1943

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(SEVENTEENTH ANNUAL REPORT OF THE)

Presented to both Houses of the General Assembly by Leave

CONTENTS

MINISTER'S STATEMENT

THE Department's activities during the year have continued to be concentrated on problems arising out of the war. The year has seen the fruition of a number of projects which previously were only in the developmental stage. For example, both the Dominion Physical Laboratory and the Radio Development Laboratory have been established in improved buildings and provided with such additional skilled staff as is enabling them to provide greater assistance to the three armed Services and to the munitions industry. Moreover, both of these laboratories have been designed and equipped so that in post-war years they will function to provide a sound fundamental basis for servicing the manufacturing industries of the Dominion. Important defence scientific units have been established at the University of Otago and at Auckland and Canterbury University Colleges. Several up-to-date units of scientific equipment have been provided for use in the South Pacific area. The year has also seen the coming into operation of the first commercial dehydration plants for butter, vegetables, and meat. All these plants are producing very satisfactory dried foodstuffs, largely because of the scientific effort put into their design and to previous testing on pilot plants by the staff of the Department. Investigations have not been limited to the dehydration operation alone, but have extended to examination of the raw materials being used, their pre-treatment to conserve their food values and vitamin content, and their packaging in a form suitable to retain high quality when used as Army rations by troops operating in difficult field conditions. Work on an up-to-date fruit-dehydrating plant is well advanced and it is anticipated that the first commercial unit will be used to process some of this season's apples. Work on dehydrated butter and preparation of butter for use in the tropics has continued satisfactorily.

Maps showing the soil types occurring in the North Island have now been completed, and based upon these maps others showing soils which will respond to lime treatments in different degrees have been prepared. A map of the areas suffering from erosion in the 10,000,000 acre mountainous region of the South Island has been completed. Three of the important linen-flax districts of Otago have been soil surveyed and the information made available in a ready form to guide this industry as to the selection of the best soils for this important wartime crop, since it has been found that fibre yields are largely dependent on soil type.

Officers of the Department are also providing assistance on soil and pasture problems associated with aerodrome turfs throughout the Dominion, and it has been possible to establish and maintain turfs in a greatly improved manner to withstand the very severe strains to which they are being subjected under wartime conditions.

In view of the importance of building in the post-war period, the Department during the year has established a Building Research Committee which is giving consideration to the numerous problems which will arise and will require investigation in connection with materials necessary for the construction of the large number of houses to be erected after the war.

The Department has maintained its policy of co-operating with all other State Departments on many projects which have from time to time required the assistance of scientifically trained staff. Of great importance also has been the close association of the Department's activities with similar activities in progress in Great Britain, in other Dominions, and in the United States of America. With all these, association has been maintained by regular correspondence and exchange of reports and, where possible, by staff visits.

I desire to express to the staff of all branches of the Department my appreciation of the good service which they have rendered during the year in carrying out the heavy responsibilities which they have had to undertake.

D. G. SULLIVAN,
Minister in Charge of Scientific and
Industrial Research Department.

SECRETARY'S REPORT

The Hon. D. G. Sullivan, Minister in Charge of the Scientific and Industrial Research Department.

I have the honour to submit herewith the annual report of the Department for the year 1941–42.

The Council of Scientific and Industrial Research held six meetings during the year.

The Council suffered a severe loss in the death of its Chairman, Professor H. G. Denham, which occurred on 15th February, 1943. Professor Denham had been a member of the Council since it was established in 1926, and its Chairman since 1935. The appreciation of the Council was expressed in the following resolution carried at its meeting of 10th March, 1943:—

> "That this Council wishes to place on record its deep sense of the great national loss sustained through the death of its Chairman, Professor H. G. Denham, and to pay tribute to the conspicuous services he rendered to every phase of scientific activity in the Dominion for a number of years. His scientific attainments and deep interest in research, together with his foresight, sound judgment, and wide human sympathies, admirably fitted him to be an outstanding counsellor in the promotion, organization, and administration of research in New Zealand. The Council, appreciating keenly his sterling character and the inspiration which his leadership and generous understanding afforded to all those with whom he came in contact, desires to extend to Mrs. Denham and Dr. E. Denham its sincere condolences in the great personal loss which they have sustained."

In the death of the Director of the Wheat Research Institute, Dr. F. W. Hilgendorf, on 23rd September, the Department sustained the very serious loss of an able administrator and a distinguished scientist. It is fitting that the following resolution, carried by the Wheat Research Institute Committee, be quoted in this report:—

> "That the Committee of the Wheat Research Institute place on record its deep regret at the death of its Director, Dr. F. W. Hilgendorf, who, ever since the inception of the Institute in 1927, took the foremost responsibility of laying down that policy which has enabled the Institute to fulfil with such signal success its dual objective of improving wheat yield and quality. The notable contributions which the staff of the Institute have been able to render during the past fifteen years to the baking, farming, and milling interests of the Dominion are in themselves a testimony to the masterly and inspiring nature of his leadership. The Committee deplores the loss of its Director, but rejoices that the work of the Institute afforded to Dr. Hilgendorf an opportunity of pursuing with such conspicuous success the line of research work which had already made his name a household word in the farming community of New Zealand."

Sir Theodore Rigg, Director of Cawthron Institute, has been appointed Chairman of the Council of Scientific and Industrial Research in succession to the late Professor Denham. Messrs. A. H. Cockayne and G. A. Pascoe retired from the Council during the year.

The personnel of the Council is as follows:—

Sir Theodore Rigg, M.A., M.Sc., F.I.C., F.R.S.N.Z., Director, Cawthron Institute, Nelson (Chairman).
Dr. J. C. Andrews, Ph.D., M.Sc., Fertilizer-works Manager, Auckland.
Professor E. R. Hudson, B.Sc., B.Agr., Dip.C.A.C., Director, Canterbury Agricultural College.
Dr. R. O. Page, D.Sc., Tannery-works Manager, Christchurch.
Mr. J. M. Ranstead, Dip.C.A.C., Bledisloe Medallist, Matangi, Farmer
Professor W. Riddet, B.Sc.(Agric.), N.D.A,, N.D.D., Massey Agricultural College.
Mr. Sandys Wunsch, M.A. (Oxon), B.Sc. (McGill), M.I.Chem. E., Assoc.Inst.M.M., Factory-manager, Edendale.
Mr. E. J. Fawcett, M.A. (Cantab.), Director-General of Agriculture.
Dr. E. Marsden, C.B.E., M.C., D.Sc., F.R.S.N.Z. (Secretary).
Mr. F. R. Callaghan, M.A., F.R.E.S. (Deputy Secretary).

The expenditure of the Department during the year was as follows:—

Permanent services—

	£
Head Office: Comprising general expenses of administration, publications (including the *New Zealand Journal of Science and Technology* and departmental bulletins), research scholarships, and grants to the Royal Society of New Zealand, the Imperial Institute, and the Carter Observatory	17,838
Dominion Laboratory (with branches)	27,922
Dominion Observatory	1,527
Geological Survey	10,108
Magnetic Observatory	3,370
Grants to Imperial Agricultural Bureaux	7,300*
Dominion Physical Laboratory	43,554
Research investigations	150,096
	261,715
Recoveries	85,702
	£176,013

* For footnote, see page 4.

Grants were made to the following research organizations in Great Britain:—

	£
Imperial Agricultural Bureaux Headquarters	1,438
Cambridge Low Temperature Research Station	500
Farnham House Laboratory	750
Wool Industries Research Association, Torridon	50
Imperial Mycological Institute	350
Imperial Institute of Entomology	450
Imperial Bureau of Dairy Science	112
Imperial Forestry Bureau	187
	£3,837 *

As in immediately preceding years, the Department's energies have been concentrated on problems relating to the war. Certain research and development problems of a defence nature are being investigated by a special branch of the Department in collaboration with University Colleges and other Departments.

The membership of the special Defence Scientific Advisory Committee is as follows:—
Dr. E. Marsden, Director of Scientific Developments (Chairman).
Representative of the Chief of the General Staff.
Representative of the Chief of the Naval Staff.
Representative of the Chief of the Air Staff.
Mr. R. L. Andrew, Dominion Analyst.
Dr. J. C. Andrews, Works-manager, Auckland.
Professor P. W. Burbidge, Professor of Physics, Auckland University College.
Wing Commander G. Carter, Munitions Controller.
Professor T. D. J. Leech, Professor of Engineering, Auckland University College (Deputy Director, Engineering).
Professor F. G. Soper, Professor of Chemistry, University of Otago (Deputy Director, Chemical).
Professor F. H. Smirk, Professor of Medicine, University of Otago.
Mr. N. A. Marris, Department of Scientific and Industrial Research (Secretary).
Mr. J. A. D. Nash, Department of Scientific and Industrial Research (Assistant Secretary).

It has been found possible to devote some attention to certain matters likely to be of great importance in the post-war period.

STAFF

I wish to express appreciation of the assiduous and loyal manner in which the staff has performed its duties during the year.

E. MARSDEN, Secretary.

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

BUILDING RESEARCH COMMITTEE

Personnel.—Mr. G. F. Wilson (Chairman), Chief Architect, Housing Construction Department; Mr. G. W. Albertson, Director of Housing Construction and Building Controller; Mr. J. Fletcher, Commissioner of Defence Construction; Mr. B. C. Ashwin, Secretary to the Treasury; Mr. J. Mawson, Town Planning Adviser, Department of Internal Affairs; Professor C. B. Knight, Professor of Architecture, Auckland University College; Mr. R. A. Campbell, Consulting Engineer, Christchurch; Mr. C. W. O. Turner, Designing Engineer, Public Works Department; Mr. R. A. Patterson, Government Architect; Professor H. G. Denham, Council of Scientific and Industrial Research; Mr. F. W. Furkert, Chairman, Building Code Committee, New Zealand Standards Institute; Mr. L. J. McDonald, Secretary, New Zealand Standards Institute; Dr. E. Marsden, Department of Scientific and Industrial Research; Mr. F. J. A. Brogan (Secretary), Department of Scientific and Industrial Research.

The establishment of a committee with the above personnel was approved during the year by the Hon. the Minister on the recommendation of the Council of Scientific and Industrial Research, and the preliminary meeting was held on 21st January, 1943. Its functions are—

(*a*) To determine and direct the broad lines of research for the building industry and to deal with policy matters arising in this connection:
(*b*) To make recommendations to the Government through the Minister of Scientific and Industrial Research for expenditure required for research and developmental work approved by the Committee.

The outstanding importance of the building industry, with its wide ramifications, to the industrial and social development of the Dominion, and the great expansion that is envisaged in the post-war years, make it imperative that planning for a balanced

* Contributions amounting to £3,837 were paid to research organizations in Great Britain by the High Commissioner for New Zealand during the year, but in addition the payments made for the previous financial year to the amount of £3,463, did not come to charge in New Zealand until 1942–43.

programme for the building industry be started now. In addition to dealing with technical problems and materials in connection thereto, it will be the province of the Committee to consider the conditions that will provide the maximum productiveness and use of the building industry in the immediate post-war period, consistent with the provision of national and regional plans, a balanced production for all industries, the welfare of those employed in the building industry, and the development of good building design and amenities.

It is realized—

(1) That the establishment of a Building Research Station in New Zealand is not practicable during the war period;
(2) That meantime maximum use of available testing and research facilities and staff, both in Government and non-Government organizations, will need to be made; and
(3) That the organization which is now being developed will need to be reviewed after the war.

The Committee's first task is to survey the problems involved in their order of reference and to decide upon the best methods of attacking them and the lines along which research work should develop. The wartime appointment of an Acting-Director of Building Research and a graduate assistant has been recommended by the Committee as a first step towards the establishment of a research staff and to assist the committee in its preliminary surveys. It is proposed also to take appropriate steps to secure close liaison with the British Building Research Station at Watford.

DAIRY RESEARCH INSTITUTE (N.Z.)

Dairy Research Management Committee.—Mr. A. Morton (Chairman), Prof. H. G. Denham, Messrs. T. C. Brash, C. H. Courtney, G. A. Duncan, H. E Johnson, A Linton, A J Murdoch, J. Murray, W. E. Scott, G. M. Valentine; Secretary, F. R. Callaghan; Director, Professor W. Riddet.

Investigations during the year mainly embraced the production and utilization of dry butterfat for creamery and whey butter, alternative methods of disposal of unexportable whey butter, continued study of loss of activity of starters in cheese-factories, the control of cheese-mites, and studies of the manufacture of cheese and milk production.

Production of Dry Butterfat.—Investigations completed in 1941 indicated that dry butterfat could be prepared from butter by a simple and inexpensive process whereby flavour and vitamin content was maintained and deterioration avoided in storage at atmospheric temperatures. Dry butterfat could also be exported in non-refrigerated space without loss of quality.

Towards the end of 1941 a pilot plant capable of dealing continuously with approximately 1 ton of butter per hour was set up at the Institute, and, following favourable reports from a consignment of dry butterfat sent to Great Britain, the Marketing Department arranged for the establishment of a full-scale commercial plant at Auckland. During the period of construction of the commercial plant a substantial order for dry butterfat was received from the United Kingdom Ministry of Food, and to supply part of this the Institute's pilot plant was maintained in operation and up till June, 1942, had converted some 1,700 tons of butter into dry butterfat. The staff of the Institute were directly concerned with the equipment of the commercial plant of the Marketing Department. Most of the plant in this factory comprised equipment which could be used in dairy factories, but it was necessary for new equipment to be designed by Dr. F. H. McDowall, of the Institute staff, and by Mr. H. L. Murray, of Murray Deodorizers, for certain stages of the processing. Briefly, the process consists of melting butter by the direct impingement of live steam, the partial separation of the melted fat from serum and solids-not-fat by gravity, further removal of these by centrifugal separation in cream-separators, more complete extraction of moisture from the fat as it flows continuously through a dehydrator under vacuum, cooling the dry fat in a water-cooled rotary cooler, and packaging it in hermetically-sealed tin containers of 39 lb. capacity by a simple method that avoids the trapping of free air.

The output of a commercial unit amounts to some 5,000 tons of butterfat per annum.

The development of the dry-butterfat-extracting process has made a valuable contribution to the war effort and to the welfare of the dairy industry. It has increased the supply of butterfat available to overseas consumers, without decreasing its nutrient properties. It has prevented the accumulation in cold stores of a product that would markedly deteriorate in long storage, and made the stores available for other products. It has enabled dairy companies to continue the separation of butterfat from whey, thereby avoiding drainage difficulties, and permitting the continuation of a return of approximately 75d. per lb. for all butterfat delivered to companies. Thereby the saving to the Dominion in the season 1941-42 was, on a conservative basis, approximately £300,000 to £350,000, and is likely to be about £300,000 in the 1942-43 season.

Utilization of Dry Butterfat.—Dry butterfat, though of excellent food value, is unattractive to the consumer, being devoid of characteristic butter flavour and of different appearance. It can be used as a substitute for butter in pastry, in cooking, and in making ice-cream. A slight metallic flavour remains when reconstituted into butter and cream, and investigations are in progress to overcome this and to devise various spreads based upon dry butterfat.

Incorporation of Whey Cream in Cheese Milk.—In the 1941-42 season investigations were initiated for the purpose of incorporating cream separated from cheese whey into the cheese made on the following day. This was prompted by the urge to increase cheese-production to a maximum. This practice was proved successful, provided the whey cream

was pasteurized under conditions which ensured destruction of any bacteriophage present. Incorporation of this cream increased the output of cheese by 1·2 times the weight of fat, but as the cream contained approximately only 5 per cent. of the total fat contained in the milk from which the cheese was made, the fat content of the cheese was not greatly increased. The experiments showed the absolute necessity for insisting upon adequate pasteurization of the whey cream.

Starter Studies.—Much work continues to be done on problems designed to reduce the damage done through bacteriophage entry into both single-strain and mixed-strain starters used in cheese-factories. Starters can be kept vigorous for long periods when these are prepared in isolated rooms fitted with air-filters to prevent potential contamination from the atmosphere in the vicinity of cheese-factories. The past year's work has revealed that cheese milk can become infected with bacteriophage to an extent that will affect the quality of the cheese even when an active and phage-free starter is used. This difficulty can only be overcome by scrupulous treatment of cheesemaking plant and by properly washing suppliers' cans used in the transport of whey.

Control of Cheese-mites.—In collaboration with the Entomology Division of the Plant Research Bureau, studies of the prevention of mite growth in cheese have shown that ammonia, though destructive to the mites, is not an effective fumigant in large stores, where methyl bromide used at the rate of 4 lb. per 1,000 cubic feet of storage space is more toxic to the insect and not detrimental to the flavour of treated cheese.

Milk-production Studies.—The studies of the influence of different pasture diets on stock health and the yield and composition of milk produced thereon have been continued. As yet, no outstanding differences attributable to different swards have been observed. Weekly examinations of milk from the Institute's dairy herd have been made by the Wallaceville Veterinary Laboratory, and after three years of freedom from trouble some cows became infected with mastitis, while others produced milk of high leucocyte count, though not infected.

FOOD PRESERVATION AND TRANSPORT ADVISORY COMMITTEE

Personnel.—Professor H. G. Denham (Chairman), Dr. J. C. Andrews, Mr. A. H. Cockayne, Mr. C. A. Duncan, Mr. F. W. Grainger, Dr. E. Marsden, Mr. G. M. Pottinger, Professor W. Riddett, and Mr. F. J. A. Brogan (Secretary).

The following is a brief review of the activities under the general supervision of the Committee, which held four meetings during the year.

Dry Butterfat.—After the Dairy Research Institute had produced for export to Great Britain about 1,400 tons of dry fat from whey and second-grade butters, commercial production ceased there and was taken up by the dry-butterfat plant of the Internal Marketing Division at Auckland at the end of July. Dr. F. H. McDowall, Chief Chemist, visited Australia to study methods of processing dry butterfat and other dairy products for wartime use. The Institute is now concentrating on research problems relating particularly to the improvement of keeping quality of dry butterfat and to the manufacture of dry-butterfat milk-powder spreads, and butterfat preparations of high melting-point which will withstand tropical temperature conditions. The experiments on the high-melting fats are being conducted at the request of, and in close collaboration with, the armed Services.

Cheese.—Experiments are being made on the modification of cheese for Army rations to enable it to withstand tropical temperatures without loss of body and palatability.

Fibre-board Butter-boxes.—Full reports from Great Britain on experimental shipments of butter in fibre-board boxes which were arranged by the Committee were most satisfactory, and further larger consignments are to be forwarded to Great Britain.

Butter-wrapping Experiments.—Reports from Great Britain on experimental shipments of butter to determine the relative value of Pliofilm and Pliofilm plus parchment for wrapping butter forwarded in chilled cargo with cheese were not decisive as regards the merits of these two methods. Neither method, however, was as good as sending the butter in the form of fat.

Dried Meat.—At the request of the British Ministry of Food, experiments were arranged on the use of a special coating for dried-meat blocks to render them moisture-proof. Investigations were also made on methods of increasing the fat content of dried meat.

Dr. J. C. Andrews visited Australia to investigate methods of dried-meat production and to consult with Dr. J. Vickery, Director of the Division of Food Preservation and Transport, Council for Scientific and Industrial Research. The large-scale production of dried meat to meet the Government contracts is now under the supervision of the Department of Agriculture, to whom Dr. J. C. Andrews is technical adviser, and a commercial plant is in course of erection.

Dried Vegetables.—With information obtained from Great Britain, the United States of America, and Australia, and following research and developmental work by the Fruit Research Officer, the Plant Chemistry Laboratory, Palmerston North, and the Chemical Engineering Section of the Dominion Laboratory, processes and plant for the local production of dehydrated vegetables were worked out and brought to the stage of commercial production. The first full-scale commercial vegetable-dehydration plant is now being installed at the Wattie Canneries, Hastings.

Army Rations,—Much of the work initiated and developed by the Committee on the processing of foodstuffs for storage and transport under war conditions is finding important applications in the preparation of special rations for the armed Services.

FRUIT COLD STORAGE RESEARCH

Advisory Committee.—Mr. W. K. Dallas (Chairman), Sir Theodore Rigg, Messrs. H. G. Apsey, W. Benzies, F. R. Callaghan, J. T. Cross, F. W. Grainger, H. C. Heays, J. L. Mandeno, A. Powell, A. M. Robertson, H. E. Stephens, L. W. Tiller (Secretary).

Refrigerated Gas Storage of Apples

Owing to staff shortage the detailed work begun on the gas storage of the Granny Smith in the small-scale experimental store in 1941 by the Dominion Laboratory could not be followed up in the season under review, and attention was concentrated more on the semi-commercial scale gas storage of Jonathan and Sturmer. Since, however, superficial scald had been troublesome in the previous year's gas-storage tests on Granny Smith, a detailed study is being undertaken in ordinary refrigerated storage to obtain more fundamental knowledge regarding the time of appearance of scald in storage and on the effect of delayed storage. Progress notes on this work are given in the next section.

Jonathan.—This season the fruit was not received till nearly three weeks later than in the previous year, and was of advanced maturity. The carbon-dioxide content of the storage atmosphere was maintained at 8 per cent., as this had proved the optimum in previous years' work, but it was found that severe brown-heart developed during the first eight weeks of storage and that every fruit was affected to a greater or lesser extent. It is evident that maturity of fruit at harvesting is a factor of vital significance in the successful gas storage of the Jonathan.

Sturmer.—In 1941, trouble akin to brown-heart was experienced in this variety and was attributed entirely to an escape of refrigerant from a leak in the evaporator. The defect was located and repaired, but nevertheless a disorder of similar appearance has been encountered in the fruit again this season, although it has been very much less in amount. It appears to be brown-heart, and this suggests that some undetermined factors are preventing the successful results obtained in previous seasons' small-scale tests from being duplicated in large-scale trials. Further detailed study of the Sturmer variety is obviously demanded, and this is to be put in hand in the 1943 season.

Superficial Scald on Granny Smith

Wrapping Test.—Two sets of fruit were observed, one in which the apples were wrapped in oiled paper at various stages in their storage life and the other in which they were left unwrapped for a similar short period. The test was conducted on fruit at two stages of maturity, and the length of the period during which any one lot of fruit had its special wrap or no-wrap treatment was three weeks. It is of interest to note that none of the fruit that was unwrapped for only a three-week period developed scald. The other series, however, indicated that the period of maximum scald susceptibility was between the ninth and twelfth weeks of storage.

