeration, high moisture-holding power of the soil, and the presence of an ærobic bacteria have been noted as some of the factors in corrosion. In the investigation of bacterial corrosion the assistance of the mycologist, State Forest Service, is appreciated.

Hokowhitu Plots.—A paper has been published showing how treatments such as ammonium sulphate, designed to give a good, hard-wearing brown-top - chewings-fescue turf, have affected the soil properties. Successful treatments have the effect of reducing the lime content of the soil, in contradistinction to normal agricultural practices, which seem to increase the lime content to favour a rye-grass - white-clover sward. This work has been applied recently in a regrassing programme for part of the Wellington Racing Club's course at Trentham.

Chlorosis in Apple and Peach Trees.—Chlorosis in the leaves of fruit-trees in orchards at Hastings is considered, from field and chemical evidence, to be due to overliming. In conjunction with the Plant Diseases Division, an experiment is in progress for reducing the alkalinity of the soils.

Yellow-leaf in New Zealand Flax

In co-operation with the Botany and Plant Diseases Divisions, an investigation has been commenced on boron and its relation to the incidence of yellow-leaf. So far as the investigation has gone, there does not appear to be a clear correlation between boron in the plant and the health of plant. It is noted, however, that the boron level is high in New Zealand flax for a monocotylous plant and therefore it might react to a sub-optimum supply of boron in the soil.

Glasshouse Soils.—Work on a problem at the Hutt, where severe chlorosis had been encountered in tomatoes, has been suspended this season for want of suitable material. A hypothesis of an induced magnesium deficiency has been followed up, and analyses to date have shown the general low level of magnesium in chlorotic leaves, the pattern of magnesium on any one leaf, and the distribution of magnesium in leaves from different parts of the plant. The magnesium level in the soil is not nearly as low as that associated with sandrown in tobacco or premature defoliation of apples.

Kerikeri Moisture Survey.—A short paper has been prepared in collaboration with the Horticulture Division on the relation between lemon-tree performance and soil moisture in a dry season.

Pacific and Nearby Islands.—Analyses have been made on soils sent from Raoul and Aitutaki Islands. The soil from Raoul Island, derived from andesitic ash, is similar to that found in Taranaki, but is much younger. It is well supplied with lime, magnesia, potash, and soda, but the phosphate figures are variable.

The Aitutaki soil was of good fertility in the top 3 in., but decreased to low levels in both bases and phosphates in the subsoils.

Techniques.—Particular attention has been paid to shortening base-exchange procedure by faster leaching of soils and by the use of semi-micro methods. The North Auckland clays have been more difficult to handle this way, and work is in progress on the discrepancies found between the new and the standard methods.

A chemical examination has been made of samples taken from the dung and urine plots of the Grasslands Division at Lincoln and from a field at Southbridge. The data suggest that about 20 acres are necessary to make a sample, the analyses of which would be as reproducible as the chemical accuracy would allow.

Soil Physics

Soil Mechanics.—The bulk of the work has been concerned with subsurface surveys of sites for large buildings for Government Departments and local bodies.

Building-site Surveys.—Locations which have been reported upon as to anticipated buildings, settlements, or stability of foundations included hospital, post-office, freezing-works, and bank building sites.

Aerodromes.—An officer of the Soil Bureau has been co-operating with the Public Works Department, Auckland, in an investigation of soil conditions under the existing concrete runways at Whenuapai Air Base to obtain data applicable to the design of the runways for heavier aircraft.

A survey was made of the two major R.N.Z.A.F. stations in Fiji. The soils were evaluated in accordance with possible requirements for a class B international airport.

Earth Dams.—Material of glacial origin has been tested with a view to the construction of an earth embankment for raising the level of Lake Pukaki.

A site survey and laboratory tests have been made for the construction of a small earth dam for the Marton Borough Council.

Investigational Work.—Ground conditions in the South Dunedin area, where excessive settlement of structures has occurred, have been examined. Indications are that plastic movement of the soil has also taken place.

Observations have been made on the presence of buried beds of peaty soils in the northern part of the Christchurch City area.

A retaining-wall failure was investigated by soil-mechanics methods. The seepage of water into a poorly compacted backfill was primarily responsible for the trouble.

Calculations have been made of the passive earth resistance of anchor blocks for cableways.

Agricultural Soil Physics.—A study has been made of total soil porosity and the noncapillary porosity of pasture and cultivated soils from Canterbury, Wellington, and North Auckland districts. The samples were obtained *in situ* as cylindrical cores. It was found that the non-capillary porosity was of a low order in all the soils tested. The exceptions were a few intensively cultivated market-garden soils from the Hutt Valley area. The expectation of using this factor to characterize soils deteriorated due to excessive cultivation has not so far been realized. Plans have been made of an improved type of apparatus for measuring soil porosities.

