1946

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(TWENTIETH ANNUAL REPORT OF THE)

Presented to both Houses of the General Assembly by Leave

CONTENTS

MINISTER'S STATEMENT

THIS year's report indicates marked developments in avenues of research appropriate to the immediate post-war needs of the Dominion. Reviews of wartime activities have revealed a number of ways in which new knowledge gained in the interest of defence has potential application in helping our peacetime requirements, particularly in the field of manufacturing industries. The Department has kept abreast of the momentous scientific developments which have occurred in so many fields of scientific endeavour overseas in the later years of the war, and is exploring the peacetime possibilities of these developments in New Zealand. In this connection, as examples of a number of developments which are receiving close attention, mention need only be made here of the use of radar to assist coastal navigation round our shores, and of antibiotics to assist in the control of plant and animal diseases.

This rapid development of scientific research overseas, and its importance to industrial development in New Zealand, necessitate the maintenance of close personal contact with laboratories and research stations in other countries. A policy has been followed, therefore, of sending young scientists abroad for varying periods so that they might gain valuable experience and, as a result, provide a reserve of trained personnel to meet the increasing demand for scientific services in all aspects of research and its practical application.

As a practical expression of the Government's desire to extend every assistance to local production, the Manufacturers' Research Committee has done valuable work in directing scientific services to many industries, and in encouraging the development of research by means of research associations.

The Ceramics Research Association came into being during the year, and its activities should ensure improvements in the manufacture of pottery and greater economic development of the Dominion's clay resources.

Realizing that closer association between scientific effort and the manufacturing industries was desirable, the Manufacturers' Research Committee promoted the establishment of co-ordinating bodies in the four metropolitan towns to facilitate fuller use being made of the services available from the Department's chemical, physical, and engineering laboratories. It has become evident that these laboratories can provide a wide range of manufacturers with really fundamental assistance such as is not at present available in New Zealand, for the volume of requests for services has been such as to necessitate overtime being worked in some branches. It is not the policy to undertake any work which can be done by existing firms, while every effort is made to encourage firms to develop facilities for servicing industry in spheres where such service cannot at present be secured. The Department's Industrial Psychology Division, functioning in close association with the Manufacturers' Research Committee, has provided assistance in personnel problems to a number of different types of factories and offices in the main centres.

The permanent services of the Department have been very actively concerned with all the outstanding problems connected with the immediate requirements of our national welfare. The Geological Survey and the Dominion Laboratory have maintained the search for and the quality examinations of our coal resources. Direct assistance through geological and geophysical investigations has been provided wherever hydro-electric power developments have been in progress. Numerous problems relating to materials required for building purposes have been referred to the Geological Survey and Dominion Laboratory during the year. The Chemical Engineering Section of the Dominion Laboratory designed and tested a new type of tobacco-curing kiln which appears to have distinct promise in efficiency of operation. This indicates a further example of the use to which the fund of information, which has been built up by the staff over a period of years while investigating various dehydration problems, can be put.

Progress in all branches dealing with primary-industry problems has been marked during the year. The Soil Bureau has prepared further maps indicating the regions where soil erosion has occurred or is threatened, and has been called upon to an increasing extent for information of the physical characters of soils required to withstand the weight and stresses of large buildings. The Plant Diseases Division has found a ready means of controlling a number of hitherto difficult bacterial diseases of fruit-trees, and has made good progress on methods of preserving timbers against insect and fungus attack. The Grasslands Division has continued the production and testing of improved pasture plants. The nutritive values of herbage and vegetable crops have been further examined by the Plant Chemistry Laboratory. The Botany Division has been actively engaged in investigations of the weed menace, of seaweed resources, and of the vegetative cover of hill-country areas. The Entomology Division has made good progress in the development of its work against grass grub, and the Agronomy Division has continued the production of improved strains of fodder crops, together with maintenance of the pure-seed supplies of a wide range of farm crops. The Wheat Research Institute's designing and testing of an improved flour-detacher has enabled New Zealand flourmillers to change to an 80 per cent. extraction and maintain flour quality in a period of very serious grain shortage. The Dairy Research Institute's work on starters, flavours, and fat examinations continues to provide valuable assistance in improving quality in all our dairy products.

With the development of the Information Section during the year it has been possible to give wider publicity to the achievements of research, in an endeavour to shorten the gap which always occurs between a discovery and its actual assimilation into practice.

D. G. SULLIVAN,
Minister in Charge of the 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 1945–46.

The Council of Scientific and Industrial Research held five meetings during the year. The personnel of the Council is as follows :—

Sir Theodore Rigg, M.A., M.Sc., F.R.I.C., F.R.S.N.Z., Director, Cawthron Institute, Nelson (Chairman).
J. C. Andrews, Ph.D., M.Sc., Fertilizer-works Manager, Auckland (Vice Chairman).
E. R. Hudson, B.Sc., B.Agr., Dip.C.A.C., Director, Canterbury Agricultural College, Lincoln.
R. O. Page, D.Sc., A.R.I.C., Tannery-works Manager, Christchurch.
J. M. Ranstead, Dip.C.A.C., Bledisloe Medallist, Farmer, Matangi.
W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D., Professor of Dairying, Massey Agricultural College, Palmerston North.
D. F. Sandys Wünsch, M.A. (Oxon.), B.Sc. (McGill), M.I.Chem.E., Assoc. Inst.M.M., Factory-manager, Edendale.
E. J. Fawcett, M.A. (Cantab.), Director-General of Agriculture, Department of Agriculture, Wellington.
J. C. Eccles, M.B., B.Sc. (Melb.), M.A., D.Phil. (Oxon.), F.R.A.C.P., F.R.S., Professor of Physiology, University of Otago, Dunedin.
E. Marsden, C.B.E., M.C., D.Sc., F.R.S.N.Z. (Secretary).
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	19,217	
Dominion Laboratory (with branches)	50,634	
Dominion Observatory	2,066	
Geological Survey	14,544	
Magnetic Observatory	4,218	
Dominion Physical Laboratory	81,806	
Auckland Industrial Development Laboratories	12,784	
		185,269
Research investigations		187,913
Grants and miscellaneous services, including Information Section and Scientific Liaison Services		42,949
		416,131
Recoveries		84,856
		331,275