Delayed Storage Test.—Fruit of two pickings was stored in both plain and oiled wraps, and for comparison with the immediately-stored fruit other lots were held at room temperature for periods of one to four weeks before storing. Oiled wraps delayed the appearance of scald by eight weeks in the first-pick fruit and by eleven weeks in the second-pick fruit. As regards the effect of delayed storage on development of scald, the results indicate that, irrespective of date of picking or wrappers used, scald is at a minimum if the fruit is either stored immediately or else delayed for not less than four weeks. With any period of delay less than a month, scald is increased. Long-delayed storage, however, is accompanied by very undesirable effects on maturity and on incidence of fungus, so the work suggests the use of oiled wraps, immediate storage, and avoidance of early picking as the best means of achieving success in cold storing the Granny Smith variety.

Effect of Fertilizers on Cold-storage Quality

Observations have been maintained on the storage quality of fruit from the manurial blocks at the Appleby Research Orchard.

Cox's Orange Pippin.—Nitrogen has again greatly increased susceptibility to breakdown and fungus, and reduced somewhat the incidence of wilt. PK without N has given less breakdown and fungus, but more wilt, than the untreated control. The complete PNK treatment has this season given fruit showing as good storage quality as the control fruit. Both pit and superficial scald have been less severe in later picks than in earlier ones. No difference in keeping-quality could be detected between fruit from trees receiving ammonium sulphate and from trees receiving dried blood.

Dunn's Favourite.—A heavy application of 4 lb. ammonium sulphate additional to normal dressings of P and K increased both breakdown and fungus, but this season the 2 lb. dressing gave results almost identical with those of the controls that had no nitrogen. N unbalanced by P and K again caused a big increase in superficial scald, but the inclusion of P and K did much toward correcting this.

Jonathan.—As has been usual in the "off year" crops, applications of 2 lb. and 4 lb. ammonium sulphate have caused progressive increases in the incidence of breakdown, but only the heavier application has increased the amount of fungus. Potash has again reduced the incidence of breakdown and fungus, especially in late-picked fruit, and has caused only a slight increase in the amount of Jonathan-spot.

Delicious.—The storage quality of this variety continues to be unaffected by manurial treatments.

Sturmer.—N, unbalanced by P and K, has greatly increased both breakdown and fungus, but substantially reduced wilt. The PNK fruit has had no more breakdown and fungus, and only a little more wilt and superficial scald, than the untreated fruit. Phosphate alone has reduced breakdown susceptibility.

Cold-storage Aspect of Spraying Experiments

Unsprayed control fruit developed a considerable amount of ripe-spot in cold storage, but this was reduced by 57 per cent. where lime-sulphur had been used as a fungicidal summer spray, and by almost 95 per cent. where late application of summer Bordeaux sprays had been used. Incidence of fungus diseases other than ripe-spot was not affected by treatments.

Control of Wilt in Winter Cole and Winter Nelis Pears

The test on the use of waxed paper liners as a means of reducing the loss through wilt in long-stored Winter Cole pears was repeated, with an extension of the experiment to the Winter Nelis variety. Both varieties were held in store till the end of October. The treated boxes had a liner of waxed paper round four sides, between the fruit and the standard pad that lines the case. The ends of the box were not protected. With the Coles the controls showed 10 per cent. severe wilt and 37 per cent. slight wilt, while the waxed-lined fruit had only 8 per cent. slight wilt. The control Nelis had 2 per cent. severe wilt and 28 per cent. slight, while the waxed lined sample had 4 per cent. slight wilt. The bloom and general appearance of the waxed-lined fruit were distinctly superior, and except for an increase of 5 per cent. in the loss from fungus in Winter Nelis there was no offsetting disadvantage. The treatment thus proved highly economic on both varieties.

Orchard Storage of Apples

Observations on the behaviour of the principal varieties were continued in three different types of orchard store. In almost all cases a semi-underground store located in a cool position afforded distinctly better storage than above-ground stores, in which temperatures were somewhat higher. Except with Statesman and Rome Beauty, the higher relative humidity of the air in the underground store did not prove disadvantageous. Appreciation is again expressed for the willing assistance given in these experiments by the Horticulture Division of the Department of Agriculture and by the Internal Marketing Division of the Marketing Department.

Ballarat.—The variety kept in good condition till the beginning of July, when the ground colour began to change from green to yellow. The lower storage temperature was again more satisfactory, and fruit picked at the beginning of May showed the least wastage. A very early picking at the end of February proved unsatisfactory for long storage.

Washington.—The experiment showed that the best results should be obtained with fruit picked towards the end of April and stored at as low a temperature as possible. High storage temperature again increased superficial scald, the main cause of deterioration. The fruit remained marketable without much loss till the end of June.

Rome Beauty.—Fruit of a picking made about the end of April kept firmer, greener, and with less loss than that of a mid-April picking. Low-temperature storage gave the best result, and under suitable storage the fruit kept in good marketable condition till mid-July. The store should not be damp, as otherwise secondary infection by black-spot may cause loss.

Statesman.—Fruit picked at the beginning of May kept rather better than fruit picked in mid-April. The chief loss was from rots, and these were more extensive in the earlier picking. Low-temperature storage coupled with a moderately dry atmosphere was most satisfactory and enabled the variety to be held in good condition till about mid-July.

Sturmer.—The chief troubles were wilt and lenticel rots, and low-temperature storage again gave distinct control of both. The scheduled interval between first and second pickings could not be obtained, so no significant data were derived concerning date of picking. The variety kept in good condition till mid-July.

Docherty.—Fruit of a late picking made towards the end of May was very unsatisfactory by reason of a yellow ground-colour and a high incidence of lenticel rots. Under low-temperature storage the variety held well till the early part of August, when superficial scald began to appear in the early picking.

Tasma.—A picking made at the end of the first week in May kept appreciably better than a mid-April picking. Stem-end rots limited the life of the early-picked fruit. An incipient infection of secondary black-spot made it necessary to market the variety before mid-August. Low-temperature storage gave much the best results.

FRUIT RESEARCH

Advisory Committee.—Sir Theodore Rigg (Chairman), Dr. G. H. Cunningham, Messrs. W. Benzies, T. C. Brash, E. R. Callaghan, A. H. Cockayne, J. Corder, W. K. Dallas, A. Osborne, R. Paynter, F. S. Pope, A. M. Robertson, H. E. Stephens, and L. W. Tiller (Secretary).

Apple

(*a*) *Long-term Manurial Investigations.*—These have been continued by the Department on its Research Orchard at Appleby and by the Cawthron Institute at Mildura Orchard, Upper Moutere. At Appleby, Cox's Orange, Dunn's Favourite, Delicious, and Sturmer yields and growth have been considerably higher when nitrogenous fertilizer has been used, and still greater when the "complete" mixture of P, N, and K has been applied. The use of 2 lb. nitrogenous fertilizer on Jonathan has so increased the yield that the slight reduction in colour grading is more than counter-balanced. A 4 lb. application has retarded and reduced colouring to such an extent that the fruit has had to be left late on the trees, and this is undesirable from the standpoint of keeping-quality. The time of application of N and the manner in which it is applied have again produced no differences in growth or yield. The Jonathan trees that had a heavy application of K in 1933 and 1934 are still giving higher yields of fruit of superior colour.

At Mildura the Jonathan trees receiving the "complete" treatment of 2 lb. superphosphate, 1 lb. muriate of potash, and 2 lb. ammonium sulphate or dried blood continue

to maintain superiority over all the others. Omission of potash is causing increasing deterioration. Trees receiving only nitrogen remain in distinctly worse condition than control trees as regards growth, foliage quality, cropping-capacity, and fruit colour.

(*b*) *Minor Element Studies.*—The Cawthron Institute has finalized the method of making colorimetric tests on the ash skeleton of apple leaves. The method can be used for diagnosis of actual deficiencies as well as for ascertaining the distribution of minerals within leaf tissues.

Further improvements in trees suffering from magnesium deficiency have been noted by the Institute on the plots established in 1939 to test the efficacy of soil dressings of magnesium compounds. Where treatments have been repeated in two successive years the results have been more marked. This is especially so with magnesium sulphate, and is probably due to the fact that the sulphate leaches from the soil more rapidly than the carbonate or than dolomite. Dolomite has given the most consistent results, and need not be used at more than 12 lb. per tree, whether used in one lot or split into two successive lots of 6 lb. Three or four years may elapse before control can be expected in seriously-affected orchards.

(*c*) *Rootstock Trials.*—On the 3-acre block controlled by the Plant Diseases Division the most vigorous of the Malling stocks have maintained their initial lead over Northern Spy, although trees on the latter stock have to date given higher yields of fruit. Similar results obtain at Appleby, where M12 and M15 have given better growth than Northern Spy, with M1 slightly inferior to Spy. Fruit yields have also shown relationships inversely correlated to the growth responses.

(*d*) *Varietal Trials.*—Recording of the pomological characteristics of the varieties in the Owairaka collection of the Plant Diseases Division has been continued, so as to provide the industry with data that will safeguard against the planting of unsuitable varieties.

(*e*) *Plant Protection and Therapeutant Testing.*—Further successful trials with modifications of the normal spray programmes have been made at Havelock North by the Plant Diseases Division, although difficulty has been experienced with the Dunn's Favourite variety owing to its extreme sensitiveness to lime-sulphur sprays and its susceptibility to black-spot. Leaf injury may be caused by late applications of lead arsenate, even when not combined with sulphur sprays, but the use of 3 lb. hydrated lime to each 1½ lb. lead arsenate has been shown to reduce the damage. Experiments have been continued in Auckland, Hawke's Bay, and especially at Appleby to test the effect of various sprays and other factors on the incidence of ripe-spot *(Neofabraea malicorticis)*. Results to date suggest that fruit maturity and storage conditions are the main factors influencing the development of this disease. Summer applications of Bordeaux largely control the trouble on the Sturmer variety, and although a small amount of skin blemish is incurred, the eating quality of the fruit is not impaired.

The Cawthron Institute has devoted much time to the establishment of the codling-moth parasite, *Ephialtes candatus,* obtained from Canada. Two lots of larvæ have been reared from New-Zealand-bred material.

Stone-fruit

(*a*) *Peach.*—The Plant Diseases Division is continuing observations on those varieties in its collection that are already in bearing, and a few of these show some commercial promise because of their early ripening season. The trials show clearly, however, that the varieties now grown commercially are of outstanding merit and that new varieties are not likely to be accepted unless possessing exceptional qualities. Observations on both brown-rot *(Sclerotinia fructicola)* and leaf-curl *(Taphrina deformans)* show certain varieties to be definitely more resistant to the diseases than others. Tests on crown-gall suggest that it has no marked effect on peach.

(*b*) *Plum.—Bacterium pruni,* bacterial-spot of plum, has now been found to be widespread throughout the Dominion, and spray experiments for its control are now in progress.

Small Fruits

Raspberry.—Preliminary Plant Diseases Division trials on bud-moth, leaf-spot, septoria-spot, and cane-wilt show that lead arsenate has given good control of bud-moth and that Bordeaux mixture has given good control of cane-wilt and septoria-spot. On a new area a single programme is being tested to assess the economic value of spraying, using a spraying unit developed specially for the purpose. The bacterial trouble known as crown-gall does not appear to have had any effect on raspberry.

Citrus

(*a*) *Rootstock and Varietal Trials.*—At Oratia the Plant Diseases Division has planted 1¼ acres in trials of Washington Navel orange and Lisbon lemon on sweet and sour orange, citronelle, and *Poncirus trifoliata* stocks. Stock influence is already marked in the two-year-old trees, and Washington Navel on sour orange *(Citrus aurantium)* has shown stunted growth and profuse blossom. Thirty-eight sweet orange, six mandarin, and five grapefruit varieties, all on a selected sweet-orange stock, have been planted at Owairaka.

(*b*) *Mycological and Allied Studies.*—The Plant Diseases Division has found the variety Poorman to be susceptible to citrus canker under field conditions. An intensive study is being made of the so-called mycorrhizal fungus associated with the roots of citrus trees, to ascertain its relation to tree vigour and cropping.

Miscellaneous

Spray experiments have been continued at Auckland on the control of grease-spot and brown-spot of passion fruit.

The Fruit Research Officer and the Chemical Engineering Section of the Dominion Laboratory have devoted much time to the dehydration of apples, and the Department is at present responsible for the design and supervision of a large modern apple-drying plant in course of erection in Hawke's Bay.

LEATHER AND SHOE RESEARCH

Director: Mr. P. White. Assistant Director: Mr. F. G. Caughley

Leather Research Association

Advisory Committee.—Messrs. A. E. Lawry (Chairman), C. Arlington, J. E. Astley, S. L. Wright, R. L. Andrew, and F. Johnson.

The war has brought about many significant changes in the leather industry. The demand for heavier types of leather, in much larger quantities than ever before experienced, has created many difficulties. Not only has the quality of the leather to be maintained, but the tanner is faced with difficulties of expansion, supplies of raw materials, man-power, reorganization of processes, and, above all, output.

The future or the post-war period has also to be considered if the industry is to maintain its position in the economic life of the community, and the post-war problems can be faced with greater confidence by the possession of a greater knowledge of the fundamental facts of leather manufacture and how these affect the desirable characteristics of leather.

Sole Leather.—During the past year an investigation has been commenced on the involved question of flexibility of sole leather. In recent years the public have demanded that footwear shall provide a reasonable degree of foot comfort, sometimes irrespective of wearing value.

The increasing demand for comfort requires that the soles shall be sufficiently flexible so as to interfere as little as possible with the natural movements of the muscles of the foot.

Quality in sole leather is a summation of several features, the chief of which are resistance to water absorption, resistance to wet and dry abrasion or wear, and flexibility. In order to obtain the best total summation, compromises have to be made. It is necessary, therefore, to obtain detailed information on each of these individual qualities before a decision can be made as to how far the compromise is justifiable.

Some factors affecting the flexibility of sole leather have been determined during the year and to some extent, have been correlated with water absorption.

In addition, the usual routine work of checking factory processes, materials, and finished leather have been carried out.

Shoe Research Association

Advisory Committee.—Messrs. W. Denby, P. E. Edwards, W. S. Livingstone, D. I. McDonald, and R. L. Andrew.

Flexibility of Sole Leather.—The shoe industry is very much concerned with other aspects of the quality of sole leather than those mentioned above. In the first case it is very desirable that sole leather shall be reasonably easy to work in the shoe-factory. This implies that the leather must temper properly, must mould to the shape of the last, channel properly, must not be too difficult to sew, and must be able to hold tacks or screws. On the other hand, the shoe manufacturer's reputation depends on the wearing value and comfort of his products. Here, again, compromise is necessary, and the justifiability of the compromise can only be determined by a fuller knowledge of the relationships of the qualities of sole leather.

Adhesives.—Owing to further curtailments in the supply of rubber and nitrocellulose cements during the year, the position with regard to adhesives became more acute. This was lessened to some extent by the increased production of footwear for the armed forces. Rubber, with its unique properties, makes an adhesive for which no simple substitute has as yet been found. The position in regard to water adhesives and pastes is different, and little difficulty has been experienced in meeting the requirements in these lines.

Factory Problems.—That the Research Association has the confidence of the industry is shown by the number of problems submitted for examination during the year. The discussion of these in the monthly circular letters and with the staff on the occasion of visits to the shoe-factories has fully maintained the interest in the work of the Research Association.

MINERAL CONTENT OF PASTURES

INVESTIGATIONS AT THE CAWTHRON INSTITUTE

Introduction

During the past year cobalt investigations have been continued at Sherry Valley, these comprising an animal trial under different conditions of top-dressing of the pasture and an examination of the cobalt content of mixed pasture following the use of various cobalt-containing fertilizers. Animal organs from an earlier experiment at Glenhope have been analysed.

Animal Trials

At Sherry River the hoggets on areas top-dressed with the equivalent of 2 oz. and 4 oz. cobalt sulphate per acre have been retained on these areas for a further season. Another application of 2 oz. cobalt sulphate was given this last spring (1942).

Of the original five sheep on the control area, one died in May, 1942, and two others were very weak. These were drenched with cobalt and soon became strong again. The following summary gives the average live weights at different periods:—

	April, 1942.	August, 1942.	January, 1942.	December, 1942, Wool.
	lb.	lb.	lb.	lb.
Control	88·8	..	97·6	8·2
2 oz. cobalt sulphate	101·8	99·4	140·4	9·9
4 oz. cobalt sulphate	106·6	113·8	139·0	10·4
Cobaltized superphosphate	122·0	131·2	165·2	11·9

These figures show that small applications of cobalt sulphate are beneficial on this deficient area and that the 4 oz. application has kept the stock in good condition over nearly two seasons. The cobaltized superphosphate has again given outstanding results. The wool weights are instructive in showing the superiority of the cobaltized-superphosphate treatment.

Analysis for cobalt content of the pastures of the above areas has shown that the effect of the cobaltized-superphosphate application is still very marked; changes in the cobalt content of the pastures of the other plots have been found to correlate with the live weights of the animals.

At Glenhope in the 1939–40 season a trial was run in which sheep were depastured on a cobalt-deficient area until symptoms of bush sickness appeared, after which the animals were treated with cobalt chloride at the rate of 8 mg. of cobalt weekly. Periodically animals were slaughtered and samples of blood, liver, spleen, heart, kidneys, and pancreas were obtained for analysis. The necessary analyses have now been completed, and show that as the animals become progressively bush sick so the cobalt content of all these decreases continuously. After drenching began, the cobalt contents increased greatly. Three weeks after the treatment was commenced, except for the spleen, the cobalt contents were almost as high as after four months of treatment.

Pasture Top-dressing Trials

The Use of Serpentine-derived Soil

Sampling of the areas treated with 5 cwt. and 10 cwt. of a Nelson soil derived from serpentine and carrying approximately 350 p.p.m. of cobalt in February, 1940, has been continued. These applications of soil still (December, 1942) exert an effect sufficient to maintain the cobalt content of the pasture at a level satisfactory for stock health.

Use of Cobalt Compounds with Ground Limestone as Carrier

The plots top-dressed last season with mixtures of ground limestone and cobalt carbonate, hydroxide, phosphate, and sulphate have been continued into this season. Ground limestone used alone continues to slightly depress the cobalt content of the pasture. Applications of cobalt compounds equivalent to 10 oz. cobalt sulphate per acre generally show good increases, especially for cobalt phosphate. The uptake of cobalt by the pasture has therefore been satisfactory in the presence of the ground limestone.

Mowing Trial

Samples of pasture from these trials have been analysed for cobalt. Serpentine superphosphate at 3 cwt. per acre showed a very fleeting effect in increasing the cobalt content. Addition of magnesium carbonate or sulphate to the fertilizer did not affect the cobalt content of the pasture in either season of the experiment.

Molybdenum in Soils and Pasture

In view of statements in Great Britain that use of cobalt salts or of ground limestone increased the molybdenum intake by a pasture, determinations of molybdenum content were made on a number of pasture samples from previous experiments where cobalt salts had been used for top-dressing. Even where 1 cwt. of cobalt chloride per acre had been used, only slight increase in molybdenum content was found. Ground limestone showed no definite effect. In these New Zealand samples the molybdenum content hardly ever exceeded 1 p.p.m. of the dry matter.

MINERAL RESOURCES COMMITTEE

Personnel.—Dr. E. Marsden (Chairman), Mr. C. H. Benney (Deputy Chairman), Mr. R. L. Andrew, Mr. W. M. C. Denham, M.P., Mr. W. Donovan, Dr. J. Henderson, Mr. E. O. Macpherson, Mr. F. J. A. Brogan (Secretary).

The Committee continued to supervise and co-ordinate field surveys and laboratory investigations of mineral resources, especially those of war importance, carried out by the Geological Survey, Dominion Laboratory, and Mines Department. Four meetings were held during the year.

Mica.—A further examination was made of mica occurrences located by the Geological Survey in South Westland, in which representatives of the Mines Department, Geological Survey, and a company interested in the development of non-metallic minerals participated. The results were disappointing in that the quantity of mica likely to be recoverable was insufficient to interest commercial enterprise, and its average size was below the minimum marketable size specified by the British Government. Difficulty of access is another adverse factor. Nevertheless, representative samples were sent to the British Government for examination and report as a guide to further investigations. Another mica occurrence

on a privately-owned claim in South Westland is being officially investigated. Preliminary reports indicate that mica of considerably larger size is obtainable, although the quantity available has yet to be investigated.

Clarendon Phosphate Deposits.- Further geological examinations of these deposits, supplemented by geophysical surveys, were made, from which it was possible to recommend a boring programme to determine the depth and extent of the phosphate-bearing horizons. The preliminary results of the boring are reported in the Geological Survey section of this report (p. 42).

Serpentine.—Geological and chemical examinations of a serpentine mass at Black Ridge, Mossburn, Otago, suggested as a source of serpentine for South Island fertilizer-works, revealed at least 6,000 tons of recoverable serpentine of the requisite quality for serpentine-superphosphate manufacture.

Oil Shale.—The information collected in the course of geological surveys of the shale deposits and from laboratory tests of quality has been summarized. The Committee, after reviewing the data, concluded that, owing to the generally low grade of the shales and the formidable difficulties that would have to be faced in the procurement of plant and technical personnel, there is little hope of oil-production as a contribution to wartime fuel-supplies.

Refractories.—A committee comprising representatives of the Geological Survey, Dominion Laboratory, Mines Department, and Industries and Commerce Department was established during the year to develop and co-ordinate research on the quantitative and qualitative aspects of New Zealand's resources of ceramics and refractory clays and related materials, which are becoming of rapidly increasing importance in the Dominion's industrial development. This Committee will work in close liaison with the Mineral Resources Committee.

Research in Ore-dressing.—The committee recommended the establishment by the Government of an experimental ore-dressing station under the charge of a suitably qualified research officer, to enable research to be conducted on the concentration of local ore by modern flotational and other methods.

Peat Wax.—A full report on the geological survey of the Chatham Island peat deposits and the chemical investigation on the wax has been prepared for publication. Considerable interest in the wax has been evinced by local and overseas firms to which laboratory samples have been sent, but if a sufficient commercial demand should arise, the location of the deposits would no doubt make their development difficult under existing conditions.

Mercury.—Geophysical examinations in the Puhipuhi area failed to disclose any mercury-bearing formations additional to those already being worked. Reports were made on deposits at Mount Mitchell and the Rising Sun area, from which limited quantities of ore are available.

Miscellaneous.—Surveys of deposits of clays, flints, refractory materials, diatomaceous earth, and other materials of industrial importance were continued.

NEW ZEALAND WOOL MANUFACTURERS' RESEARCH ASSOCIATION

Director: Professor F. G. Soper

Wool Manufacturers' Research Association Committee.—Mr. W. R. Carey (Chairman), Professor H. G. Denham, Mr. T. E. Donne, Mr. H. Lee, Dr. R. O. Page, Mr. T. C. Ross, Mr. W. L. Wood, Dr. E. Marsden (Secretary).