The permanent wilting-point of a range of soil types has been measured by means of the freezing-point depression method. It has been found that the red-brown loams and yellow earths of the Auckland district when they are of similar texture to the alluvial Canterbury soils derived from greywacke have wilting-points of a much higher order. It is proposed to check these points by experiments with seedlings.

Soil Biotics

Te Kopuru Sand Podzol.—Last year it was reported that Te Kopuru sand responded in pots to molybdenum and boron. The plants used were subterranean clover and lettuce. The experiment was repeated this year and a similar response with subterranean clover obtained, but in the case of lettuce there was a depression of growth from these elements.

Uptake of Boron by Phormium Flax.—A pot experiment is being conducted to find the uptake of boron by phormium flax grown in Manawatu silt loam.

Deficiency in Brown Loam Soil.—An experiment has been laid down to find out whether a trace element is a limiting factor in plant or a mature yellow-brown loam.

Boron Deficiency.—The following soils—Waiwera silt loam, Wharekohe silt loam, and Manawatu silt loam—are being tested in pots with a range of plant indicators for boron deficiency.

Indicator Plants.—A paper has been prepared by the soil chemists on Virginia stock, as an indicator of available lime in the soil.

WILDLIFE SECTION

Dr. K. Wodzicki

During the year good progress has been made with the survey of the wild-life position in the Dominion. A great deal of data concerning the distribution densities and rates of spread of rabbits, wild pigs, opossums, goats, deer, and other species has been assembled, and some attention has been given to the causes leading to the present ascertained distribution of these species.

The data are being assembled into a report which will shortly be available to help in the consideration of research measures to be initiated in order to facilitate and improve methods of control.

IMPERIAL AGRICULTURAL BUREAUX

The Imperial Agricultural Bureaux have continued to provide a valuable link between scientific workers in various fields of agricultural science, particularly within the various countries of the British Commonwealth. The abstracting *Journals* of the various Bureaux and the *Technical Communications* published periodically provide excellent service.

In New Zealand, co-operation with the Bureaux is maintained through this Department, for which purpose there is a special liaison officer. In addition, contacts with Bureaux and the appropriate fields of research are maintained by official correspondents, who deal with specific inquiries. The Scientific Liaison Officer, London, also has useful contacts with all the Bureaux and is a member of the Council.

The Imperial Agricultural Bureaux Conference, held in London in July, 1946, was attended by Dr. E. Marsden and Sir Theodore Rigg as New Zealand delegates.

Reviews and notices of the Bureaux's publications have appeared from time to time in the *N.Z. Journal of Science and Technology*.

OVERSEAS LIAISON

The Department's scientific Liaison offices in London, Washington, and Melbourne have been maintained during the year and provide an essential link between the Department and scientific research and workers overseas. In addition to arranging for the regular despatch of recent and valuable technical information to the Dominion, the Scientific Liaison Officers assist the Department by establishing contact with workers in new fields of research of importance to New Zealand, advising specialist visitors and others, and arranging for the purchase of urgently required specialized equipment. Technical correspondence and reports from overseas are handled in Head Office by the Information Bureau, who ensure that all officers concerned are kept advised.

At the British Commonwealth Scientific Official Conference held in London last July detailed consideration was given to the type of organization for liaison work that would best meet the needs of the dominions and of the Commonwealth as a whole. The general opinion favoured the type of grouping found to be so advantageous in Washington, where the Scientific Liaison Officers of the United Kingdom and the dominions are housed in the same building and, although being independent units, work together on a basis of mutual helpfulness. It is probable that, in due course, a similar organization will be established in London.

THE NEW ZEALAND GOVERNMENT SCHOLARSHIP AWARD TO THE UNITED KINGDOM COLLEGE OF AERONAUTICS

Following consideration and recommendation by an inter-departmental committee, the New Zealand Government approved the award of one scholarship per annum tenable for two years at the United Kingdom College of Aeronautics recently established by the United Kingdom Government. The college has been established for the purpose of post-graduate training and research in aeronautics for the further promotion of British and Commonwealth aviation. It will undoubtedly become the foremost college in the British Commonwealth on aeronautics and the New Zealand Government's scholarship award is designed as a contribution in scientific man-power towards the promotion of Commonwealth aviation. The scholarship carries remuneration at the rate of £400 per annum (sterling) and other perquisites and a guarantee of employment in New Zealand for twelve months at the conclusion of the course in a position where the experience and knowledge acquired can be passed on. The scholar thereafter is free to gain employment anywhere in the British Commonwealth, and may even do so under certain circumstances at the conclusion of his course, provided such employment is in the best interests of Commonwealth aviation.

The Department of Scientific and Industrial Research is charged with the administration of the scholarship. The Selection Committee has met and formulated the detailed conditions and procedure for the selection of scholars. These have been approved, as required by the Government, by the Hon. Minister for Scientific and Industrial Research, and it is proposed to proceed with the selection of the first scholar during 1947.

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