Unshrinkable Wool Garments

To meet the need for reducing the well-known tendency of knitted wool underwear to shrink during laundering, the majority of New Zealand manufacturers have for many years treated the fabrics with a solution of chlorine in water. Tests carried out with a special shrinkage-testing machine in the laboratory of this Research Association during the past two years have shown, however, that wide variations have existed in the shrinkage properties of the finished garments. Fortunately, research work initiated in England, has recently shown how this "wet chlorine" process can be modified to produce a more uniformly unshrinkable fabric, and so the task in this country lay in introducing these discoveries into the industry and testing the treated fabrics. This work has taken much of the Association's time, but the results have indicated that now a much more uniformly unshrinkable product is being made, while in some cases large savings in time and chemicals have been effected.

There still remain inherent defects in the above process which make the examination of new unshrinkable processes worth while. One of these subjects the wool to the action of chlorine gas and is known as the dry chlorination process. A full-scale dry chlorination plant, on loan from the Wool Industries' Research Association, England, has been installed in one of the New Zealand mills, and members of the New Zealand Wool Manufacturers' Research Association are now having trial batches of their fabrics put through it before it is operated for commercial production. This work will be linked up with that done last year, when representative samples of knitwear were sent, through the courtesy of the Council for Scientific and Industrial Research (Australia), to Australia for treatment by the Freney Lipson process.

Influence of Hairiness on Processing

The object of this work, for which a grant was made to the Association by the New Zealand Wool Council, was to determine the effect of a known degree of hairiness in wool on its processing properties and on the finished material. Two lots of 48's quality each about 200 lb. were collected by Dr. P. R. McMahon as nearly identical as possible except for a measurable difference in hairiness. These two lots have now been processed, a portion of each being converted into serge cloth and the remainder into hosiery yarn. Some of the latter was knitted up on a frame knitting-machine and some on a circular machine. Full analysis of the processing details remains to be completed. Any differences which exist in the finished goods are only slight. Apart from the main test, smaller investigations have been incorporated—*e.g.*, comparisons of different methods of dyeing—which are of interest to the industry.

Service to Members

Numerous consulting problems have continued to be dealt with, and some of these have required special visits to mills. A few examples of these are the cause of uneven dyeing of cloth, the origin of dermatitis on the arms of workmen, the explanation of the unsatisfactory working of knitting yarns, and the devising of substitutes for chemicals in short supply. Further work has been done on woollen batching oils. Assistance has been given to a member in designing a mill laboratory and in training a laboratory worker. Quarterly bulletins containing the results of research both in the laboratories of this Association and from abroad are circulated to members as in past years.

PLANT CHEMISTRY LABORATORY

Director: Dr. J. Melville, on active service. Acting-Director: Dr. B. W. Doak

Vegetable Dehydration.—Early in the year attention was devoted to the problems of vegetable dehydration. These investigations have considerably increased in scope, and virtually the whole of the staff is devoted to work on this and associated problems. Particular attention has been devoted to the retention of vitamins, especially ascorbic acid (vitamin C), in the dried product. Very satisfactory retention of ascorbic acid has been obtained, and in certain cases the ascorbic-acid content of the cooked dehydrated vegetables is greater than that of the cooked fresh vegetables. Attention has been mainly devoted to potatoes, cabbage, onion, swede, parsnip, and beet-root, from all of which excellent products can now be obtained. Some attention has also been given to beans, green peas, spinach, and cauliflower, though results from these have been rather less satisfactory. As a result of the investigations here, small commercial lots have already been dried and a large plant is about to commence operations. To satisfactorily retain flavour, colour, and vitamin content, the vegetables need to be given a blanching treatment in steam or in hot water to which small amounts of chemical have been added.

Vitamin Work.—Arising out of the vegetable-dehydration work, the estimation of vitamins in plant materials has been extensively studied. It has been found that plants vary very considerably in their vitamin content, and from some of the highest testing species attempts have been made to extract and concentrate ascorbic acid for the fortification of rations for the fighting forces. Good progress has been made in this direction.

Rye-grass Alkaloids.—In the early part of the year some attention was paid to the alkaloids in perennial rye-grass. Some interesting observations were made, but the urgent requirements of the vegetable work precluded the further investigation of several strongly fluorescent derivatives of perloline.

Silage.—In collaboration with the Grasslands Division the investigation into losses in making silage has continued.

PLANT RESEARCH BUREAU

Plant Research Bureau Committee.—Mr. A. H. Cockayne, Chairman; Dr. F. W. Hilgendorf,* Vice-Chairman; Professor G. S. Peren; Professor E. R. Hudson; Sir Theodore Rigg; Dr. E. Marsden; Mr. R. B. Tennent; Mr. C. A. Marchant; Mr. Alan Grant; Mr. F. R. Callaghan, Secretary and Chief Executive Officer.

The Plant Research Bureau now comprises five Divisions, viz.:—

—	Location.	Director.
Agronomy Division	Canterbury Agricultural College, Lincoln ..	†Mr. R. A. Calder (Acting-Director).
Botany Division	8 The Terrace, Wellington	Dr. H. H. Allan.
Entomology Division	Cawthron Institute, Nelson	Dr. D. Miller.
Grasslands Division	Massey College, Palmerston North ..	Mr. E. Bruce Levy.
Plant Diseases Division	Owairaka, Auckland	Dr. G. H. Cunningham.

* See Secretary's report. † Mr. J. W. Hadfield, Director, was seconded to Linen Flax Section, Industries and Commerce Department, as from 1st June, 1940.

Participating in the Bureau are (1) the Department of Agriculture and its various Divisions; (2) the Department of Scientific and Industrial Research and its several research sections; (3) Massey Agricultural College; (4) Canterbury Agricultural College; and (5) Cawthron Institute.

AGRONOMY DIVISION, LINCOLN

Acting-Director: Mr. R. A. Calder

Pure-seed production of agricultural crops has again been the main divisional activity, but in addition a certain amount of breeding and investigational work has been maintained. Approximately 63 acres have been under crop during the past season.

Wheat.—To provide nucleus seed for certification purposes, 9½ acres of the following varieties were grown: Cross 7, College Hunters, Fife-Tuscan, Solid-straw Tuscan, Jumbuck, Holdfast, and Marquis. Rust and bird damage were more severe than normally, but nevertheless satisfactory seed yields were obtained.

Oats.—The testing of reselected lines of Gartons Abundance and Algerian is being continued for the purpose of developing improved nucleus stock for possible future certification. Seventy selections from the sixth-generation cross between the two high yielding varieties Resistance and Onward were grown for observation; the best of these will again be placed under trial. Increased areas of Victoria Cross and S.17 were grown. Victoria Cross—an introduction from Canada—is very highly resistant to leaf and stem rust and gives a high yield of good-quality Algerian-type grain. Favourable reports on its behaviour have been received from the North Island, where some large-scale trials were carried out, and arrangements have been made to have further tests conducted this coming year. S.17, a selection from a cross between Gartons Abundance and Ruakura, is an early, high-yielding, white oat which produces only fair-quality grain but which gives good green-feed yields.

Barley.—Ten varieties of high-yielding malting barleys introduced by this Division were grown by the Canterbury Seed Co. with a view to large-scale malting tests. Golden Archer, which shows excellent malting quality in England, is regarded as particularly promising. Selection work is being carried on with the best of these. Further satisfactory results have been obtained from Newal, a quick-growing, smooth-awned, six-row feed barley obtained from Canada, and an increased area of 1 acre was grown.

Garden Peas.—Reselected stocks of the following varieties were again grown on contract for merchants: Greenfeast, William Massey, Stratagem, Little Marvel, Onward, Harrisons Glory. The new hybrid type 8/13/2/3, developed from a cross between Greenfeast and Greatcrop, has now been named "Greencrop," and an acre block was grown for increase; this is to be multiplied again before being offered for distribution.

Field Peas.—Forty-eight acres of the new blue field pea, 5/7/1/6, which has now been named "Mammoth Blue," were grown by Canterbury Agricultural College, and 30 acres of the new white field pea, 3/42/3, now called "White Prolific," were grown by farmers on contract to the Fields Division, Department of Agriculture, which is to arrange the distribution of the produce from these areas. Two acres were grown of another new white pea which has been developed from a cross between Victoria and Stratagem and which on account of its large attractive seed will probably be named "Mammoth White."

Rape.—The yields from the nucleus areas of Giant and Broad Leaf Essex rape were disappointing owing to damage by aphides and birds.

Kale.—Selection work is being continued with the tall stemmy type and with two medium leafy types of marrow-stem kale and also with thousand-headed kale. Nucleus seed-supplies of these have been raised for distribution. Crosses between marrow-stem kale and thousand-headed kale, cabbage, and kohl rabi are also being studied.

Sweet Lupins.—Excellent reports have been received on the value of sweet lupins for stock feed. The sweet blue in particular shows great possibilities for lamb-fattening, particularly as they are not subject to any of the insect or fungous pests that attack rape and turnips. The behaviour of the yellow type in earlier trials was disappointing, but for the past two seasons areas, when sown about the middle of October, have grown particularly well and it would appear as though this type warrants further trial. Seed areas of both types were grown during the past year, and single plant selections from each are being tested with a view to increasing their productivity.

Linen Flax.—Nucleus stocks of Liral Crown, Liral Prince, Stormont Cirrus, Stormont Gossamer, and Concurrent are being maintained in order to have pure seed available for the industry. Single plant selections have been made from these and also from Hercules and Blenda. Variety trials made good growth this season. Of the ten varieties under test, Stormont Cirrus looks the most promising, with Liral Prince and Stormont Gossamer not far behind. An American strain of Stormont Cirrus compared very unfavourably with a strain obtained originally from Ireland. Breeding-work is continuing with a view to combining disease resistance with good yield of fibre. Further crosses have been made using Rio as the disease-resistant parent, also back-crosses of F.3 material to the best fibre varieties.

Preliminary experiments have been carried out on the problem of mite infestation of flax-seed in store. Experiments in progress appear to corroborate the English finding that mites cannot attack undamaged flax-seed. They also show that a dressing of approximately 4 oz. of Ceresan per bushel gives good protection against mites.

Fibre determinations were made on samples from all the trials conducted by the Fields Division, and similar work is being undertaken with commercial crops in order to devise methods to increase the amount of fibre extracted from different types of straw. Much loss is due to unevenness of stand. When the straw is variable, even retting is impossible and an excessive proportion of tow is produced. Special attention is being devoted to methods for overcoming this difficulty. In co-operation with the Plant Diseases Division and with the Dominion Physical Laboratory work is being carried out at flax-factories on temperature distribution within tanks during retting and also on losses caused by imperfect handling of the crop from pulling to scutching. Some at least of this loss is

due to faulty butting of the sheaf in harvesting. An attempt has been made in Australia to overcome this by stripping the seed before cutting the crop, thus avoiding the tangling of the seed bolls, which drag the sheaves about and makes them uneven. An attempt to strip part of one of our seed areas with a rye-grass beater stripper was unsuccessful, due to insufficient clearance.

A quantity of sinox (sodium dinitro-ortho-cresylate) ordered from America failed to arrive. The small amount on hand was used on linen-flax crops and fully confirmed the previous year's results—that is, that excellent control of fat-hen, wireweed, &c., can be secured, but that further work is required to determine the best time and rate of application.

Linseed.—An increase area of the disease-resistant, high-quality type, Rio, was grown at the Division, and an acre of New Zealand Commercial at Canterbury Agricultural College. Supplies of these are to be built up so that pure stocks will be available for the linseed-oil industry if required.

Lucerne.—Favourable reports have been received regarding the behaviour under field conditions of the first pedigree strain, Strain B, and an increase area of approximately 10 acres has been sown at Canterbury Agricultural College. Further observations have been recorded on the behaviour of the spreading species, *M. glutinosa,* and selections are to be made this year for the development of a mass selected strain.

Potatoes.—Breeding-work has perforce been restricted, but the most promising lines obtained from crosses between commercial varieties and various South American species are being tested further.

Mangels, Carrots, Chicory, and Coriander.—Small areas of reselected stocks of Yellow Globe mangels, of Holmes Improved carrot, of chicory, and of coriander were grown for seed-production.

Rye-grass and Red Clover.—On behalf of the Grasslands Division, Palmerston North, 4½ acres of Italian rye-grass and 2 acres of short-rotation rye-grass were grown for seed, and an area of Broad Red clover established for seed-production next year.

BOTANY DIVISION, WELLINGTON

Director: Dr. H. H. Allan

Some fifteen hundred specimens have been examined, several new weeds being recorded and extensions of range noted.

Considerable additions to the herbarium have been made from areas visited by the staff. Of major importance is a set of marine algæ, the result of many years' work, presented by Mr. W. A. Scarfe. Other noteworthy accessions are sets of Chatham Island seaweeds (presented by Mr. R. Gilpin), of seaweeds from Tauranga Harbour (presented by Mr. M. Hodgkins, and accompanied by notes on seasonal occurrence throughout the year), and representatives of the florulas of the Mount Arthur and Upper Awatere areas.

Seaweed Utilization

Agar.—A firm holding a license to manufacture agar has carried out preliminary work and is assembling plant necessary to deal with 1 ton of dry seaweed per week. Agar produced in small quantities in their pilot plant is of very good colour and appearance; it has a low ash content (0·9 per cent. on dry weight in sample analysed by the Dominion Laboratory), is satisfactory for use in culture media, and has a higher gel strength than the Japanese agar customarily used. *Pterocladia lucida* and *P. capillacea,* with agar contents of 40·4 per cent. and 35·2 per cent. of dry weight of weed respectively, were the best of the species submitted to the Dominion Laboratory for analysis. Between June and December, 1942, the Internal Marketing Division purchased 11 tons of dry weed (mostly *P. lucida*). The greater part of the Auckland coast was surveyed during the year, the occurrence of *Pterocladia* studied, and instruction given to collectors. Data accumulated indicate that beds can be picked in rotation without suffering permanent depletion. Spore production for the establishment of new plants is being investigated.

Carrageen.—Further samples of New Zealand carrageen (*Gigartina* spp.) were sent to the High Commissioner, London, and to British, American, and Australian firms. The most promising as a substitute for Irish moss is *G. decipiens.* The high arsenic content (20 p.p.m. of As_2O_3 on dry weight) of the fresh weed reduces on bleaching to 2–4 p.p.m. The only other kind favourably received was a broad-leaf form from Stewart Island, of which some half a ton has been ordered for trial by a Sydney firm interested in the manufacture of toothpaste. Its performance is stated to be quite satisfactory, and the cost, though higher than that from other sources, could be reduced if material were graded by suppliers. In view of the urgent need for an Irish moss substitute and the large quantities of quick-growing *Gigartinas* on our coasts, investigations are being continued.

Alginates.—Samples of brown seaweeds collected for analyses by the Dominion Laboratory yield from 1 per cent. to 24 per cent. of their dry weight of alginic acid. Those with highest yield are all common on the coast and large enough to be easily gathered.

Medicinal Plants

The results of research work have been applied to field practice as soon as they have been completed. General advice has also been given as required to the Departmnt of Agriculture.

Digitalis purpurea (Foxglove).—The results to date of experiments carried out in conjunction with the Department of Agriculture Station at Wallaceville are: Rosette leaves are equal in quality to stem leaves from flowering plants; a significant drop in glucoside content occurs as the flowering stalk elongates, and again when seed begins

to form; leaf collected under different weather conditions or at different times of the day shows no difference in potency; the activity of the leaf decreases rapidly after being kept more than twelve hours; drying at temperatures of 180° C. or over destroys the active principle; the bulk of the glucosides is contained in the blade, and the petiole may be discarded, incidentally hastening drying. Autumn sowings in the field yield a satisfactory crop and eliminate much handling of young plants. Yields of dry leaf per acre have much exceeded figures recorded for overseas crops.

Atropa belladonna (Deadly Nightshade).—Some eight hundred plants have been harvested individually for selection of high-yielding plants. These are to be propagated from rootstocks in the winter. Chemical tests show a wide range of potency in individual plants. Second-year growth from over-wintered rootstocks will yield two crops of leaves this season, but both will be lighter than the single first-year crop. Root tests showed 0·4 per cent. of total alkaloids (B.P. requirement is 0·4). Wilt disease is giving much trouble.

Datura stramonium (Thorn-apple).—About three hundred and fifty plants have been harvested individually for selection of high-yielding strains. Twenty-eight plants were selected after chemical tests and hand-pollinated. Seed has also been saved from the high-yielding plants for multiplication on a commercial scale. The "Wellington" type, multiplied from a wild plant and found to be highly productive in the experimental-plots, has made excellent growth on the Agriculture Department's area at Hastings. This strain is proving more satisfactory in every way than the English type for large-scale plantings. As the plant matures, the alkaloid content rises rapidly.

Hyoscyamus niger (Henbane).—The strains on trial have proved very susceptible to virus disease. Contrary to overseas advice, open-field sowings have proved very satisfactory, and the plants show lower incidence of disease than glasshouse-raised plants. Under somewhat droughty conditions this season at Hastings the plants have flourished. All chemical tests on the biennial type have given satisfactory results, while the annual type, though much freer from disease, is low in potency.

Papaver somniferum.—All three types used made excellent growth. The white-flowered Indian variety, planted out early in the spring, was badly damaged by wind, and needs close planting. A red-flowered variety from seed collected from a local wild plant made good growth but yields small capsules. The purple-flowered variety averaged from 5 ft. to 6 ft. in height, each plant bearing from six to eight large capsules. The results of chemical tests are not yet available. Sufficient material was saved from the tall variety to carry out a pilot extraction. Sixty pounds of seed were saved. Open-field sowing proved entirely satisfactory.

Digitalis lanata.—This continues to do excellently and seed stocks are now sufficient for a trial on a commercial scale. Selection work is in hand. Tests so far show about 0·75 per cent. glucosides on a dry-weight basis (overseas results give figures of from 0·8 per cent. to 1·0 per cent.).

Other Medicinals.—*Mentha piperita* var. *citrata* has grown prolifically and came into full flower in the second season of growth. Harvesting for extraction of oil has been completed. *Datura metel* suffered a severe attack of mosaic disease, but field sowings have shown less infection than glasshouse-raised plants. Other species of *Datura* are also under test. The growth of castor-oil plants (*Ricinus communis*) has been satisfactory; yields of 300 lb. of beans per acre have been obtained, with an oil of satisfactory quality. Satisfactory yields of oil have been obtained from the seeds of coriander and fennel. Other medicinals, including species of *Ephedra, Barosma,* and *Glycyrrhiza,* are still in the preliminary stages of trial.

Rubber Plants

Taraxacum kok saghyz (Russian Dandelion).—Seed has been handed over to the Department of Agriculture for preliminary field trials in selected areas in both Islands, and a larger area will be autumn-sown for seed-production. Surface-sown seed germinates excellently, and deep sowing is to be avoided. Plants from seed sown late in November began to come into flower within eight weeks. By mid-February they showed flat rosettes of leaves 8 in. to 10 in. across and are flowering freely. Rubber-content tests will be made at two-monthly intervals. Selection work will be undertaken.

Sonchus littoralis (Native Sowthistle).—Of numerous species of plants tested, this proved the only likely source of rubber. Cultivated plants have produced large roots, which are under test.

The present results of inquiries concerning the Moreton Bay fig (*Ficus macrophylla*) and Assam rubber (*Ficus elastica*) suggest that there are not likely to be sufficient trees available in New Zealand to make them a practical source of rubber within a reasonable time.

Fibre Plants

Phormium.—The experimental plots tabulated in the last annual report are in good condition and have been kept under observation. No results can be expected until a four-year period of growth has elapsed. The area of *P. colensoi* × *tenax* has grown well and will be tested next season. Large-scale trials of close-planted phormium, using both swamp and selected strains, have been arranged. Additions continue to be made to the area devoted to observation of individual plants of promise. Some fibre tests have been made, and it is hoped that arrangements can be made for detailed work on this aspect.

Hemp.—The harvest from the seed plot promises to be good. One and a half acres of Hungarian hemp have been cut for fibre tests. Several small batches have been water-retted, and a large-scale trial has been arranged for at one of the linen-flax factories. A scheme for more extended and detailed work will be put into practice next season.

Linen Flax.—The work of this Division has so far been confined to anatomical studies. This work has so far shown (i) that there was very little difference amongst the flax from the manurial trials (however, the flax from the different treatments was placed in the same order as it was in the Lincoln fibre analysis, which also showed differences that were hardly significant); (ii) no effect from oversowing with potash; (iii) certain differences due to soil types; (iv) that differences between flax grown after turnips and after lea may be very striking; (v) in one case a crop manured with blood and bone had much more heavily lignified fibres than the corresponding crop without blood and bone.

Fibrous Plaster.—A number of species have been tested, with emphasis on grasses and sedges, since this material does not require decortication. *Nassella* leaf proved excellent and combined well with linen-flax tow. It has the advantage of an existing large source of supply, but there is only a limited period during which the leaf can be collected without danger of spreading the weed by seed caught up in the leaves. Further work has therefore been postponed. Preliminary tests of cabbage-tree leaf (*Cordyline australis*) showed great promise, and a bulk lot will be prepared for a thorough try-out. The fibre is sufficiently promising for certain types of work to merit detailed research on the various questions involved in bringing it into commercial production.

Weeds

Hard Fern.—From the study of the significance of spores in hard-fern infestations (*N.Z. Jour. Sci. & Tech.*, *23*, 113B–125B) it has been concluded that (i) many areas if once thoroughly cleared of hard fern could be kept permanently free of the weed; (ii) on colder slopes in high-rainfall areas where a close sward of grass cannot economically be maintained reinfestation is inevitable after even the most thorough elimination, and here afforestation is recommended.

Gorse.—An experiment with wheat indicated that a gorse cover definitely increases soil fertility. Germination of seed was found to be fairly uniform throughout the year. Seedlings develop a taproot about 5 ft. long in six months if water-table conditions are suitable, with good production of nodules to 3 ft. Plants in which the crown had been grubbed right out showed no regrowth; with the crown chipped at ground-level strong regrowth occurs. Stem cuttings root readily, but no growth was obtained from root-cuttings, either in the field or in the glasshouse. General field studies have been continued.

Nassella.—Field-work during the year revealed increasing density of infestation in the infected areas, and in Marlborough considerable spread to previously non-infected areas. Experimentally-grown tussocks eleven to fifteen months old flowered and gave high yields of seed, some of the older plants producing over twelve hundred inflorescences in two crops, one after complete defoliation). Regrowth after cutting is rapid, of the order of ½ in. to 1 in. in twenty-four hours. Seed in soil was still germinating after nine months. Extensive germination trials are under way. Seeds treated with a wide range of chemical weed-killers indicate that such treatment accelerates permeability to water of the husk and promotes germination.

Tussock-grassland

Tussock areas were examined at Mount Kurow, Te Akatarewa (Waitaki Valley), Mount Meyer, Hunter's Hills, Cass, Molesworth, and Tarndale. Special attention was paid to selecting areas for observational and experimental work on improvement of cover and erosion control.

Taxonomy

Work has been continued on the seeds of legumes, weeds, and indigenous species, and many illustrations have been completed preparatory to the issue of bulletins covering these projects. The major genera under revision are *Acaena* (for biological control work, and as agents of erosion control) and *Cotula* (with special reference to species useful as material for surgical dressings). General taxonomic work is being done on the Graminæ, Cyperaceæ, Coniferæ, and marine algæ. Much other incidental taxonomic work is in progress, including revisions of the weed species of needle-grass and oxalis.

Ecology

Ecological work in hand, to be presented as papers, bulletins, or books, covers the topics distribution of marine algæ, the plant covering of the Wellington District, the vegetation of New Zealand, the influence of climatic factors on vegetative cover and distribution, vegetative aspects of erosion in the Orongorongo area, and polymorphy in indigenous species. Much ecological work is, of course, involved in the projects dealt with under other heads.

Miscellaneous

Of the miscellaneous projects in hand the following may receive brief mention. *Teasel:* Growth has been good, and sufficient heads for a thorough test should be available. *Viper's Bugloss* ("Blue Borage," *Echium vulgare*): Material from Marlborough was forwarded to the Wallaceville Laboratory. No ill effects were observed in sheep during the feeding trial. *Lampe's Mallow:* Sufficient seed has been harvested to provide material for a feeding test of this forage plant. *Sweet Brier (Rosa rubiginosa):* Surveys have been made for the localities where hips can be obtained in quantity for vitamin-supply purposes.

ENTOMOLOGY DIVISION, NELSON

Director: Dr. D. Miller

Diamond-back Moth (Plutella maculipennis).—The opinion expressed in last year's report that the parasitic control of the diamond-back moth will be secured seems now to be well on the road to being confirmed by observations made during the current year. Thus, this entomological activity should eventually rank with that of the parasitic control of the white butterfly. In spite of the control the parasites finally accomplish, however, temporary outbreaks of the moth are to be expected, as in most cases of parasitic control, but under such circumstances parasites are effective for all practical needs of the farmer.

For the past twelve or fourteen years, cruciferous crops have never been so free of diamond-back moth as they are at present, even though weather conditions have been favourable for the development of the pest. Indeed, moth infestation in the observed areas has been perceptibly declining during the past three seasons.

A field survey was carried out during February through Hawke's Bay, the Wairarapa, and westwards of Palmerston North, eighty-five crops being studied. An analysis of the material collected revealed that both the larval (*Angitia cerophaga*) and the pupal (*Diadromus collaris*) parasites are establishing well, and the following percentages illustrate the range of parasitism exercised at present as compared (in parentheses) with the position four years ago: The larval parasite, 9·1 per cent. to 100 per cent. (0·1 per cent. to 5 per cent.), and the pupal parasite, 5·8 per cent. to 65 per cent. (0·5 per cent. to 29 per cent), the average of the combined parasitism of the two parasites being 77·8 per cent. (3·93 per cent.).

Close watch will be kept on the progress of these parasites, and if the present rate of their increase is maintained, then the protection from moth attack of the Dominion's cruciferous crops (approximately 600,000 acres) will be assured, and the crops re-established in areas where the pest has prevented their cultivation.

Apart from the establishment of the diamond-back-moth parasites, laboratory and field studies of climatic influences upon both moth and parasites have been undertaken for the purpose of prognosticating outbreaks of the moth and the influence of its parasites in different localities.

White Butterfly (Pieris rapæ).—Observations throughout the country show that the white butterfly has generally been successfully held during the year by the pupal parasite (*Pteromalus puparum*). The larval parasite (*Apanteles glomeratus*) introduced from North America has become well established in the Nelson District; only one liberation outside Nelson was made during the year, but a general distribution of this valuable insect will be undertaken as soon as restricted facilities allow. From the limited data at present available, it can be said that this larval parasite is aiding the pupal one in exercising a greater control of the white butterfly in the Nelson District than where control depends solely on the pupal parasite.

Subterranean Grass-caterpillar (Oxycanus cervinata).—Since this insect, next to grass-grub, ranks as the most serious pest of New Zealand pastures, farmers will welcome the results of experiments which have now proved that chemical control is both practicable and effective under farm conditions.

Damaged pastures are treated (preferably not later than February) with a poison bait consisting of 2 lb. Paris green, 50 lb. bran, and 6 gallons water to each infested acre; as a substitute for Paris green, 4 lb. of lead arsenate can be used with equally good results. One application will destroy 80 per cent. of the caterpillars and there is no danger of stock poisoning. The bait can be spread broadcast by hand over small areas, but otherwise a mechanical distributor is used. For this a horse-drawn fertilizer-distributor covering 12 acres a day, or a motor-truck with top-dressing attachment covering 80 acres a day, can be utilized. However, a specially-designed bait-distributor covering 10 acres to 20 acres an hour has been effectively operated, the cost of treatment being from 8s. to 9s. per acre. As a basis for the above control results, the ecology of the insect was studied.

Cheese-mites.—This problem involves an investigation of species of cheese-infesting mites (their occurrence, biology, and environmental reactions), and of possible control measures as a protection of large stocks of cheese held for shipment outside cool store.

The species of mites found upon cheese in New Zealand are *Tyrophagus putrescentiae, Tyroglyphus siro* (not previously recorded), *Tyroglyphus farinae,* and *Glycyphagus* sp.

The biology of certain of these mites is being studied, and there are indications that the development of the different species depends on temperatures peculiar to each.

It has been found that mite-infested reject cheese held at the factory may be a source of initial infection of the exported product.

Control methods being experimented with involve (i) fumigation, (ii) waxing, (iii) smearing with butterfat or lard, and (iv) use of dusts. All of these methods present their difficulties and have not yet reached a stage where conclusions can be drawn.

Cocksfoot Stem-borer (Glyphipteryx achlyoessa).—A serious infestation of cocksfoot in the seed-producing areas of Canterbury and Akaroa is due to the larvæ of this moth boring in the stems of the grass. The insect also occurs in other parts of the Dominion. Considerable progress has been made in the study of the life-history, which had been unknown, while field observations point to the infestation being greater in older areas of cocksfoot where the grass has been established for some years, reaching as high as 78 per cent. at least. The influence of this insect on the seed yield must be considerable, but the full extent has yet to be ascertained. The moth larvæ also infest the stems of prairie-grass, tall fescue, onion twitch, long twitch, timothy, and wheat. In the last case, infested stems produce white heads, as in cocksfoot, which are poorly filled. The present season's observations are not yet concluded.

Clover Case-moth (Coleophora spissicornis).—This is an introduced insect which is a serious pest of red clover in Denmark. It occurs in both Islands of New Zealand, where it damages the florets of white clover at North Auckland, Hastings, Blenheim, and Ashburton. Similar injury to red clover at Ashburton and in South Canterbury is possibly due to this insect. The insect has been studied and an account of the work has been prepared.

Tobacco-store Insects.—Attention has been given to the control of moths infesting stored tobacco.

Argentine Wheat-weevil (Hyperodes griseus).—Owing to the importance of this insect in the wheat-growing areas of New Zealand, an endeavour is being made to locate parasites of this weevil in the Argentine. The insect occurs there, but is not known to be destructive.

Linen Flax.—The possibility of plant bugs having a detrimental influence upon linen flax led to a preliminary study of the position. There are indications that certain species of plant bugs possibly attack the seeds. A watch has also been kept upon the leaf-mining fly (*Phytomyza atricornis*), which is extremely abundant in New Zealand and is known to mine linen plants in other countries.

In view of the occurrence of a mite (*Tyroglyphus farinae*) amongst flax-seed, an investigation, in conjunction with the Agronomy Division, is being made into the influence of this mite upon flax-seed under varying conditions of temperature and humidity.

Termite Research.—See Timber Protection Research Report, p. 25.

GRASSLANDS DIVISION, PALMERSTON NORTH

Director: Mr. E. Bruce Levy

General

Plant Breeding and Pedigree-seed Production.—The plant-breeding work of the Division is fundamental to the maintenance and improvement of the standard of pedigree seeds of pasture species, and as far as possible, therefore, with the reduced staff available, the volume and scope of the plant-breeding work has been maintained. The short- or long-rotation type of pasture offers great possibilities in any scheme of rapid increase of pastoral production, and the policy of the Division has therefore been to breed strains of pasture plants for a rotational type of farming as well as maintaining and improving the strains bred for truly permanent pastures.

Breeding is being carried out with the following pasture cocksfoot species: Perennial rye-grass, Italian rye-grass, short-rotation rye-grass, timothy, white clover, broad red clover, and Montgomery red clover.

Blind-seed Disease of Rye-grass.—The possibility of breeding a line less susceptible to the disease than the strains at present available is being studied. A series of crosses with resistant and susceptible plants has been made, and this season some five hundred of the progeny plants have been inoculated with spores of the disease in an attempt to obtain information in the inheritance of resistance and susceptibility.

Short-rotation Rye-grass.—A new glasshouse isolation has been made of a type which has shown great promise under trial. Seventeen bushels of nucleus seed of this type have been harvested at Palmerston North and 84 bushels at the Agronomy Division. Breeding-work is being continued with this type and with various other types obtained by hybridization of perennial and Italian rye-grass.

Cyanogenesis in White Clover.—The mode of inheritance of cyanogenesis in white clover has been determined. From this information two strains of white clover have been bred, the first exceptionally high in the cyanogenetic glucoside, and the other free from the glucoside. Areas of these two strains have been planted and after harvesting will be used for feeding trials.

Vegetable-production.—Variety trials of the more common vegetables have been made and quantities of each produced for the dehydration of vegetable work by the Chemical Laboratory.

Strain-testing

Grasslands Substation, Lincoln.—Testing of selected strains is continuing at Lincoln, and a further series of grass plots, tiller rows, and single plants were spring sown. A further trial comparing subterranean-clover types will be established this autumn.

Trials in Great Britain.—Following on the establishment of field trials of New Zealand seed in Great Britain, bulk supplies of the following species have been forwarded for additional trials: Perennial, Italian, and short-rotation rye-grass; cocksfoot; timothy and broad red; Montgomery red and white clovers. In addition, a comprehensive range of New Zealand seeds have been forwarded for plot trials.

Field Ecology

The trial on the effect of animal excrements on pasture growth has been continued, and results continue to show the importance of a complete and intelligent use of this valuable material. There is also consistent evidence of the great value of the improved strain of white clover used in this trial. Production on the paddock on which no return of either dung or urine is made has increased in the last year. This has been mainly due to the clover content holding up; but there has also been much better growth of the grass, most probably because of the nitrogen secretions into the soil from the clover bacteria.

It is a pity that detailed soil work has not been done, but arrangements are under way to have the trial repeated as soon as possible on both good and poor soil, using complete soil, botanical and chemical services to obtain a more complete picture of this most important cycle of growth.

Some limitation in the chemical analyses work has perforce had to be made and no balance figures are available for the last year's results.

Yield figures in terms of D.M. per acre under different treatments are as follows (periods 1st January to 31st December):—

	Full Return.	No Return.	Urine Return.	Dung Return.
1941	17,082	10,791	12,544	12,473
1942	15,915	12,016	14,272	14,473
Difference ..	−1,167	+1,225	+1,728	+2,000

Pasture Trials on Conway Block.—These trials have now been closed, due to insufficient staff both in the field and the laboratory. Results of the species trials have shown some very interesting results, which may be summarized as follows:—

(1) Pedigree No. 1 white clover is able to compete most successfully with the grass species in the sward, and under the conditions of the trial perennial rye, cocksfoot, and timothy were the only species able to compete at all successfully:

(2) It was found that the development of cocksfoot and timothy was much better under close grazing for the first year than under a loose system. This was apparently due to the fact that these high-fertility grasses responded readily to the constant animal droppings and made more headway than when spelled for longer periods and subjected to first weed and later clover competition:

(3) The No. 1 white sown with a pedigree rye gave a 40 per cent. increase over the same rye-grass sown with a commercial Dutch clover and resulted in a higher-quality sward—the yield of the sward using Montgomery red clover instead of No. 1 white was 80 per cent. of the latter:

(4) There was very little difference in the total yield of the complex and simple swards, the simple mixture being slightly the better of the two. This mixture is easier to handle, but tends to dry out quicker than the complex sward, where several species can take up the running. However, the complex swards rapidly develop into simple mixtures of rye white and the benefit of the added species is quickly lost. There is, however, a definite advantage from the inclusion of some small amount of the Italian rye-grass, in so far as it gives added initial weed smother and allows of an earlier grazing, consolidation, and manurial turnover in the developing sward.

Trial to show superphosphate response gave a consistent increase of some 8 per cent. on this soil type. A trial especially designed to test the validity of mowing trials and the Marton mowing and grazing technique has shown somewhat outstanding results. The mowing technique, whilst giving fairly good total yield comparison, results in too much clover competition, whilst the Marton technique makes it very difficult to find responses other than the most marked, due to the transference of fertility from the good to the poor plots and above all from all plots to the headlands. A technique of measurement involving actual collection and correct proportional redistribution of stock droppings has given results very close to full-scale paddock responses, both from a total yield and a botanical composition point of view. The results of this trial are in the course of publication..

Nutritional Block in Collaboration with M.A.C.—Measurements and botanical analyses of this trial have been kept up to date. Whilst interesting pasture figures are being obtained, it is still apparent that the difficulty of running pasture and animal experiments is very great. Relative yield figures over the past year in relative terms of D.M. per acre are as follows:—

Manurial Trial: 4 cwt. super, 100; 1 cwt. super, 91; 4 cwt. slag, 90; 4 cwt. super + lime, 105; 4 cwt. super + lime + potash, 100·1.

Strain Trial: M/S + M/S, 100; ped. rye + ped. white, 103; ped. rye + low HCN white, 94; ped. rye + M/S white, 98; M/S rye + ped. white, 97.

Botanical analyses for different period for each treatment, also botanical composition of individual paddocks, have been made, and these show some very interesting variations.

Silage and Digestibility Trials.—The work has been continued, in so far as the trials of last year have been repeated. The data obtained and the sample material secured awaits chemical testing before results can be interpreted fully. However, the losses on a D.M. basis were consistently over 30 per cent. Prior to the commencement of this season's work large concrete silos and bases for stacks were constructed to collect exudate on the normal field pits and stack basis in order to pursue further our study into dry-matter losses. Also experimental pits have been put in using A.I.V. and other acidification methods.

Digestibility trials of the material ensiled as well as on the cured silage have been carried out. Collections of exudate have been made and their pH variations daily have been determined.

Botanical Analyses.—The service offered by this Division to other Departments is still being availed of. Many samples continue to be sent in even though experimental field trials have been cut down throughout the country. In addition, all trials on the Station are maintained under full botanical measurement. The method adopted of storing separations gives a ready supply of pure species for any special chemical work desired.

Aerodrome-turf Production

Good progress has been made during the year in the establishment of hard-wearing turfs. This improvement has followed the adoption of the principles underlying playing-turf construction rather than following the well-established principles underlying pasture practice. Strict adherence to ecological concepts is of prime importance, and when one considers the very wide range of soil types and climate upon which aerodromes are placed, full application of the ecological knowledge which this Division has accumulated over its wide grassland experience is imperative.

The transition of certain low-load-bearing turfs and soil types to high-load-bearing turf by species modification, drainage, and acidification of the soil to discourage worm and bacterial activity, is a special feature of the aerodrome-turf-construction programme. In this transition mistakes of the past in conserving and replacing unsuitable topsoil and in the use of high-producing pasture grasses and clovers, together with the over-use of lime and phosphate, have and still will require much attention before the ideal aimed at is reached. It has been by no means an easy task to counter the popular belief that aerodrome-turf construction should proceed along the lines of general farming practice, and the fact that many aerodromes of secondary importance are still open to grazing by stock further complicates the issue from an advisory point of view. Where, however, the prime objective is a turf solely for the use of aircraft and where mowers have replaced stock, turf principles rather than pasture principles must apply. Nitrogen in the form of sulphate of ammonia has been the main factor in aerodrome-turf establishment and in the building of a sod-bound, hard-wearing turf.

Acid soils (usually referred to as sour) are of fundamental importance in the production of a dense hard-wearing turf. Such soil conditions combined with good drainage and an inherent lack of the common plant nutrients favour the dense turf and mat-forming species. This set of soil conditions, however, discourages clovers, weeds, and coarse tussocky grasses. Clovers are undesirable, as they produce a slippery surface.

A useful step forward was made during the latter part of the year under review by the holding at Palmerston North of a conference, relative to aerodrome-turf construction, of responsible officers in charge of aerodrome administration. The Greens Research turf plots at Hokowhitu proved invaluable in demonstrating the general principles upon which our advisory work is based.

PLANT DISEASES DIVISION, OWAIRAKA, AUCKLAND

Director: Dr. G. H. Cunningham

I. Plant Diseases Investigations

(1) *General.*—Two new fungus diseases, two new hosts for known pathogens, and eleven new insect pests have been recorded during the year.

(2) *Grass Diseases.*—Work has been continued on the endophytic fungi associated with *Lolium* and *Festuca*. Five bushels of endophyte-free tall fescue and 2 bushels of endophyte-infected darnel-seed have been harvested for animal-nutrition studies at Wallaceville.

(3) *Crop Diseases.*—Detailed surveys have been made of the diseases present in crops of linen flax and seeding swedes. Trials of seed treatments were carried out with the former. Mite infestation of linen-flax seed was found to be conditioned by moisture content of the seed on entering the store.

(4) *Potato Diseases.*—Trials were carried out to compare copper oxychloride with Bordeaux sprays for the control of late blight. The former causes less foliage damage, but the differences in yield were not significant. No advantage was secured by the addition of cotton-seed oil to Bordeaux. A fine misty spray gave better control of the disease than did a spray composed of larger droplets.

(5) *Vegetable Diseases and Pests.*—Much work has been carried out on the biology and control of the carrot rust-fly (*Psila rosae* F.). It has been found that the fly can complete its life-cycle at any season, that the time period is longer in winter than in summer, and that there is much overlapping of generations. The life-history of the vegetable weevil (*Listroderes obliquis* Klug), which attacks most vegetables, is being studied with a view to methods of control.

Late blight of tomatoes was controlled by both copper oxychloride and Bordeaux sprays, but yields were higher with the former owing to reduced damage to foliage. The same sprays gave only partial control of leaf-mould. Seed-production of the leaf-mould-resistant tomato variety Vetamold has continued, 526 packets having been distributed to growers. In some localities Vetamold has shown susceptibility to the local strains of the fungus, and cross-breeding with other varieties is in progress in the hope of evolving more highly resistant strains.

Downy-mildew of onion was largely controlled by sprays of Bordeaux with various spreaders and wetting agents, giving increased yields. Pre-emergence damping-off of peas, which causes severe mortality and loss of vigour in early-sown peas under conditions of high soil moisture, was effectively controlled by copper oxide and copper carbonate dusts, the former giving slightly better results. Better and cheaper control of white butterfly and diamond-back moth on cabbage and cauliflower was secured with derris dust than with

nicotine sulphate. Derris dust does not control cabbage-aphis, and experiments are in progress to overcome this by addition of pyrethrum and nicotine. Improved model dusters for more effective application of derris dust have been designed.

Bean-wilt is becoming a serious problem owing to the greatly increased acreage for war purposes. The only feasible method of control is by the use of resistant varieties, and for this forty-one commercial varieties have been tested in three localities. Only two varieties have proved immune, but several others are sufficiently resistant to assure negligible loss. These are being propagated to built up stocks of seed.

A bacterial disease of peas apparently new to New Zealand is under investigation.

Promising results in the control of eelworm have been secured by soil fumigation with chloropicrin.

(6) *Fruit Diseases.* (See Fruit Research report, p. 8.)

II. Certification of Therapeutants

Routine testing of field samples of certified spray materials has been carried on, and it is pleasing to note that all have maintained the standard certified.

III. Timber Preservation

(See Timber Protection Research report, p. 25.)

IV. Fruit Research

(See Fruit Research report, p. 8.)

V. Miscellaneous

(1) *Pyrethrum Production.*—Approximately 600 lb. of dried flowers have been sold from the experimental areas; the present season's crop is being allowed to seed for sowing extensive production areas.

(2) *Medicinal Plants.*—Samples of four plants of medicinal value were grown, harvested, and sent to the Botany Division for test of their therapeutant value when grown under local conditions.

(3) *Kumera Varieties.*—Stocks of selected lines have been maintained.

(4) *Linen-flax Retting.*—The bacterial flora of flax rets, and its modification, have been studied with a view to establishing a standard factory practice.

(5) *Industrial Microbiology.*—The complex factors governing the citric-acid fermentation of sugar by the mould fungus *Aspergillus niger* have been studied with a view to factory production of citric acid in New Zealand. Assistance has been given to State Departments and manufacturers in problems of damage by mould fungi.

(6) *Production of Ergot.*—Much work has been carried out to determine the feasibility of commercial production of high-alkaloid ergot on rye. It would appear that, owing to variations in yield and value due to environment and to high costs under local conditions, the project offers slight economic prospects in New Zealand.

(7) *Lucerne Inoculation.*—There was a substantial drop in the demand for lucerne inoculum during the past year, due to labour stortage on the farms. Enough culture to treat 108,630 lb. of seed was sold in 1941–42 and 70,620 lb in 1942–43.

(8) *Identification of Pests and Diseases.*—Approximately three hundred and fifty specimens have been sent in for identification and advice. Eight shipments of potatoes and onions from the United States of America have been examined and found free from serious disease.

VI. Experimental Areas

Cultivation and maintenance of land and buildings have been carried out satisfactorily under increasing labour difficulties. Both the Owairaka and Oratia areas have improved greatly in response to cover cropping, drainage, and improved shelter.

SOIL SURVEY

Soil-survey investigations are undertaken by the Soil Survey Division (Dr. L. I. Grange, Director) and by the Cawthron Institute (Sir T. Rigg, Director).

Soil Survey Division

General Survey, North Island

During the year progress has been made in the colouring of several sets of the North Island soil maps on a scale of 4 miles to an inch. These are to be handed over to organizations interested in land utilization. A legend containing information on all properties of the soils mapped has been prepared. In co-operation with Army officers, a set of topographic maps of North Auckland on a scale of 1 mile to an inch showing land-slope units were prepared from data on the general soil maps. The Division co-operated with the Fields Division of the Department of Agriculture in compiling a map of the North Island showing the lime requirement of the soils. Areas were demarcated which gave (*a*) little or no lime response, (*b*) slight to moderate lime response, (*c*) good lime response, and (*d*) strong lime response. Of the total ploughable land in the North Island that is being farmed (6,662,000 acres), about half (3,052,000 acres) require the application of lime.

Survey of High Country, South Island

The field-work in connection with the survey of erosion in the high country of the South Island has been completed and a draft report on the project prepared. Along with the Botany Division, two pastoral runs—Te Akatarawa and Molesworth—were examined with a view to reporting on their suitability for the laying-down of plots, similar to those established by Dr. Cockayne on the Dunstan Range, in Central Otago, to study the regeneration of soil and vegetation cover by self-seeding of existing species and by the introduction of suitable plants. Areas where severe erosion has taken place and vegetation cover is badly depleted have been chosen for experimental work. The soils on both these runs belong to the grey-brown loams mentioned in the 1941–42 annual report—they are of moderate fertility and receive a higher rainfall than those on the Dunstan Range.

Linen-flax Surveys

In Southland, Gore has been added to the districts already surveyed for the purpose of assisting in the problem of selecting the best soils for the growing of linen flax. The Division co-operated with the Fields Division of the Department of Agriculture in writing short accounts of linen-flax growing in Balclutha, Tapanui, and Gore districts. These are for distribution to interested farmers.

Some detailed mapping has been done on the linen-flax soils centred on Timaru, but a good deal yet remains to be surveyed.

The linen-flax soils in the Leeston-Dunsandel area and in the Rangiora-Cust districts have been classified.

Altogether it can be said that much information is already available which can be utilized with the object of working the crop over, as far as possible, to the better classes of soil.

Aerodrome Surveys

One officer has been assisting the Public Works Department on the problem of establishment and maintenance of grass-covered aerodromes. Full reports have been made on the fertilizers required and the drainage of many of the aerodromes

Soil Cement

An extensive survey has been made of typical soils found on aerodromes with a view to finding their suitability for soil-cement stabilization. Soil-cement preparation consists in tamping the soil mixed with 10 per cent. cement at suitable moisture contents to give a maximum density. Subsequent curing gives a resistant surface that is suitable for runways or roads. The survey has shown that a number of soils are very well suited to soil-cement treatment. The soils that give the best results are sandy types with 5 per cent. to 10 per cent. clay. Silt loam or heavier textures in the main do not give good test blocks, and even the addition of more cement does not always produce a satisfactory result. The Taupo pumice, widespread in Central North Island, has the correct texture, but does not at present form good blocks, and there is need for further research on it.

Pot-culture Work

Pot-culture work has been undertaken primarily with a view to finding plants which will show by different growth forms whether a particular plant food is deficient or in adequate supply in the soil under test. A search is being made for a plant which will show differences in form related to the lime content of the soil, another for phosphate, and a third for potash. If these indicator plants are found, the Division can then make a biological analysis of all our main soil types. It would have a method which would supplement chemical analyses in stating what plant foods are deficient in all of our different kinds of soil. Besides the search for indicator plants, some attention will be given to testing the efficiency of various phosphatic fertilizers on soil types and to methods of making available to plants the phosphorus that occurs naturally in the soil.

Soil Erosion

Besides measuring the soil erosion in the high country of the South Island, the Division is represented on all the district committees of the Soil Conservation and Rivers Control Council and has prepared maps of various parts of the Dominion showing the nature and extent of soil erosion according to information obtained from its surveys.

Miscellaneous Projects

Some attention has been given to the analysing and tabulating of the results of detailed surveys in North Auckland and in Hawke's Bay. A set of maps of North Auckland on a scale of 1 mile to an inch are almost completed, and copies have been made for the Department of Agriculture.

The Division has assisted the Department of Agriculture in selecting soils for the growing of vegetables.

For the Public Works Department the geology of some of the coastal islands and of parts of the mainland was examined and well-sites selected in an endeavour to get an assured water-supply for military camps and coastal defence posts.

Advantage was taken of visits made for water-supply and other purposes to map the soils of the islands lying in the Hauraki Gulf and farther north. To date most of the islands lying off the coast between Whangarei and Auckland and some in the Bay of Islands have been visited and sketch maps prepared of the soil distribution. Many of the soils are fertile silt loams, and one—on Motutapu Island—a black sandy loam is noteworthy in that it is derived from a volcanic-ash deposit which is the product of an eruption from Motutapu in Recent times. The islets in the Bay of Islands and Kawau have been impoverished in part by mismanagement and are in places eroded.

Cawthron Institute

Soil Survey

The absence of several men with the armed forces has greatly curtailed soil-survey operations.

Soil-mapping has been continued in the Moutere Valley, and the whole of this and its tributary valleys were completed during December. The finalization of the soil map for the Moutere Valley must await the texture determinations of typical soil samples taken in the district. The principal soil type in the Moutere Valley is silt loam. There is a considerable acreage of light-phase silt loam, but only a relatively small area of sandy loams and sands. The soils are naturally low in available phosphoric acid and potash. They are acid in reaction, but in several cases the reaction has been modified by heavy liming. The magnesia tends to be somewhat low, usually below 1·5 mg. equivalent per cent. The base saturation of a number of samples varies between 47 per cent. to 88 per cent.

A land-utilization map of the Moutere Valley has been made showing the exact acreages of all the principal crops. Hops, tobacco, and fruit are not represented by a great acreage. Pasture and arable farming take the bulk of the land.

There has been a reduction in the tobacco-growing districts of 144 acres during the last season, the acreage for 1943 being 2,960, as compared with 3,104 for 1942. The decrease has been apparent in all districts except Motueka Valley, Dovedale-Thorpe, and Moutere Valley, where there have been substantial increases.

Chemical Work

The routine examination of soil samples collected in connection with the soil surveys has proceeded steadily. Some time has been spent in studying the effect of steam sterilization on the plant-food content of Nelson tomato soil. Samples for ammonia nitrogen and nitrate nitrogen were taken regularly from unsterilized and sterilized plots in the Cawthron tomato-house. In the initial stages steam sterilization appeared to cause a retardation in ammonia-production, but within six weeks the ammonia figures were much greater than for the unsterilized plot. Moreover, this advantage in ammonia content was retained by the steam-sterilized soil over several months. On the unsterilized soil the ammonia figures after the first month tended to drop considerably. In regard to the content of nitrate nitrogen, the differences effected by steam sterilization of the soil do not appear to be so pronounced, but this is probably due to the fact that the tomato plants were taking up nitrate almost as quickly as it was formed in the soil. The figures were rather higher for the steam-sterilized soils, but the general level was considerably below that of the ammonia-nitrogen figures.

SUGAR-BEET RESEARCH SECTION

Research Officer: Dr. O. H. Frankel

On the experimental area at Tai Tapu three field trials and eleven bulk areas for selection were laid down. Harvest, testing, and selection took place from May to July, 1942. A total of 17,309 sugar tests were made—partly from individual beets, partly from composite samples—for which about 26,000 beets were weighed and bored. Out of the fifty-eight progenies under test, the best beets out of the fifteen best lines were selected for seed propagation and further selection. Of the eleven varieties included in a variety trial, "American 3," "New-Zealand grown," and "Schreiber S.S." gave the highest sugar returns per acre. Selected individual beets were retained from these and three other bulk areas.

Seed beets were raised successfully in the glasshouse, but considerable losses were incurred among those planted out in various groups in the Lincoln and Tai Tapu districts. This was shown to be due to a combination of circumstances—insufficient disinfection of the borehole, unsuitable pitting method, dry soil conditions on the lighter soils used, and lack of shelter. There were also indications of heart rot due to boron deficiency. Steps have been taken to obviate such losses in future.

Self-fertilization with the object of establishing a number of inbred lines has been successful in the glasshouse. A number of polyploid shoots were induced by the application of a 0·75 per cent. solution of colchicine, and seeds have been produced on most of them which will be tested further.

The new beet crop, of 2½ acres, was laid down at Tai Tapu on a more suitable area. It shows excellent growth. It contains two field trials and three bulk areas for selection.

TIMBER PROTECTION RESEARCH

Timber Protection Research Committee.—Mr. L. E. Brooker (Chairman), Mr. R. L. Andrew, Mr. F. R. Callaghan, Dr. G. H. Cunningham, Mr. R. L. McPhail, Dr. D. Miller, Mr. E. H. Walden, Mr. N. A. Marris, Mr. A. F. Clark (Secretary).

The following is an account of the work which has been carried out during the year:—

Dominion Laboratory

During the year the Laboratory carried out such chemical work as was required by the Timber Protection Research Committee. As part of an investigation into the permanence of the more volatile toxicants, samples of treated wood were examined for naphthalene,

Entomology Division, Plant Research Bureau

Termite Research.—Apart from the routine identification of termites, a detailed study as an adjunct to control has been made of the Australian and native termites in New Zealand with the object of securing reliable data upon which to identify the different castes of all the species. This has involved the examination of many hundreds of individual insects and has given valuable results which have been embodied in a detailed report.

Work on the biology of the Australian termites has also been carried out and useful information secured on the habits of the insects. A commencement has been made to elucidate the habits and establishment in timbers of the native termites.

In connection with the above, surveys of termite establishments have been made and new foci recorded in Auckland and New Plymouth. Further Australian termites have been found well established in an area near Gisborne where a survey of the position was made.

Plant Diseases Division, Plant Research Bureau

Work has been directed once again towards determining standardized methods for toxicity tests of products used to control fungous and insect damage to timber.

Testing of Fungicides.—Preliminary experiments have been undertaken to determine the species of fungi and the type of wood to be used in testing.

Testing of Insecticides.—The parasite which upset previous work on *Ambeodontus* has been overcome. The method, however, still needs further testing to ascertain the reliability of results. A concentrated effort to discover the optimum breeding-conditions for *Anobium* attack has been made this year. In all, a total of well over six thousand adult beetles have been handled, this number far exceeding any previous number. Results of the work will not be available for some months. Much time has been devoted to the testing of treated and untreated Pinex board with Australian subterranean and New Zealand drywood termites.

Testing of Therapeutants.—This side of the work, through shortage of staff, has been curtailed considerably. Work is still proceeding on a method to test the length of time a certain therapeutant will remain effective in the wood.

State Advances Corporation

The State Advances Corporation has concentrated upon field investigations of timber-infesting insects and fungi, the field application of termite control, and the field application of wood preservatives.

Termite Control.—Under the Termites Act, 1940, the application of chemical measures to control foreign termites is the responsibility of the State Advances Corporation. The work, while being carried out by the Corporation, takes full advantage of research being undertaken by the Entomology Division, and close co-operation is maintained with both the Entomology Division and the Plant Diseases Division. The original technique for treating termites has been altered in two important respects. Field-work showed that in many cases where termite nests were removed in only a few was the queen captured; while laboratory work proved that, contrary to overseas' opinions, the queen could, if necessary, move long distances at a rapid pace. There is therefore the possibility that in a number of cases the queen escaped, and if circumstances were favourable it might be possible that she could establish a new colony. The removal of nests has therefore been abandoned, and a close watch is kept upon all areas from which nests have in the past been removed. A further modification of technique concerns the actual application of the arsenic dust. The original technique required that arsenic dust be blown into termite runways. It has now been found that owing to the ease with which termites abandon runways and the rapidity with which arsenic absorbs moisture and cakes, this method is unsatisfactory in some cases. A new technique which aims at dusting the insects themselves has been developed, and the indications are that it is proving very effective. Unfortunately the number of termite infestations in Auckland and New Plymouth has increased to over three hundred, but the results of termite control work are generally satisfactory. A small area of termite infestation has been located in the Gisborne district.

Native Termites.—The incidence of native termites, especially in Auckland, is still high, and in co-operation with the Entomology Division work has been done upon the biology of the insects. One of the most interesting and important points is the frequency with which queens and supplementary queens appear to be produced, and this explains the occurrence of so many small disconnected colonies. It has previously been mentioned that, in co-operation with a commercial concern, a new method of chemical control for native termites has been planned. This work has continued and the formulation of a definite specification has been possible. The specification requires work on an intensive scale, but the point has now been reached when sufficient jobs have been done to enable the effectiveness of the work to be determined and there is a possibility of modifying the specification.

Ambeodontus tristis.—This house long-horn beetle continues to engage the attention of the Corporation, and cases in which houses erected for only a few months yielding infested timber continue to occur. It is obvious that the timber is infested by the insect at the time it is first used for building purposes. In conjunction with the Plant Diseases Division, investigations are continuing.

Fungi.—Field information upon the incidence of wood-rotting fungi in houses, especially in relation to the type of house-construction involved, is still being obtained. The Timber Protection Research Committee was concerned to some extent with the problem of mould occurring on interior linings in State rental houses. This problem, however, was shown to be one involving factors other than mycological, and the investigation is now being dealt with by another organization.

Wood-preservation.—The application of wood-preservatives on a field scale is still proceeding. In order to gain information regarding the penetrability of commercial species of New Zealand timber by water-soluble wood-preservatives under pressure, arrangements have been made with the Forest Products Laboratory, Princes Risborough, England, to have a series of pressure impregnation tests made. A series of the main commercial species of timber both native and exotic has been obtained and shipped. Advice has been received that the shipments have arrived safely. These tests are in addition to those which are under way at the Forest Products Division of the Commonwealth Council of Scientific and Industrial Research.

TOBACCO RESEARCH

Advisory Committee.—Sir Theodore Rigg (Chairman), Messrs. F. R. Callaghan, L. J. Schmitt, W. K. Dallas, N. J. Adamson, H. L. Wise, C. C. Nash, E. M. Hunt, F. A. Hamilton, B. T. Rowling, J. F. Balck, and R. Thomson.

During the year four meetings of the Tobacco Research Committee have been held. Further improvements have been effected on the Station grounds, and a large shed has been built which serves as a combined implement and coal shed with accommodation for leaf-tying during the harvesting season.

As in former years, the tobacco research work has been carried out jointly by the staff at the Research Station and by officers of the Cawthron Institute. Work at the Research Station has consisted of fertilizer studies both quantitative and qualitative, methods of fertilizer application, seed-producton trials, variety trials, and mosaic investigations. At the Cawthron Institute the work has included chemical studies dealing with the intake of plant nutrients, the chemical composition of cured leaf, nicotine extraction from waste tobacco leaf, and the preparation of tobacco dusts. In addition, considerable time has been devoted to mosaic and disease investigations, seed-germination tests, and the prosecution of the soil survey of tobacco lands.

1942–43 Season

During the present season variable weather has been experienced, but nevertheless crop prospects are good and it is anticipated that the yield will be similar to that of the previous year. During the planting period frequent strong winds and rather dry weather were experienced. Five inches of rain during the early part of December undoubtedly leached out of the soil much of the soluble nitrogen in the base dressing of fertilizers. Very dry weather was then experienced for a period of a month, and this was accompanied by low night temperatures which bordered on frost on several occasions. Heavy rain during February somewhat interfered with harvesting, and a frost of 4° on the 12th of March spoiled about two hundred sticks of tobacco leaf.

The results of fertilizer experiments for the 1942–43 season will not be available until the leaf is graded, but the following field notes give some indication of the results which have been obtained. Where the standard fertilizer was used at different rates the heaviest application has given the highest yield. Maturity of leaf was somewhat delayed, but not to a serious extent. The effect of nitrogen from different sources showed some interesting differences. The organic forms of nitrogen were conspicuous in maintaining growth after the heavy rains in early December. On the other hand, the more readily available nitrogenous fertilizers gave the quickest recovery when the top-dressing was applied after the rain. The studies of different methods of fertilizer application showed that a reasonable proportion of the fertilizer should be within easy reach of the root system during the early growth stages.

Fertilizer Experiments.—The crop in the 1941–42 season amounted to 13,427 lb. of cured leaf from 13 acres. The quality was satisfactory, and the average price realized was 2s. 2d. per pound. A profitable increase of yield in tobacco leaf was obtained by increasing the quantity of standard fertilizer from 1,000 lb. to 1,200 lb. per acre. When the fertilizer was still further increased to 1,600 lb. per acre, the increase in yield was not sufficient to justify the additional cost of fertilizer. In the experiment dealing with the effect of varying amounts of nitrogen and potash in the fertilizer the highest yield of leaf was obtained from the plots receiving extra nitrogen. This increase did not appear to have been obtained at the expense of leaf quality. On the plots without nitrogen the tobacco leaf was not only lower in yield, but the quality was likewise lower. When the quantity of potash in the fertilizer was altered little effect was shown on yield of leaf, but extra potash gave better body and texture of leaf.

Seed-bed Work.—In the manurial treatment of the seedling beds it was found that ½ lb. of standard fertilizer (3:8:8 mixture) per square yard gave the best results both in the case of bed-sown and pricked-out plants. Fertilizers containing a high proportion of organic ingredients proved unsatisfactory for the seedlings. In the bed-sown beds the reduction of the rate of seed to half the usual quantity produced sturdier and better-rooted plants which were less subject to damping-off disease. The same advantage of thin seeding was noticed in the case of box-raised seedlings.

Mosaic and Disease Investigations.—These have been conducted partly at the Tobacco Research Station and partly on the grounds of the Cawthron Institute, Nelson. During the past three seasons the amount of mosaic on typical blocks at the Tobacco Research Station has been reduced from over 40 per cent. to less than 5 per cent. initial infection. Strict attention to the removal of sources of infection and the observance of well-recognized rules for the care and handling of tobacco seedlings have played the major part in controlling mosaic.

The following are the more important results emerging from this season's work:—

(1) The percentage of mosaic was higher with pricked-out plants than with bed-sown plants. This difference was particularly marked with the higher rates of manurial treatment in the seed-bed.
(2) In the case of both bed-sown and pricked-out plants there was an increase in the amount of mosaic when the manurial treatment of the seed-bed was increased from nil to ½ lb., to 1 lb., standard fertilizer per square yard. In the main, however, the differences resulting from manurial treatment were comparatively small. The unfertilized beds and those with phosphate and potash only gave the lowest percentage of mosaic.
(3) Increasing quantities of standard fertilizer (3:8:8 mixture) from 800 lb. to 1,600 lb. per acre in the field treatment did not result in any appreciable increase in the percentage of initial mosaic in the tobacco crop.
(4) Variation in the amount of nitrogen and potash in the standard fertilizer used in the field did not result in marked difference in mosaic incidence. The lowest figure was obtained without nitrogen, and the highest with extra nitrogen. On two types of soil the range of mosaic under different manurial treatments was nil to 3.5 per cent.
(5) The continuous tobacco plot as compared with the alternate oats-tobacco plots showed little difference in the amount of mosaic, 2.3 per cent. compared with 1.8 per cent. for the alternating oats-tobacco plot.
(6) The incorporation of tobacco trash in the soil of the seedling bed resulted in a comparatively large increase in the amount of mosaic in the tobacco seedlings.
(7) Soil suspensions made from bed treated with tobacco trash two months previously gave on inoculation a 50 per cent. infection of tobacco seedlings.
(8) Milk spray (1:10 with water) gave some protection against infection from mosaic virus in the seedling beds.

An interesting demonstration concerning the ease with which mosaic virus is transmitted when the hands of workers have become contaminated by touching mosaic plants was carried out at the Research Station. In those cases where workers had previously handled mosaic plants, the virus was transmitted to all the plants subsequently handled. The control plants handled after thorough washing and cleansing were not affected with mosaic.

Control of Collar-rot.—The results of investigation conducted during the present season were not conclusive, but zinc oxide gave the best result of several chemicals tested.

Seed-production and Plant-breeding.—A total of 17 lb. of tobacco seed was distributed from the Station to the manufacturers last season. This seed was raised at the Station from once-tested single plant selections. So far the results have been encouraging.

Plant-breeding work has commenced, and some of the commercial varieties were crossed with Ambalema, a mosaic-resistant variety. The F_1 generation was grown during the winter under glass, and the F_2 generation was planted out in the field this season. The plants showed segregation for mosaic resistance, and it is intended to back-cross resistant ones to the original flue-cured parent.

Seed-germination Tests.—Germination tests of tobacco seed supplied by the manufacturing companies and the Tobacco Research Station have been carried out at the Cawthron Institute. Generally speaking, seed germination was good, but where the tests followed closely after the harvesting of the seed, germination was slow.

Intake of Plant Nutrients by Tobacco.—Chemical analyses of tobacco-leaf samples obtained during the previous season, 1941–42, have been completed.

In the early growth stages of the tobacco plants the leaves contained comparatively high percentages of different plant-food constituents—*e.g.*, nitrogen, 3.67 per cent.; potash, 4.98 per cent.; phosphoric acid, 0.84 per cent. The percentages fell considerably at later growth stages. On the 12th February, when harvesting of the plot commenced, the figures were: Nitrogen, 1.84 per cent.; potash, 3.65 per cent.; phosphoric acid, 0.57 per cent., on the dry-matter basis. At this date the total quantities of plant foods taken up by the plant, including leaves and stalk, were: Nitrogen, 40.5 lb.; potash, 82.8 lb.; phosphoric acid, 13.8 lb.; and magnesia, 11.2 lb. per acre. The importance of adequate nitrogen and potash in the manurial treatment of the tobacco is well illustrated by the analytical data.

Approximately 50 per cent. of the total tobacco growth is represented by stalk and small leaves unsuitable for harvesting. This portion of the crop is frequently ploughed into the soil and must aid considerably in maintaining reserves of plant food. Analyses show that the stalks and unharvested leaves contain the equivalent on the acre basis of superphosphate, 40 lb.; sulphate of potash, 75 lb.; ammonium sulphate, 112 lb.; and dolomite, 30 lb.

Chemical Composition of Cured Leaf.—Samples of cured tobacco leaf from the plots with different fertilizer treatment have been analysed. The results suggest that seasonal effects must be taken into consideration in interpreting the analytical data. The absence of either potash or nitrogen from the fertilizer was reflected in the analyses by smaller percentages of these plant foods; there was no effect, however, on the percentages of other plant foods.

In all samples analysed the amount of both reducing sugars and of total sugars was high, while the nitrogen content fell within the limits shown by high-quality American leaf.

Nicotine Extraction from Waste Leaf.—Following up laboratory work which indicated that when an alkaline tobacco mixture was moistened with water just sufficient to give a crumb condition, as against a thin mixture, emulsification difficulties were overcome, small-scale works trials were undertaken using the above procedure. With quantities up to 30 lb. of ground tobacco per batch successful results were obtained, 90 per cent. or more of the nicotine present being extracted.

Tobacco Dusts.—With a view to testing the value of waste tobacco for insecticidal purposes, samples of ground tobacco have been mixed with finely-ground limestone, dolomite, magnesite, and kaolin. When these mixtures were exposed to the air for a period of two months no loss of nicotine occurred.

Soil Survey of Tobacco Lands.—(See Soil Survey report, p. 24.)

WHEAT RESEARCH INSTITUTE

Advisory Committee.—Dr. H. G. Denham (Chairman), Mr. F. R. Callaghan, Mr. C. S. Sapsford, Mr. R. B. Tennent, Mr. R. K. Ireland, Mr. R. J. Lyon, Mr. J. P. O'Connor, Mr. C. E. Boon, Mr. G. R. Harker, Mr. A. H. Yarrow, Mr. W. W. Mulholland, Mr. J. Carr, Mr. P. R. Talbot, Mr. W. O. Rennie, Mr. G. Fleetwood. Director: Dr. F. W. Hilgendorf (till 24th September, 1942). Acting Chief Executive Officer: Dr. O. H. Frankel. Chief Chemist: Mr. E. W. Hullett.

Dr. Hilgendorf

Dr. F. W. Hilgendorf, the first Director of the Institute, passed away on the 24th September, 1942. It was largely from his previous work on wheat that the idea of the Institute emerged. He carried through its establishment, defined its spheres of activity, and was largely instrumental in gaining the confidence of the wheat industry. His wide knowledge and experience on all matters connected with wheat were invaluable to the Institute and its staff. His wisdom and knowledge of human nature made him an admirable scientific leader. His death is an irreparable loss to the Institute; the tradition he created will live after him.

Wheat-growing

The threshing returns from the 1942 harvest were analysed as usual. Cross 7 continued its advance from 41·6 per cent. to 48·7 per cent. of the wheat area, and contributed 51·5 per cent. of the wheat crop. Fife-Tuscan increased from 120 acres to over 2,000 acres, and sowings in 1942 are estimated at 11,000 acres. Tainui has become the dominant wheat in the west coast counties of the North Island, where until two years ago Jumbuck was the principal wheat. Tainui yields distinctly better (in Rangitikei County by 8·5 bushels an acre) and it is suited for heading, whilst Jumbuck is not.

Plant-breeding

Owing to the absence on military service of the geneticist, sowings at Lincoln were greatly reduced in scope. They consisted mainly of small-scale yield trials. Six hundred and sixty-nine lines were tested in twelve two- or three-dimensional lattices. These include the first of the new compound crosses made from 1935 onward after the success of Cross 7 became apparent. The normal scope of wheat-breeding work will be resumed during the coming season.

Laboratory Work

(*a*) *Moisture Testing.*—For the harvest of 1943, stations were again available for farmers, merchants, and others at Blenheim, Christchurch, Ashburton, Temuka, and Timaru. In addition, the co-operation of the Seed Testing Station, Palmerston North, made a service possible for North Island growers, and that of the N.Z. Wool Manufacturers' Association facilitated one for South Otago.

(*b*) *Milling and baking tests* were carried out as in previous years.

(*c*) *Work for the Armed Forces.*—Army bakers received instruction in the method of using dried yeast which had been devised by the Institute and in the baking of bread under hot climatic conditions. Other activities included work and consultation on the packing and storage of flour and Army stocks and the inspection of bread supplied to various Air Force stations.

(*d*) *Research Work in Progress.*—The investigation on water-vapour pressure of wheat of various moisture contents has been resumed and the chemical study of baking quality is being carried on. The research programme is curtailed owing to the partial absence of the chief chemist on war work.

RESEARCH WORK AT AGRICULTURAL COLLEGES

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

CANTERBURY AGRICULTURAL COLLEGE

Subterranean-clover Investigations

The fourth grazing season on the Ashley Dene trial area was completed at the end of March. The autumn of 1942 was very dry—especially in April, when only 0·5 in. of rain fell—and only a moderate establishment of the clover occurred. The winter was mild and a very favourable lambing season was experienced. The rainfall in August, however, was only 0·69 in., and the growth of the pastures throughout the remainder of the season seemed to be adversely affected by the lack of moisture in August. The number of stock which were wintered on the plots was considerably higher than in previous seasons, and

the increased numbers, combined with the dry spring, prevented any hay being saved. However, sufficient hay has been left over from last season's crop to provide the greater part of the winter feed for the coming season.

The original ewes with which the experiment was started were culled shortly after weaning, having provided four crops of lambs. This has resulted in a reduced rate of stocking for the fifth season, but it is expected that any surplus growth will be conserved as hay or grazed by flocks of followers.

The coming season will be an important one in the life of the experiment, in that it will be the first season in which all the stock carried will have been bred on the particular fertilizer treatment.

The number of ewes carried per acre on each of the four treatments during the past four seasons is as follows:—

Treatment.	Fertilizer, per Acre.	Number of Ewes carried per Acre.			
		First Year.	Second Year.	Third Year.	Fourth Year.
A	5 cwt. lime, 1 cwt. super (alternate years) ..	1·0	1·3	1·6	2·15
B	2 cwt. super annually	1·3	1·2	1·2	1·44
C	1 ton lime initial dressing and 2 cwt. super annually	1·6	1·7	1·8	2·05
D	1 ton lime initial, 2 cwt. super and ½ cwt. potash annually	1·6	2·1	2·3	2·35

Re-establishment and Rainfall

In the re-establishment of subterranean clover the effective rainfall during the months of March and April is an important factor. A dry autumn often results in a late autumn establishment and the young clover may be killed by early frosts. With good rainfall in March and April early autumn establishment occurs and the prospects for a good season are ensured.

On the light porous soils of the Ashley Dene type, spring rainfall also has a considerable effect on production. During the past season the autumn was dry, resulting in a fair establishment, but the spring was abnormally dry—particularly in August—and growth on the pastures was consequently low.

In the previous season, 1941, when growth during the spring was considerably higher than in 1942, the August rainfall was 9·3 in. The experiment has not run for a sufficient number of years to attempt to correlate production with seasonal rainfall, but on the evidence which is available it would appear that high rainfall in March and April is necessary for good establishment, and, in addition, high rainfall in August is necessary for good production. There are, of course, other factors such as wind, temperature, &c., which also affect growth and would require to be taken into account in any attempt to measure correlation.

Mowing Trials

The small-scale experiment designed to measure production by cutting plots with a horse mower was cut once during the season—*i.e.*, on 21st October, 1942. In the past at least two cuts have been taken in the season. A certain amount of growth developed after the first cut, but it was insufficient to warrant cutting. The production from these plots, though considerably less than in previous years, shows the same trends as in previous seasons.

Conclusion

One of the interesting and important results arising from the fourth year's trial, supplementary to those of previous years, is the fact that the treatment A in the grazing trial and treatment No. 7 in the mowing trial, though they are the lightest in fertilizer application, are second in production to the heavy-fertilizer treatment, D in the grazing trial and No. 2 in the mowing trial. It would appear that frequent applications of relatively light dressings of lime and super will compare favourably with a heavy initial application of lime followed by heavy annual dressings of super only. It would appear that in order to maintain the lead it will be necessary to give treatment D a further application of lime, as the effect of the heavy initial dressing of 1 ton is beginning to get less.

Entomological Investigations

Mr. L. Morrison

Sheep-dipping Experiments

This investigation was interrupted for a considerable time due to the general mobilization order of December, 1941, which involved the personnel engaged in the work. It has now been reorganized and is again under way. Results with derris powder have continued to be highly satisfactory as far as sheep-ked is concerned. Not only are the adults destroyed, but those emerging from pupæ, up to twenty-one days, fail to survive. Even in spite of considerable falls of rain shortly after dipping, the results were still very satisfactory. Attention is now being devoted very largely to the effect of derris-powder dips upon lice. Sheep infested with body lice (*Bovicola ovis*) are dipped at intervals, kept isolated in pens, and examined periodically. Since lice, when present in small numbers, are extremely difficult to detect even when the sheep is subjected to careful examination, a different procedure from that adopted for keds must be followed. Individual animals are dipped, kept isolated over a lengthy period, and examined at intervals. If an animal is found to be free of lice on each examination up to a period of twelve months, then it is declared clean.

The effect of derris-powder dips on leg lice (*Linognathus pedalis*) is also to be investigated. Besides the effect of dips on lice, data are being gathered on the behaviour of lice and the factors affecting their success or failure in building up large populations on individual animals.

Insect Pests of Wheat

Studies on varietal resistance to attack by Hessian fly and stem weevil were continued during the past season. In replicated plots of twelve varieties sown at the Agronomy Division, Lincoln, infestation by Hessian fly was nil in the following varieties: Tuscan, 7701, 6502, 7706, 7801, Tainui, Palestine 2, and Fife Tuscan. Infestation occurred in the following varieties, arranged in descending order of severity: Holdfast, Hunters, Cross 7, 7704. Infestation was much greater in the spring-sown than the autumn-sown plots.

The position as regards stem weevil was found to be much more complicated, but results were in close keeping with those of previous years.

Insect Pests of Cocksfoot

Observations were continued on the cocksfoot midge (*Stenodiplosis geniculati* var. *dactylidis*) and the stem borer (*Glyphipteryx achlyoessa*). The loss of cocksfoot seed due to stem borer appears to be much greater than the loss due to midge. When a stalk is infested by the borer, and generally killed, all the seeds on the head are lost. When midge attacks a head, only those flowers which are invaded, and this is normally a small percentage, fail to produce seeds.

Animal Production Research

Professor C. P. McMeekan

Nutritive Value of New Zealand Mutton and Lamb

In collaboration with Massey Agricultural College and the Chemistry Section of the Department of Agriculture, detailed anatomical, chemical, and nutritive value data were obtained of New Zealand mutton and lamb. Ten carcasses of every weight and grade of North and South Island mutton and lamb were dissected and chemically analysed. A full report was supplied for the information of the British Ministry of Food. Results were related to shipping-space. Considerable differences existed in nutritive value per carcass and per pound as between grades and weights. A short report summarizing the results has been published. Of direct importance in relation to war supplies was the demonstration that, both per carcass and per cubic foot of shipping-space, mutton has a higher nutritive value than lamb, and heavy lamb a higher value than light lamb. Data on the anatomical, chemical, and nutritive composition of a working bullock were also supplied for the information of the British Ministry of Food.

Preparation of Hormones

The practicability of preparing pituitrin, adrenaline, and thyroxin of a standard equal to imported products has been demonstrated. Practical procedure for collecting glands under New Zealand freezing-works' conditions has been worked out. Over 100 g. of standard pituitary powder, representing 10,000 1 c.c. doses, was prepared against emergency shortage. The co-operation of the Westfield Freezing Co., Ltd., Auckland, and the Medical School, Dunedin, played a material part in these investigations.

Growth Studies

The effect of plane of nutrition on the growth of Corriedale hoggets has been examined. Marked effects on body conformation and carcass composition (bone, muscle, and fat) were obtained from feeding methods typical of those employed in practice. Incomplete recovery from effects of under-nutrition by subsequent good feeding was shown to occur in a differential manner, such that late-developing tissues (fat) recovered more than early (bone, muscle). A report has been prepared for publication.

Further carcass data on growth and carcass quality of different breeds and crosses of fat lambs under different methods of feeding have been accumulated. Work on the fattening value of sweet lupins for lambs has been extended. The study of breed and seasonal influence on the thyroid gland of sheep has been continued and considerable data accumulated.

Reproduction Studies

With a view to establishing "norms" as a basis for further work, over two thousand cattle pituitaries were examined in detail. Measurements, weights, shape, relative proportion of anterior and posterior lobes, and relative yields of pituitrin were obtained for glands from dairy cows and steers. Histological examination is in progress. The work has been extended to cover comparisons of glands of sterile and fertile dairy cows. A study of the œstrua cycle in Romney and Corriedale ewes is in progress.

Breeding

Work in establishing a pure breeding red strain of pigs derived from a Large White-Tamworth cross has been continued. Pure breeding reds have been obtained. Selection and multiplication with a view to fixing productive qualities is proceeding. Results to date are promising. Inbreeding studies on Large Whites have continued. Work in the establishment of an inbred line of Romney sheep for experimental purposes has been continued. Progeny-testing work with sheep in collaboration with the Wool Metrology Section of the Department had to be abandoned owing to shortage of personnel.

Wool Metrology Laboratory

Dr. P. R. McMahon

The absence of Dr. P. R. McMahon on war work for the greater part of the year meant considerable curtailment of the activities of the section.

Investigations undertaken by Mr. A. A. Dunlop in conjunction with this laboratory established that repeat judgments of wool fineness were consistent to within one count (corresponding to an accuracy better than 1/10,000 of an inch in mean fibre diameter) nineteen times in twenty. Visual judgments of wool fineness and wool character at the standard hip position were in good agreement with the average of many samples taken over the whole fleece.

Analysis of survey data collected in 1941–42 was continued and the results can be summarized under the following headings:—

(*a*) On the best of sheep country where rainfall is heavy and evenly distributed, and where sheep have as much grass as they can eat throughout the year, Leicester-type Romney wool of 40/44's count gives the heaviest weight per ewe, the advantage over wools of 48/50's count averaging 3 lb. per head. This weight superiority is more than adequate to compensate for the lower price of the stronger wools.

(*b*) On medium-class country, where Romney sheep are normally run, and where summer and winter feed-supplies are less adequate, Romney-type fleeces of 44/46 to 48/50 are within the optimum range of count and give the highest cash return per sheep at the present time. Counts finer than 48/50 are associated with a drop in fleece weight for which the small premium for finer wools is insufficient to compensate. Counts stronger than 44/46 yield heavier fleeces even on this country, but the difference is not great enough to make up the drop in price of the very coarse wools.

(*c*) On the poorer types of country associated with light rainfall and low carrying-capacity, a half-bred type of wool gives the best returns. The optimum count is about 54/56, and there is no advantage to be gained from selecting wools stronger than 48/50's. Higher weights will be gained at such stronger counts, but the increase is insufficient to counterbalance the normal price difference.

Under all conditions short-stapled Down-type fleeces are considerably lighter than other types of similar fineness, while hairy, Carpet-type fleeces weigh lighter than Romney or Leicester type of the same count.

A pamphlet on wool and wool-classing has been prepared for the Army Welfare and Education Service.

MASSEY AGRICULTURAL COLLEGE

Sheep Nutrition Experiment

Mr. W. M. Webster

The collection of data on this experiment has been rendered difficult by reason of the shortage of skilled labour, but fleece weight was recorded and samples taken for yield determination and estimation of medullation. It was not possible, however, to continue recording other fleece characters such as quality and style. While the results of previous seasons' records have not been statistically analysed, the absence of any pronounced trends makes it appear unlikely that any differences will be shown to be highly significant.

Data have again been collected on lambs at time of slaughter. In most cases mean values for the different treatments are very similar and seasonal differences are more marked than treatment differences.

Pregnancy Toxæmia (Sleepy Sickness).—During the latter part of August and the first fortnight in September a total of eighteen deaths from pregnancy toxæmia occurred among the experimental (thirteen) and reserve ewes (five). This condition is generally regarded as essentially an acute ketosis associated with the mobilization of the body fat reserves. It was formerly believed to occur only in ewes on a falling plane of nutrition during the latter stages of pregnancy, but recent experiments at the Rowett Institute have shown that the disease can be readily induced in fat high-conditioned and adequately-fed ewes by twenty-four hours' starvation at the critical period—*i.e.*, about a fortnight prior to lambing. A clinical diagnosis is confirmed by a positive acetone reaction in the urine of affected animals, and the total ketone bodies may be estimated quantitatively in urine and blood, the generally-accepted normal limits for these fluids being under 10 mg. and under 2·5 mg. per cent. respectively.

The experimental shepherd reported that the ewes succumbing to the disease were invariably first affected with foot-rot, which was at the time rife in the experimental flock. Since the experimental flock was undoubtedly in high condition and not in any way stinted for feed during the critical period, such an observation fits in with the etiological picture of the Rowett experiments.

Urine and blood samples were collected from the above-mentioned six cases, five of which succumbed despite medicinal treatment, whilst one recovered and subsequently gave birth to dead twins. High values for ketone bodies were found in all cases and are in accord with figures reported elsewhere in connection with pregnancy toxæmia.

Report on Thyroid Glands.—Continuing earlier work, observations were made during the past year on thyroid weights at birth and at time of slaughter. Last season, in contradistinction to the two previous years, there was no abnormally high natal mortality, but the high lambing percentage and the "single lamb" policy made it necessary to slaughter a total of seventy twin lambs within a day or two of birth. Thyroid glands

from all these lambs, together with those from six natal deaths, were dissected out and weighed. Glands for all fat lambs were also obtained at the time of slaughter. In February, 1942, a visit was paid to Longburn Freezing-works and glands were collected and weighed from a number of lines of college lambs in order to secure control figures for comparison with the weights of the experimental lambs.

From examination of the data secured it is apparent that the lambs from the nutrition experiment have consistently developed hypertrophied thyroid glands throughout the three years that the experiment has been under way. How far this condition is correlated with the high natal mortality in the first two years (30 per cent. in 1940 and 11 per cent. in 1941) is not clear, but it is hoped that the restocking of the experimental block with young ewes next season will throw further light on the subject.

Drainage Research

Mr. A. W. Hudson

No new work has been undertaken during the year, but routine activities involving examination of existing experiments and recording of outflow measurements have been continued.

A method of joining minor moles to majors by pulling the minors across the majors at an angle of from 30° to 45° was described in the 1940 report. Junctions so made in November, 1939, were tested and found to be satisfactory.

The effect of speed of pulling was the subject of a trial laid down in October, 1940, and experimental evidence to date indicates that the efficiency of the drains was not affected by pulling at speeds of from one to three miles per hour.

In conjunction with the above experiment the effect of direction of pull—*i.e.*, towards the outlet, as opposed to away from it—was investigated, and evidence suggests that there is no justification for the practice sometimes adopted of pulling one way only.

During the year a limited number of water-flow meters of a pattern devised by the Dominion Physical Laboratory from a design by Childs were procured and installed. These enable continuous records of the outflow to be obtained. It is intended to install meters on all experiments, and it is hoped that a recording rain-gauge will be available.

The Public Works Department made available a sum of money for the purpose of laying down experiments on aerodrome drainage.

A study of the practice of pulling the mole plough through the gravel backfill over the tile drains was made, and revealed that the mole channel, where it entered and left the gravel in the main drain, was disrupted, and unless some attempt was made to connect the individual moles to the main drain this system was likely to be effective for a very short time only.

A series of experiments was laid down at Milsom Aerodrome entailing a comparison of mole drains, tile drains, and shallow gravel-filled drains. Various methods of backfilling the tile trenches were investigated, and also the effects of variations of the gravel drains in respect of such factors as width and depth of trench, distance apart and length of drains, and type of gravel backfill. Preliminary results indicate that shallow gravel-filled drains are likely to be of considerable value as short lateral collecting drains provided their limitations in respect to length, width, and size of metal are recognized. Mole drains are unlikely to be satisfactory except as a temporary expedient unless conditions are extremely favourable to mole-drainage operations.

Root-development Studies

Mr. W. A. Jacques

Fertilizer Placement Plots.—Plots were laid down in April, 1942, in order to verify results obtained from pot trials in the three previous seasons, but due to labour shortage root sampling could not be undertaken. The summary of results of the pot trials were given in last year's report.

While no root weights were obtained, observation showed that the surface application gave the best early response, but differences subsequent to the second grazing could not be observed.

Root Development as affected by Seasonal Mowing Treatment.—This series of trials has been completed. While there is a decided response by the tops, and increased herbage yield following lenient defoliation is apparent, very little difference in root weight can be noted. It would appear that some mechanism within the plant is responsible for this, as within three weeks of altering the treatment to more lenient or less lenient defoliation the plant has adapted itself to the new conditions without any apparent increase or decrease in root weight.

Root Development as affected by Degree of Defoliation.—It is considered that the amount of leafage left on the grass plant after grazing or mowing will have an influence on the productivity of both roots and shoots. A trial to test this has been under way for two years, and root samples are at present being weighed. From the weights of herbage taken over this period it is obvious that both too little and too much herbage can be left on the plant, the optimum amount being between 1 in. and 1½ in. Root figures are as yet incomplete, but so far as they have been observed they will not (on a weight basis) support the herbage weight figures.

Strain Differences.—A periodic examination of plants of rye-grass, cocksfoot, dogstail, and red and white clover is being made to determine any factor in root development which may throw light on their growth behaviour. One factor—*i.e.*, that of the completeness of root replacement in autumn—is proving interesting and instructive. There is a difference in this respect between Dutch and New Zealand cocksfoot and white clover. The replacement of the primary taproot system in clovers by an adventitious one is also instructive from the point of view of persistency. Dogstail shows almost 100-per-cent. root replacement each year.

Pig Research

Professor W. Rudet

Research work has been entirely devoted to continuation of previous studies on factors affecting the inheritance of length in pigs and to modifications of breeding methods adopted in the last five years that were deemed desirable in the light of results.

It will be recalled that when the experiment was planned five years ago, it was decided to study the mode of inheritance of length by fixing long and short types through inbreeding and selection crossing successive generations of long and short and examining the carcasses of the pure long, pure short, and long-short progeny in successive generations as they reached baconer weight of 180–200 lb. live weight. This work was initiated by the writer, continued by Professor McMeekan till he was appointed to Lincoln College staff in January, 1939, and carried on by Mr. Cooper since that time. During the present year Mr. Cooper brought up to date the analyses of data that Professor McMeekan previously deduced. He has examined data relating to the 373 carcasses measured between August, 1938, and October, 1943. The following is a brief summary of his results.

The average length of the baconer side of 226 progeny of 4 "long" boars (three of which were grandsire, sire, and son) was 750 ± 22 mm. with a coefficient of variation of 2·8 per cent., while the corresponding length of 147 progeny of 3 short boars (grandsire, sire, and son) was 729 ± 21 mm. with a coefficient of variation of 2·9 per cent.

By inbreeding and selection of both males and females the average length of side of the baconer progeny of successive boars used was increased from 735 ± 17 mm. to 765 ± 21 mm. Individual pigs have now reached 820 mm. The progeny of long sows was not markedly different from those of short sows when they were mated to the same boars. This may be due partly to the fact that the sows had not been sufficiently long inbred to be pure for their outward character. It nevertheless emphasizes the important influence exerted by the sire on his progeny.

The difference in length of side between short and long pigs is partly but not wholly explained by differences in numbers of ribs. A variation of from thirteen to seventeen pairs has been observed in different carcasses. Differences in lumbar vertebræ have also been noted, but it has not been possible to keep an accurate account of these.

Little difference in the average length of side has been observed within a weight range of 126 lb. and 150 lb. carcass weight; the difference has been least in the short strains.

During the course of the above work it became evident that most progress could be made in increasing length by testing as many likely boars as possible, and thereafter breeding as extensively as possible from those sires that have proven themselves to leave long pigs. This policy has been accordingly adopted. In addition, it has been deemed desirable to introduce "mildly" new blood with the object of increasing the number of available long genes. This was tried by the use of an unrelated boar but his progeny had to be rejected for an inherited weakness, and another unrelated boar is now being tried.

All of the methods referred to above in increasing the length of baconer sides have been disappointingly slow in achieving results, especially since other features of commercial quality in baconer pigs—*e.g.*, thickness of hams—have had to be taken into account in making selections of breeding-stock. Thus an attempt is being made in collaboration with Lincoln College and St. Peter's School Farm, Cambridge, to develop a baconer pig predominatingly red in colour by crossing the Tamworth and Large White pigs, mating the half-breds, selecting the desirable types of red-coloured pigs of the second generation, and thereafter continuing the breeding and selection of successive generations of these. The task of eliminating white colours has been simplified by the appearance of red as a recessive character, but an interesting array of combinations of colours has emerged in the course of the work. Dr. Dry is making a study of these. In the meanwhile, the red recessives are being multiplied, and it is hoped to secure from the third generation litters a reasonable sample for examination of length and other desirable features of bacon quality. The crossbreds of the first generation and the "non-reds" of the inbred second generation have proved to be longer than the pure-bred Tamworth.

Sheep-breeding Methods

Mr. R. Waters

In recalling the objects of this investigation, contrast should first be made between the quality standards that must be adopted and those customarily accepted by studmasters. It would be courting disaster to establish close-breeding experiments—such as have already been attempted on a small scale—using sires with pedigrees and appearances that would appeal to studmasters choosing sires for cross-breeding in what would ordinarily be regarded as well-conducted studs. For close-breeding experiments choice must be according to standards different from those—standards much more difficult to attain. The investigations carried out do not disregard pedigree and appearance, but are more particularly concerned with a search for sires and dams above average in their ability to transmit to their progeny certain vital and commercial characters making for better mutton and wool production—sires and dams, therefore, with some qualification for close-breeding tests and experiments. This search entails a progeny-testing on recently-approved lines, and this in turn involves a technique of examination, measuring, and recording which has gradually been devised—a technique which could not reasonably be undertaken by studmasters raising rams for sale as a livelihood.

In pursuance of these objectives, sixty-one sires, many of which are highly-expensive animals, have to date been progeny-tested. A number of these sires are of definite value for future cross-breeding experiments with the hope of securing offspring capable of giving progeny tests above average. However, it is a significant fact that up to the

present only one of them has shown promise of being sufficiently above average in requisite vital and commercial characters to warrant his use on a small scale for close-breeding experiments. The work of the past season has, in fact, brought out more clearly this significant fact: that the present methods of cross-breeding current amongst Romney breeders lead to pronounced heterozygosity amongst their sheep, a condition from which there is little hope of escape except by means of well-planned close breeding.

The present staff are engaged on the following programme:—

(i) The further recording and investigation of the results arising out of the examination of 758 hoggets of 1941 for fleece weight and body conformation:
(ii) The superintendence of the 1943 matings now in progress. This involves inspection and careful recording of about one thousand breeding-ewes and their mates:
(iii) The examination later in the year of the fleeces and body characters of over eleven hundred hoggets born 1942. This will afford progeny tests for twenty-five sires next year:
(iv) Weighing and recording the fleeces of about one thousand breeding-ewes and those of the sires in use:
(v) At docking, superintending the mothering of the lambs of 1943 and making up the lambing list this year.

DOMINION LABORATORY

Director: R. L. Andrew

The Dominion Laboratory is a service laboratory for Government Departments. There has again been an increase in the volume of work and the number of samples dealt with. These increases are wholly due to war conditions.

GOVERNMENT DEPARTMENTS

The number of samples received at the main laboratory and branches were: Wellington (main laboratory), 9,624; Auckland, 7,393; Christchurch, 7,424; Dunedin, 2,120; total, 26,561.

Customs

A variety of samples were examined to afford data for classification for Tariff purposes. At the request of the Department of Health, samples of all the brands of iodized salt at present imported were forwarded for examination. It was found that with very few exceptions the brands of salt now imported comply with the new standard of 1 part iodide in 20,000. The former standard was 1 to 2 parts in 250,000, which was considered too low to be effective.

Police

Auckland.—The police work has fortunately been less than usual. One interesting case involved the examination of a number of bank-notes, the proceeds of safe-breaking, for evidence of gelignite and sawdust, &c. An increasing number of samples of wine and other liquor has been examined in connection with sly-grog raids.

Wellington.—Five series of exhibits were examined in connection with accidental and suicidal poisoning. The poisons found were medinal, cocaine, oxalic acid, and in two instances carbon monoxide. A potato thought to be poisonous was examined for solanine, a poisonous principle sometimes developed in green potatoes. No solanine was found. Examination of viscera of a dog revealed that the animal had been poisoned with arsenic. Fragments of glass were identified as coming from the windscreen of a motor-car involved in a fatal accident. A considerable number of samples of blood and urine were examined for alcohol. This work is increasing, and is often of great value in deciding whether or not a deceased person was under the influence of alcohol at time of death. Samples of motor-spirit were tested to establish identity with spirit alleged to have been stolen. A number of samples of liquor were examined for the police in cases of alleged illegal sale.

Christchurch.—Substances detected in exhibits submitted for toxicological examination were hydrocyanic acid, potassium cyanide, and phenol. A sample of percaine was examined in connection with an anaesthetic death. A number of samples of liquor were examined in connection with sly-grog charges. Two samples of cider contained 15 per cent. proof spirit, and two samples of locally-made wine liqueurs contained 35 per cent. and 27 per cent. respectively. Samples of blood and urine were examined for alcohol in connection with fatal motor accidents, positive results being obtained in three cases. In a case of suspected theft of aviation spirit, the analysis of a number of samples led to the conclusion that aviation spirit had been added to ordinary spirit.

Dunedin.—No poisons were found in any of the samples submitted. A number of liquor samples were alleged to be "Hokonui" or illicit whisky. It is generally found impossible to prove this definitely, although the analysis may strongly indicate that the liquor is not the regular imported whisky. These suspicious liquors are generally turbid and may contain fourteen times as much non-volatile matter as is usual. They are frequently low in alcohol and the taste and smell are definitely inferior.

DEPARTMENT OF AGRICULTURE

Christchurch.—A large number of samples of milk was examined for the Dairy Inspector in connection with the retail milk-supply of Christchurch City.

An investigation was made into the cause of death of some 250 pigs. The pig-swill, which had been consumed in quantity by the pigs, had been prepared largely from cooked mangels and contained considerable amounts of nitrites. A full examination was made of all the materials used in the preparation of the swill, and the conclusion was arrived at that the nitrites were derived during the cooking process from nitrates naturally present in mangels, probably by bacterial action.

A supply of milk was found to clot on heating to boiling temperature. Investigations showed that traces of calcium chloride had been introduced from a cooler containing this substance, and laboratory experiments indicated that the clotting complained of could be caused by very small amounts of the calcium chloride solution.

DEPARTMENT OF HEALTH

Milk

The total number of milk samples analysed at the four laboratories during the year was 17,495.

Auckland and District.—Five thousand eight hundred and twenty-two samples were examined.

Attention has been given to the possibility of a higher reductase standard for pasteurized milk, and some progress has been made.

It is clear that the four-hour-minimum reductase standard should be exceeded by all pasteurized milks on early-morning delivery, and a minimum of eight hours has been suggested. This standard can be attained and exceeded, using a good raw milk for pasteurization and giving attention to the proper cleaning of pasteurizing plant, bottles, and cans. The high-temperature reductase test at 63° C. can be used to detect improper cleaning of pasteurizing plant.

An increasing proportion of the Auckland milk-supply is now pasteurized, and it is clear that more inspection of the farm milks and of the pasteurizing plant is necessary in some cases.

Owing to the restriction of permanent licenses, temporary milk-supplies had to be obtained from nearby cheese-factories, and this milk on arrival in Auckland was in a very unsatisfactory condition. This type of milk cannot be eliminated until an adequate number of permanent suppliers are licensed.

Wellington.—Four thousand and seventy samples were examined. Of 1,193 samples from Wellington City, 11 contained added water, 12 were below the standard for fat, and 8 failed to comply with the reductase test. This position must be regarded as very satisfactory. Of 1,742 samples received from the country districts, 33 contained added water, while 15 were below the standard for fat.

Christchurch.—Four thousand two hundred and eighty-six milk samples were examined during the year, of which 2,236 were from Christchurch City and suburbs, 914 from military camps, 301 from school milk-supply, and the remainder from the provincial districts of Canterbury and Westland.

Christchurch City and Suburbs: Zoning was introduced in connection with the delivery of milk in Christchurch, and has given rise to numerous complaints from consumers, many of which were found not to be warranted.

Only two pasteurizing plants are operating in the metropolitan area, and special attention has been given to the control of the efficiency of the pasturizing processes.

The question was raised during the year as to the reasonableness of the fat standard (3·25 per cent.) in this district. The records of this laboratory indicate that the average fat content of the Christchurch supply is over 4 per cent., and it is reasonable to suggest that the legal standard should be raised to 3·5 per cent. rather than that it should be reduced below the present low value.

Outside Districts: The number of milk-samples examined was 835, of which 504 were from Canterbury and 331 from the west-coast districts.

Pasteurization plants have been under control, and occasional deficiencies in this connection have been detected.

Dunedin.—One thousand six hundred and forty-five samples were examined. Of 968 samples from Dunedin City, 2 were watered, 49 were deficient in fat, and 47 failed to comply with the reductase test. Of 677 samples from outside districts, 7 were watered and 44 were deficient in fat.

This record is not good, the proportion of milks deficient in fat being higher than in other parts of the Dominion.

It is a matter for comment that the number of samples from Dunedin City failing to comply with reductase test, which is a measure of staleness, was about six times as many as in Wellington.

In all the districts special attenion has been given to milk supplied to schools and to military camps.

Water

A total of 897 samples from projected and existing water-supplies were analysed at the main laboratory and the three branches. A large proportion of these were taken in connection with supplies to military camps.

Sewage

Samples of sewage, some of them taken in connection with disposal of effluents from military camps and linen-flax factories, were examined in each of the four laboratories.

Miscellaneous

A wide range of articles used as food and drink were examined. They include apple-juice, apples, apricots, arrowroot, bacon, baking-powder, beer, brandy, butter, canned meats, carbonated beverages, cider, coffee and chicory, coffee, cornflour, cheese, cream, essences, gin, ground almonds, custard-powder, ground rice, honey, jam, ice-cream, margarine, milk-powder, mince meat, olive-oil, orange-juice, peas, rose-hip syrup, sausages, sugar, tea, tomatoes, tripe, wheat germ, whisky, condensed milk, dripping, flour, and spice.

A number of drug samples were examined for compliance with the standards of the British Pharmacopœia.

The Department of Health also submitted samples of enamelware, cigarette-papers, and dental and shaving creams to ascertain if they contained harmful substances.

Mines Department

Samples examined included scheelite concentrates for export, gold and silver assays, mine airs and gases, stone-dusts, and brattice cloths. Analyses of coal and other fuel samples and a large amount of investigational work in connection with fuel problems were carried out by the Coal Survey Division of the Laboratory.

Government Stores

A very large number of samples were submitted by various Government purchasing departments to ascertain if they complied with the specifications under which they were purchased or for special investigation of some defect or failure. Samples of tars and other roading-materials were examined for the Main Highways Board.

GAS INSPECTION

The gas-supplies of the four main centres and most of the other principal towns of the Dominion were regularly examined for calorific value, for pressure, and for freedom from sulphuretted hydrogen. It has been found that several works are experiencing difficulties in keeping up the calorific value of the gas and ensuring freedom from sulphuretted hydrogen. This has been explained by difficulties in supplies of coal and lack of trained labour. The systematic testing of the accuracy of all gas-meters passed for service was carried out as usual.

RESEARCH AND OTHER ACTIVITIES

Spray Materials

Spray work for the Plant Diseases Division has been confined mainly to checking certified spray materials—*e.g.*, oils, arsenates, and nicotine sulphate. A series of pyrethrum flowers was analysed, the figures for pyrethrin I varying from 0·35 to 0·7 and for pyrethrin II from 0·25 to 0·75.

A series of analyses of samples from kegs of colloidal sulphur was undertaken to ascertain the best method of mixing the material prior to use in orchards.

Metals and Alloys

A large number of samples of metal were analysed or examined metallographically in connection with munitions-production. These included samples of iron and steels, brasses, bronzes, aluminium alloys, bearing metals, solders, zinc, and zinc-base die-casting alloys. An examination was made for the Public Works Department of materials used in the arc welding of penstock pipes on hydro-electric development schemes.

Corrosion of Materials

Corrosion problems submitted from a number of sources included corrosion of high-voltage fuses due to traces of water present in the quenching liquid of the fuse, deterioration of aviation refuelling hoses induced by an alkaline cement used to attach couplings, corrosion of domestic coppers, steel bomb components, and dezincification of brass.

Chemical Engineering Section

A plant for drying medicinal herbs was constructed by the Public Works Department to design data supplied by the Chemical Engineering Section. This plant has been operating satisfactorily for two seasons.

Towards the end of 1942 the Section was asked to furnish designs for plants to produce dehydrated vegetables and apples to be supplied to the armed forces. The plant for vegetables, capable of dealing with between 4,000 tons and 5,000 tons of fresh vegetables per annum, is now in production. The plant for apples will soon be ready for operation. The Chemical Engineering Section has supervised the construction of these plants.

A commercial unit of the fescue-seed dryer (New Zealand patent) developed by the Section has been erected at Invercargill, and although it has not yet undergone final test it is reported to be giving good results.

The possibility of producing from coconut charcoal activated charcoal for filling gas-masks was investigated, and it was decided that this could in the circumstances best be done in intermittent gas-retorts. One of the main gas companies undertook the work of activation in consultation with this Section, and many tons of a satisfactory material have been produced. In connection with the manufacture of gas-masks, a special apparatus was designed for testing their efficiency.

Regular testing of the octane rating of aviation fuels for Air Headquarters has been carried out with the C.F.R. test engine.

Some mobile producer-gas plants have been tested for licensing purposes during the year. A number of Government type B producer-gas plants, designed in collaboration with this Section, are in operation and are giving satisfactory service.

The Section has been called upon to design pieces of laboratory equipment and to give advice on problems connected with the establishment of industries.

Organic Section

Medicinal Plants.—A large number of analyses have been made of drug plants grown both for export and for experimental purposes. Plant materials examined included *Digitalis purpurea*, *D. lanata*, *Belladonna*, *Hyoscyamus*, *Stramonium*, and other *Datura* species, *Artemesia absinthium*, opium poppy, and the New Zealand native pukatea bark and koromiko leaf. Lavender, peppermint, coriander, fennel, castor-seeds, and olives were examined for yields and quality of oil.

Army and Air Departments.—A wide variety of materials were examined including nitrocellulose dopes, camouflage and finishing colours, hydraulic fluids, compass fluids, rubber, engine sludges, &c., in connection with manufacture and maintenance of aircraft, waterproofing preparations for hand grenades, electrical equipment, maps, and food-cartons. Foodstuffs were analysed for vitamins B and C.

Miscellaneous.—A large series of pine-wood samples were examined for seasonal variation of resin content in connection with an investigation being carried out by the State Forest Service.

Rotting of tenting in the Rotorua district was found to be due to the action of sulphuretted hydrogen on the copper rot-proofing compounds in the canvas.

Petroleum and tars and tar distillates were examined for toluene content.

Seaweeds for Arsenic.—Twelve samples of seaweed (Gigartina) were examined for arsenic for the Botany Division. The amount of arsenic trioxide found varied from 0·017 grains per pound to 0·17 grains per pound calculated on the oven-dried sample.

Dermatitis from Watch-strap.—A wristlet-watch strap, stated to have injurious effects on the skin, was found to contain a considerable amount of coal-tar dye. A chrome tanned leather, stained with resorcin brown, has been used, and the raw cut edges had been dyed with a second coal-tar dye. There was definite evidence that the straps had caused dermatitis.

Spectrographic Analysis

The large quartz spectrograph is now mainly used for the examination of metals for Government Departments, and much of the work is connected with the war. For testing for compliance with specifications for content of impurities, the A.S.T.M. solution method has been modified for application to brasses, lead, copper-cadmium, phosphor-bronze, zinc, aluminium, and steel. A special method has been devised for solders. Spectrographic analyses were also made of general laboratory samples—for example, the examination of plaster for lead. The only biological work carried out was the examination of the bones of lambs suffering from osteoporosis. The spectrograph has also been of use in forensic work. The small glass instrument has been used daily for the examination of zinc-base die-casting alloy, samples of which now come from four factories. It is occasionally useful for other metals, especially aluminium.

Coal Survey

The physical and chemical survey of the Dominion's coal resources has been continued by the Coal Survey Laboratory and by the field staff appointed by the Geological Survey. Work in the Greymouth field is now nearing completion. A number of field reports have been made on areas in the Greymouth district and also for the new North Island State mine areas of Tatu and Mangapehi. The Coal Survey has issued seventeen reports during the year and has undertaken a number of investigations on behalf of Government Departments and for private companies.

Analyses have been made of a large number coals from the Strongman, Mangapehi, Tatu, and Wallsend Mines. Bore samples from the Westport Coal Co. have been examined. Co-operative mine samples have also been analysed. Producer fuels for mobile units and for a Wellman industrial producer have been reported on and recommendations made. Analyses were made of fuels used in the Sesci furnace of the New Zealand Railways workshops, and it was shown that according to the constitution of the ash, Paparoa coal would be suitable and Waikato char unsuitable for use with an acid-lined furnace. A number of shales from Nevis, Otago, were too high in ash content (74–93 per cent.) to allow of commercial development. A shale from Freshford gave 38 gallons of crude oil per ton. One of the main concerns of the Section during the year was the successful production on a commercial scale of activated carbon from Samoan coconut shell charcoal for use in gas-mask canisters. An entirely satisfactory product was produced. Two gases examined from west coast oil-prospecting bores consisted wholly of methane and gave no indications of oil. A number of smokeless solid fuels and the different ways of packaging them were investigated on behalf of the Military authorities. Other analyses included those of charcoals and peats. On behalf of the Wellington Fire Brigade four Salvus valves were adjusted to deliver oxygen at the required rate.

Thermal Regions

A member of the staff visited Tokaanu and determined the amounts of steam and water being ejected from two bores recently sunk in the Tokaanu alkaline area. Samples were brought back for determination of boric acid and ammonia in the water and steam. During the construction of new buildings by the Public Works Department at the Rotorua

Sanatorium a large number of soils and water from various sites were examined for titratable acidity and corrosive properties. Several of the waters were found to be extremely corrosive, and most of the other samples would have a deleterious effect upon building-materials generally used for foundations.

Building Materials

Fire-resistance tests were carried out for the Public Works Department and the Housing Construction Branch on a series of wallboards. The lack of fire-resistance of most of the fibre-boards available was demonstrated.

A considerable amount of investigational and testing work on paints was carried out during the year, mostly for the Defence authorities. During the year a salt spray corrosion test apparatus was set up, and an ultra-violet light accelerated weathering unit.

Advisory and Consulting Work

The Director and other senior members of the staff have been consulted frequently on scientific and industrial matters. This phase of the work is increasing. They have also represented the Laboratory on various technical and inter-departmental committees, including those of New Zealand Standards Institute. Papers by various members of the staff have been published in scientific journals both in New Zealand and abroad.

DOMINION OBSERVATORY

Acting-Director: R. C. Hayes

REPORT FOR THE YEAR ENDED 31st DECEMBER, 1942

Time Service

Control of Clocks.—During most of the year the control of the time service was greatly facilitated by circumstances (arising from the E.P.S. Fire-watching Regulations), which enabled additional check time signals to be received from Greenwich and Washington. Local transit observations were also made from time to time. The clocks were seriously affected by local earthquakes on 24th June, 2nd August, and 2nd December, but none of the clocks or other apparatus suffered permanent damage.

Time Signals sent out. The usual time-signal service was maintained. In addition, arrangements were made in July for the National Broadcasting Service to send out time signals daily, at each hour from 7 a.m. to 7 p.m., to replace the chimes of the General Post Office clock. Owing to rearrangement of their apparatus, the National Broadcasting Service was unable to transmit time signals from 16th to 19th October.

The error of the ZLW time signals exceeded 0·25 second on one occasion only during the year, when the error was 0·34 second slow. The ZLW signals partially failed on 25th November and 4th and 13th December. On each occasion the fault was outside the Observatory.

During the latter half of the year there was a considerable increase in the number of telephone calls for correct time, placing additional duties on the staff. This increase was probably due in part to the dismantling of the General Post Office clock following the earthquake on 2nd August. Time has been supplied frequently by telephone to various branches of the armed forces, including local United States Army establishments.

Public Clocks. The General Post Office clock was checked daily up to 24th June, when the chimes were put out of action by the earthquake. The maximum errors observed up to that date were 8 seconds fast and 8 seconds slow.

The Government Buildings clock was also checked daily. The clock was damaged by the earthquake on 24th June, and was stopped again by the shock on 2nd August. It was very erratic from 26th to 30th June. This clock cannot be regulated during week-ends and holidays; consequently, errors of half a minute or more are likely to accumulate during those periods.

The longest uninterrupted run of the synchronous clock was from 6th January to 24th May (138 days). Readings taken twice daily showed a maximum variation of 66 seconds during that period.

Free Pendulum. The free pendulum continued to give satisfactory performance, but was disturbed rather frequently by local earthquakes. Investigation has shown that marked changes of rate which occur from time to time are not due to defects in the clock mechanism, as was previously suspected, but are associated with one or other of the following causes: (1) Violent fluctuations in barometer pressure; (2) changes in the direction of local ground tilt; and (3) local earthquake.

Chronometers.—Two second-hand chronometers were purchased during the year, for time service and general use. A number of chronometers belonging to the Royal New Zealand Navy, the Marine Department, and to ships were issued after having been at the Observatory for rating and safe custody.

Seismology

Summary of Seismic Activity in New Zealand in 1942.—The outstanding seismic event of the year was the outbreak of severe activity in the Wairarapa district on 24th June. The main shock reached intensity R.-F. 9+ at points east and south-east of Masterton,

where surface evidence of fault movement was found on 29th June in the course of a reconnaissance of the area carried out by the Acting-Director, in company with officers of the Geological Survey. A very severe aftershock occurred on 2nd August, and a third severe shock originated in the same region on 2nd December. A very large number of subsidiary shocks also occurred, upwards to six hundred being recorded at Wellington to 31st December. About 7 per cent. of these were perceptible in Wellington.

No other parts of the country experienced any notable seismic disturbances. Most of the activity was confined to the normal seismic areas. Two notable occurrences during the year were (1) a shock on 27th June with epicentre near White Island and focal depth 370 km. (230 miles), the deepest origin so far recorded in the New Zealand region; (2) a shock on 1st November, centred in the south-east Tasman Sea, approximately 150 miles off the Milford Sound coast.

The total number of earthquakes reported felt in New Zealand in 1942 was 196. Of these, 162 were felt in some part of the North Island and 48 in some part of the South Island; 14 were felt in both Islands. The maximum intensity recorded in the North Island was R.-F. 9+, and in the South Island R.-F. 6. The above figures are based on reports furnished by officials at post-offices and lighthouses and by several private observers.

Seismograph Stations. Seismographs were in operation throughout the year at the following places: Auckland, New Plymouth, Hastings, Bunnythorpe, Wellington, Christchurch, and Monowai. The Jaggar instrument at Rotorua was out of action most of the year owing to defective clock mechanism; and the Wood-Anderson at Tuai was temporarily suspended from January to July. During August the Imamura strong-motion seismograph at Takaka was transferred to Bunnythorpe and replaced by the Bunnythorpe Jaggar. The Wood-Anderson at Kaimata was finally installed in September; and subsequently the Jaggar at Greymouth was discontinued.

The tiltometer, which was broken by the earthquake on 24th June, has been lent to the Geophysical Survey for trial in the Rotorua region, after repair.

Research in Seismology.—Shortness of staff and increased work in connection with the unusual seismic activity have restricted progress in research. However, some further work was carried out on the distribution of earthquake activity in New Zealand and on the structure in the New Zealand region as indicated by the depths of earthquake origins.

General

Some assistance has been given to the Carter Observatory and the New Zealand Astronomical Society in matters concerning astronomy, especially in connection with the new star observed by Mr. A. G. C. Crust on the evening of 10th November, 1942.

DOMINION PHYSICAL LABORATORY

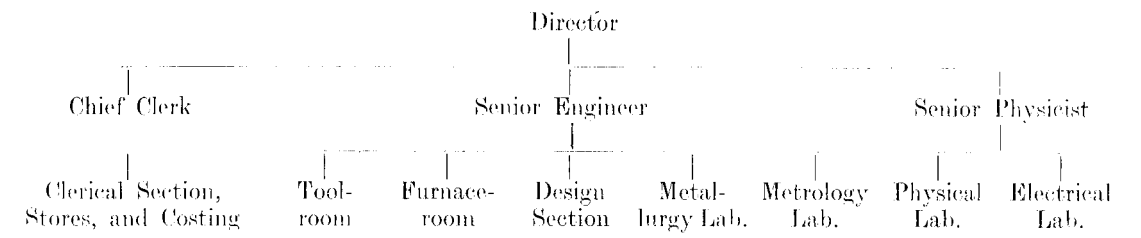
Director: E. R. Cooper

Advisory Committee.—Professor T. D. J. Leech (Chairman), Dr. E. Marsden, Wing Commander G. Carter, Mr. G. W. Wyles, Mr. R. C. Porter, Mr. R. Burn, Mr. J. Brooke, Dr. E. R. Cooper, and Mr. F. J. A. Brogan (Secretary).

(1) General

Seven meetings of the Committee were held during the year. The Laboratory occupied its new premises at Gracefield Road, Lower Hutt, at the commencement of 1943; the town office is being maintained at Molesworth Street, Wellington, and a van service between the town office and Gracefield is being run daily. The new premises offer a floor area exceeding 30,000 square feet. The title of the Laboratory has been altered from Physical Testing Laboratory to Dominion Physical Laboratory.

Out of the staff of the Laboratory, twelve members are engaged in the physical and electrical laboratories, five in the metallurgy laboratory, sixteen in the metrology laboratory, twelve in the design section, eight in the clerical, and seventeen in the instrument workshop. The organization is set out in the following chart:—



The Laboratory is organized into three main branches, headed by the Senior Engineer, Senior Physicist, and Chief Clerk, respectively. The Senior Engineer is responsible to the Director for the operations of the tool-room, furnace-room, instrument workshop, design section, and metallurgy and metrology laboratories; the Senior Physicist for the physical and electrical laboratories; and the Chief Clerk for the clerical, stores, and costing work.

(2) Physical and Electrical Laboratories

The following investigational work has occupied the attention of these laboratories during the year:—

(*a*) *Pyrometric Control.*—An instrument has been developed which after two months' trial can be said to be a successful pyrometric control for furnace work. The principle of operation is not original, but the details of design are such as to offer improvement over commercial instruments of the same type. The basis of the design is that whereby a narrow beam of light falling on a photo cell is intercepted by the deflecting needle of a galvanometer connected to a thermocouple placed in the furnace. With slight alteration the instrument can be made to control any temperature covered by commercial thermocouple wire to an accuracy of ± 0·3 per cent. All parts of the equipment except the photo cell and mercury relay can be made in a workshop possessing moderate equipment. A description of the instrument is being written for publication in the *New Zealand Journal of Science and Technology*.

(*b*) *Chromium-plating of Gauges and Tools.*—Apart from the value of chromium-plating as a decorative and protective coating, it now has a wide application to many forms of tools and machine parts on account of its hardness and wear-resisting properties. An investigation was therefore made into the process known as "hard chrome-plating" with a view to making first-hand information on the plating of dies, tools, and gauges available to New Zealand industry. A circular is being prepared for issue to the various industries likely to be interested, and the results of the investigation are also being published in the *New Zealand Journal of Science and Technology*.

(*c*) *Surface Metallizing of Mirrors.*—So much instrument repair and construction work done in the Laboratory workshops has necessitated the preparation of good surface mirrors that it was necessary to set up equipment for the manufacture of such surfaces by vacuum sputtering or evaporation. This has absorbed no little time of the Physical Laboratory staff, and equipment has been developed for the routine manufacture of surface metallic mirrors.

(*d*) *High-speed Thrust Bearing.*—An investigation was made for the Public Works Department into possible physical causes of the failure of a thrust bearing on a large turbine electric generator recently brought into the country from overseas. The investigation related to the surface finish of the bearing and to its warping when heated. Largely as a result of the conclusions arrived at, the trouble has been rectified.

(*e*) *Measurement of Low Illumination.*—The testing of personnel for their suitability for night vision in anti-aircraft, &c., work is carried out by various methods, and it was necessary to develop these methods in New Zealand in order to obtain reliable and absolute estimations of candle-powers as low as ·0001 ft. candle. The equipment in use by the Armed Services was calibrated by means of a special photometric arrangement.

(*f*) *Repair of Lightning-arrestors.*—Large porcelain lightning-arrestors were damaged at various substations during the severe June earthquakes, but these were found to be capable of repair, provided a metal-to-porcelain soldered joint could be made. An investigation is proceeding to determine the best method of obtaining a silver or copper deposit on porcelain to which solder will adhere strongly.

(*g*) *Mould on Wallboard.*—Trouble has occurred in New Zealand houses due to mould growth on the interior surfaces of walls and ceilings. Investigations are proceeding to determine whether any specific material is responsible for the rapid appearance of the mould and whether the type of wall structure is such as to induce condensation of moisture on the interior wall surfaces.

(*h*) *Linen-flax Industry.*—Problems of a physical nature are present for investigation in this industry. A member of the Laboratory has been placed on the Linen Flax Technical Advisory Committee, and it is hoped that the Dominion Physical Laboratory can help in the development of better processing equipment. To date the Laboratory has helped in setting up thermometric equipment for analysing the temperature conditions in retting-tanks, a method of measuring the strength of the flax fibre has been developed, and portable vulcanizing equipment for repairing certain rubber belts *in situ* is being made up.

In addition to the above investigational work, a very considerable portion of the Laboratory's time has been taken up with the calibration of instruments and the testing of materials. Approximately one hundred and eight instruments of all types have been calibrated this year and forty items of materials testing have been dealt with.

(3) The Metrology Laboratory

This laboratory has been equipped this year for all types of precise linear measurement. The work has been almost wholly routine, in that the measurement of some thousands of gauges and tools for the munitions industry has proceeded steadily. Most of these measurements are made to an accuracy between 0·002 in. and 0·0001 in. The new laboratory rooms are being air-conditioned, so that all measurements are made at the International Standard temperature of 68° F.

(4) Metallurgical Laboratory

An engineer from the staff was sent to Australia for training in metallurgy, chiefly the metallurgy of ferrous metals, in order that the heat treatment of tools and gauges might be efficiently carried out. This has proved to be of great service to all types of industry, quite apart from munitions, and active steps are being taken to develop the service. The furnace-room, where the tools and gauges made in the Laboratory's tool-room are hardened, comes under the guidance of officers of the metallurgical laboratory. Two electric salt-bath furnaces of 25 kW. capacity, 1,000° C., and a third of 50 kW. capacity, 1,400° C., are in continuous use, the former being automatically controlled by the pyrostat mentioned in (2), above. A special furnace for the nitriding of steels is to be installed.

Apart from heat-treatment work required by the Laboratory's tool-room, special work has been sent from outside firms. Usually this has consisted of high-speed steel tools requiring careful heat treatment, and in some cases the nature of the steels had to be determined before a hardening procedure could be laid down. In the latter cases samples of the steel had to be sent for analysis to the Dominion Laboratory. Some idea of the volume of work passing through the heat-treatment room can be gained from the fact that two hundred and sixty items of high-speed steel tools, dies, &c., have been successfully treated for outside firms.

The metallurgical laboratory has also been called upon to calibrate pyrometers *in situ* and at various factories throughout New Zealand. For this purpose, portable equipment is used, and this is first calibrated against standards held by the electrical laboratory. The latter standards were in turn calibrated at the National Standards Laboratory, Sydney.

For the examination of castings, finished components, &c., 250 kV. X-ray equipment is being installed.

Considerable attention has been given during the year to the question of substitute solders.

(5) The Design Section and Instrument Shop

The work of the design section is divided into two parts—viz., the design of tools and gauges and the design of instruments and equipment. The major portion of the work this year has been for the Director, Scientific Development, the Armed Services, and the Directorate of Production, and has covered a wide variety, including the following equipment constructed: Glass-grinding equipment and tools for the production of standard interchangeable ground-glass joints and taps; electric-wire-wound salt-bath furnaces for heat treatment of small metal parts; optical projectors for gauging munitions components; mechanical device to operate valves when exposed to daylight; anti-aircraft plotting equipment; aerial-mapping equipment; surface metallizing of mirrors apparatus; minute mandrels and wheels for electric lamp coil filament manufacture; recording hygrometers using bimetallic strip; refrigerator unit for testing low-temperature thermometers; lever type 0·001 in. dial gauges; pyrostats; portable field filter-pump for Army use; model to show precession of 18-pr. shell; apparatus for developing and viewing 35 mm. film strip.

In addition, the instrument workshop dealt with over two hundred and fifty instrument-repair items received from outside sources.

(6) Munitions Tool-room

The tool-room has been expanded to cope with the increasing demand for tools and gauges; since moving into the new premises the efficiency of the workshop has improved considerably, and the output is rapidly approaching the maximum to be reasonably expected from the machines and personnel employed.

GEOLOGICAL SURVEY

REPORT OF DIRECTOR (Dr. J. Henderson)

During the past year the Director, in addition to his normal duties, visited Macrae's, Clarendon, and other localities in the South Island in order to inspect mineral deposits.

Little regional mapping was carried out, field officers using most of their time in examining and mapping deposits of possible economic value. Dam-sites and rocks for concrete aggregate were reported on for the Public Works Department. Sites for bores to test underground water-supplies were selected, many of them for the military authorities, for whom also four officers made special examinations and reports on other matters. Geophysical work was carried out in several localities, some of it in connection with a proposal to utilize the "thermal heat" of the volcanic zone, and a few test bores were drilled for steam.

Regional Surveys

Mr. H. W. Wellman's mapping of D'Urville Island was the only regional work undertaken. A fair part of the island had already been mapped in connection with special examinations for serpentine tale and sulphides, and Mr. Wellman completed the work.

Coal Survey

Persistent bad weather and the absence of a geologist for some months on work for the Military Authorities retarded the survey of the Grey Coalfield. The usual assistance in the elucidation of faulting, thinning, and boring problems was given to the industry without any charge, and consumed much time. Mr. M. Gage also made a preliminary examination of a coal-bearing area in the basin of Flaxbush Creek, Inangahua Survey District.

The detailed examination of the Ohai Coalfield, required in order to assist in its prospecting, was begun in January by Dr. A. R. Lillie, assisted by Mr. R. L. McHenry.

Palæontological Work

Dr. J. Marwick visited the important Muddy Creek section in the Gisborne district and collected widely from Pliocene horizons in the Hunterville and Marton districts. He identified many shells from the Tertiary of North Westland for one of the oil companies. He also examined all the collections from the Moeraki-Hampden district and described new species from the Eocene beds of the area.

Micropalæontological Work

Dr. H. J. Finlay, assisted by Mr. N. de B. Hornibrook, identified the foraminifera from a great many samples sent in by oil companies and field officers. The more important groups of samples were from the Midhurst bore, North Westland, and the Moeraki district.

Petrological Work

Dr. C. O. Hutton, assisted by Mr. A. E. Leopard, determined rocks, minerals, dusts, fillers, and residues for several Departments, commercial firms, and private individuals. Most of the samples were used in industry or were in some way connected with it. The collection of New Zealand rocks has been classified and catalogued.

Geophysical Work

Mr. N. Modriniak geophysically examined rocks at possible dam-sites along parts of the Waikato River, using magnetic and seismic methods. He measured the seismic velocities of certain rock layers near Arapuni, and made extensive magnetic surveys at Puhipuhi, Tokaanu, and Awakeri. At Puhipuhi thermal solutions have altered and destroyed the magnetic properties of basalt and deposited ores of mercury. At the other two localities the work was undertaken to ascertain the areas of low magnetic value to aid in selecting sites for bores for steam.

Special Examinations

Phosphates.—After much delay, the prospecting of the phosphate-bearing sandstone at Clarendon was begun. The few bores drilled by the end of January showed that an area of about ⅓ acre contains a minimum of 27,000 tons of hard phosphate-bearing sandstone. The overburden in this area amounts to 8,000 cubic yards. Farther in the hill the overburden is greater, but the evidence is that there is a large amount of phosphatic rock in the margin of the deposit under relatively little cover of barren material. Messrs. E. O. Macpherson and R. W. Willett have visited and sampled the deposit on several occasions, and a report by the former will be published as soon as possible. Mr. J. Healy spent several days investigating an occurrence of phosphate reported in the Whakapirau district (Kaipara Harbour), but found nothing of value.

Serpentine.—Messrs. E. O. Macpherson and R. W. Willett visited Mossburn and examined the quarry opened at the foot of Black Ridge to supply serpentine to the southern fertilizer-works. Samples were taken and reports furnished.

Limestone.—Mr. R. W. Willett sampled and reported on deposits of limestone near St. Patrick's, south of Lumsden, and in the Waimumu district, near Gore. The latter is already quarried for use on farms.

Diatomite.—Many years ago diatomite was found in the Akaroa district, but the precise place of its occurrence was forgotten till Mr. Willett relocated it. The deposit seems to be of fair size and the material of good grade.

Mica.—Mr. Willett was several weeks at a deposit of mica now being prospected in South Westland. He was able to make a reconnaissance survey of a considerable area of little-known country.

Clay.—Mr. Willett also relocated a deposit of feldspathic clay reported many years ago in the Wyndham district. The clay bed, 4 ft. thick, is interbedded with Mesozoic strata. Mr. J. Healy is supervising the prospecting of clay deposits in the Whangarei district. The first deposit to be investigated is on the flank of Maungarei, a volcanic hill north of Kamo. This deposit yields clay for the refractory bricks made at Kamo.

Underground Water.—The problem of underground water-supplies has lately become of increasing importance. Mr. J. Healy, with conspicuous success, has selected many sites for boring on several types of terrain in the North Auckland district. Other officers have advised on boring for water in other parts of New Zealand.

Volcanic Steam.—Many people have considered the possibility of using the steam of some areas in the Rotorua-Taupo region as a source of power and heat in industry. As little is known of sub-surface conditions, any work undertaken is regarded as merely exploratory. Four bores were drilled at Tokaanu, and geological and geophysical work is now proceeding in the Bay of Plenty district.

Wairarapa Earthquakes.—Following the earthquake of the 24th June, Mr. M. Ongley and other geologists visited the Wairarapa district and examined slips, slumps, and other ground disturbances. A new fault-step was found and traced in the Tauweru Valley, east of Masterton, and as its position corresponds well with the seismological data, movement along this fault is considered to have caused the earthquake.

MAGNETIC OBSERVATORY, CHRISTCHURCH

Director: H. F. Baird

SUMMARY OF OPERATIONS FOR THE YEAR ENDED 31st MARCH, 1943

During the year the customary observational and recording programmes have been maintained. In addition, further progress has been made with the magnetic resurvey of New Zealand; the resurvey is meeting immediate needs and will also have post-war value.

Terrestrial Magnetism

The Eschenhagen, Adie, and La Cour magnetographs have been kept recording continuously at the Amberley Substation. From hourly measurements of the magnetograms and the thrice-monthly absolute observations the mean hourly values of D, H, and Z have been computed. The resulting mean values for the year 1942 are as follows:—

		Change since 1941.
Magnetic declination	18° 42′·5	+ 6′·6
Magnetic horizontal force	22,232·7γ	— 0·3γ
Magnetic vertical force	—55,207·8γ	+11·7γ
Magnetic inclination	—68° 03′·90	+ 0·2γ
N.	21,058·1γ	—13·8γ
E.	7,131·0γ	+40·1γ
T.	59,516·3γ	—11·0γ

In the above table the changes in the respective elements since 1941 are given also. The most striking feature of the table is the high value for the secular change in declination. This change has been progressively increasing since 1933, the year of the last sunspot minimum. To a lesser extent a similar increase occurred during the period 1921–30 (sunspot minimum in 1923), the rate dropping back to normal rather sharply at 1931. Large earthquakes in New Zealand occurred approximately a decade after both 1921 and 1931. This may not be mere coincidence, and will be investigated after the war.

International character figures have been derived from the magnetograms and supplied quarterly to the Carnegie Institution, Washington, and the Secretariat de l'Organisation Meteorologique Internationale, Lausanne. Similarly, "K" values, representing the three-hour range index of geomagnetic activity, have been forwarded to the International Association of Terrestrial Magnetism and Electricity at Washington.

Magnetic Resurvey

Magnetic observations have so far been made at twenty-four stations in the North Island and twenty-three in the South Island, and are being pushed on to meet exacting demands. The observational programme was arranged so that information could be obtained in areas not covered during the first year's work, and particularly where defence demands were paramount. All the stations observed now give a better coverage of the country, resulting in more reliable values for any part of New Zealand. As far as other work would allow, analysis of all field data has been pushed ahead. Preliminary results from H and I data appear to indicate that the geographical distribution of secular change in these elements is not so marked as in declination.

The Carnegie Institution have been supplied with provisional values covering the first year's work. This information has proved to be of great value to them in their work of modernizing naval magnetic charts. Numerous inquiries from Service organizations for information regarding the magnetic elements in various parts of New Zealand have been dealt with. As a result of the extensive field programme we have been able to give them accurate data, which in some areas of important defence significance were greatly different from what had been anticipated. The Carnegie Institution, who provided the instruments required, have been most grateful for valuable information being derived by their use.

General

Seismological.—A Wood-Anderson seismometer was installed on behalf of the Dominion Observatory at the Public Works power-station at Arnold River, on the West Coast. This is functioning very satisfactorily, and the records obtained therefrom are already assisting materially in the interpretation of local earthquakes.

Electric Potential Gradient.—The Bendorf electrometer has recorded continuously, and the measurement and reduction of records is well forward. Further improvements have been made to the calibrating circuit. Through the courtesy of the Director of Meteorological Services, a spare Bendorf electrometer and other atmospheric electric equipment formerly in use at the Apia Observatory was transferred to us.

Cosmic-ray Meter

Owing to the difficulty in obtaining suitable electrical supplies in New Zealand to operate this instrument, a short break occurred in the recording programme. Records have been measured and the data forwarded as regularly as possible to the Carnegie Institution of Washington.

Meteorological

The usual meteorological observations for climatological purposes have been maintained and the results forwarded monthly to the Director of Meteorological Services. Numerous inquiries from the public regarding weather statistics at Christchurch have been answered.

OBITUARY

It is greatly regretted that in the closing weeks of this year both Dr. C. C. Farr, F.R.S., who originated the magnetic survey last century, and Mr. W. T. Neill, former Surveyor-General, who was associated at its beginning with Dr. Farr, passed away. Throughout life, both remained keenly interested in the work, and shortly before their death expressed pleasure that a magnetic resurvey was being undertaken.

METEOROLOGICAL BRANCH

Consequent on the outbreak of war, the Meteorological Branch of the Department, together with the Apia Observatory, was transferred to the Air Department for the duration of the war.

The report of the Meteorological Branch during the past year is contained in the annual report of the Air Department.

IMPERIAL AGRICULTURAL BUREAUX

The Imperial Agricultural Bureaux were established to act as clearing-houses for the interchange of information between research workers in various fields of agricultural science throughout the world, but more particularly within the various countries of the British Commonwealth.

In New Zealand co-operation with the Bureaux is maintained through the Department of Scientific and Industrial Research, for which purpose there is a special liaison officer. In addition, contacts with individual Bureaux and the appropriate fields of research are maintained by official correspondents, who deal with specific inquiries.

LIAISON OFFICE, LONDON

During the year the Scientific Liaison Office in London continued to give most valuable service in maintaining liaison between Great Britain and New Zealand in research and other scientific activities. Special attention has necessarily been given to the procuring and exchange of information on the scientific aspects of defence, the processing, storage, and transport of foodstuffs under war conditions, and substitutes for essential materials now unavailable or in short supply. A wide range of inquiries on these and other matters of wartime importance has been dealt with, and the information received has greatly assisted the Department in keeping abreast of scientific developments in Great Britain and allied countries.

PUBLICATIONS

The monthly publication of the *New Zealand Journal of Science and Technology* has been continued during the year, alternate numbers being devoted to two different classes of papers. Section A of the *Journal* is composed entirely of agricultural-science articles, while Section B deals with general subjects apart from agricultural, including papers on chemistry, physics, geology, seismology, economics, and industrial technology.

RESEARCH SCHOLARSHIPS

In view of the fact that applications were not up to M.Sc. standard, no National Research Scholarships were awarded during the year.

Approximate Cost of Paper.—Preparation, not given; printing (815 copies), £72 10s.

By Authority: E. V. PAUL, Government Printer, Wellington.—1943.

Price 1s.]