Grants made to research and allied institutions in Great Britain, £6,863.

With the cessation of hostilities during the year the course of policy which was tending already in a direction which anticipated an early conclusion of the war was accelerated in order that research development might meet the complicated and difficult conditions of the immediate post-war period.

Naturally, most action was required in the physical and engineering sections of the Department, as these had been geared directly in to the war effort, assisting in the provision of munitions. Conversion to peacetime activities has not been an easy task, but in the course of the year the position has clarified to a marked extent. Fortunately,

the wartime temporary staff were eagerly sought after by their previous employers, and branches easily returned to an establishment which is now kept busy on problems arising directly from industry. War conditions have brought many industries into closer contact with the Department, and this appears to have resulted in a continued demand for services in peacetime on a scale greater than was anticipated. There appears to be no doubt but that the service which such a branch as the Dominion Physical Laboratory rendered New Zealand industry in wartime, through its gauge and tool production, and through the research and development work it undertook, could be continued in peacetime and form an essential foundation for the future welfare of our manufacturing industries. The idea has been placed on trial in Auckland, where a number of the Department's wartime activities have now been grouped into the organization known as the Auckland Industrial Development Laboratories. This branch has made good progress during the year and has already demonstrated its capacity to be of great help to local manufacturers. In none of these activities is it intended to enter into competition with local manufacturers or to do work that they can do. Careful supervision of all service rendered is regularly undertaken by a Committee to ensure that such does not occur. On the other hand, it is hoped that new activities sponsored in the Laboratories may ultimately be taken over by units of industry and serviced therefrom, leaving the Laboratories to concentrate on further research and development and to undertake only such specialized services as are essential to industry and yet unlikely to be provided in New Zealand by private firms.

The policy and organization in relation to secondary industries, of the Dominion Physical Laboratory, the Auckland Industrial Development Laboratories, and the Defence Development Section, Christchurch, which have developed along quite promising lines during the period since the cessation of hostilities, will require some time before they are generally accepted, but it is anticipated that this progress will do much to strengthen the link between research and secondary industries which in the past left much to be desired.

During the year consolidation of some of the wartime activities, working as separate units in each centre, has been brought about. The Radio Development Laboratory and other sections in Wellington have, for example, been absorbed into the Dominion Physical Laboratory, and not only in Wellington, but in other centres, there has been a grouping of the chemical, physical, and engineering activities so that the requirements of the post-war secondary industries, which generally are found to embrace all three types of assistance, can be more readily met. While the Department's policy is one of preference for research and development, leaving servicing to other organizations, it seems likely that in some directions at least it will be impossible for some time to avoid participation in servicing. Nevertheless, it is evident that, just as science is characterized by development along lines of specialization, so is it becoming increasingly necessary to bring together all these diverse activities in order to solve the practical problems of the day. It is a definite part of the Department's policy of organization to provide means whereby the whole impact of scientific progress from every angle will be brought to bear on the problems of both primary and secondary industries. In regard to secondary and manufacturing industries it is desired to make the fullest possible use of the wartime advances, staff, facilities, &c., made available to the Department to help them in their peacetime problems and their future progress.

Probably no problems are more vital to the future welfare of New Zealand than those associated with soil conservation. During the year the Soil Bureau, Grasslands Division, and Botany Division have combined in investigations which have covered areas where soil erosion is in progress or threatens. Over considerable portions of the Dominion it is now possible to measure the extent of soil fertility decrease through erosion, and to indicate measures for checking the losses. The Grasslands and Botany Divisions have carried out surveys and have initiated investigations, on hill country in both Islands, designed to conserve soil fertility. The Botany Division has continued its work of investigating the weed problems of the Dominion, some of which—*e.g.*, nassella—are constituting a very serious threat to good pastoral land. In order still

further to promote better economic use of our pastures, the Grasslands Division has continued to breed, test, and multiply improved strains of grasses and clovers. Studies of the best utilization of these by the animal, direct and through conservation, as silage or hay, are proceeding with the realization that the potentialities of our grasslands for food-production are as yet very imperfectly understood and offer good fields for further exploitation. The Agronomy Division is pursuing similar investigations in connection with arable supplementary fodder crops, both alone and in association with pastures, and for the whole range of arable crops continues to produce supplies of high-quality seeds for certification. The work of the Entomology Division, now that improved methods for control of the insect pests of brassica crops are generally established, has been focused on grass-grub, the major insect pest affecting pastures. Already this Division has devised successful means for controlling the grass caterpillar, but it is realized that grass-grub control will prove a much more difficult task. The Plant Diseases Division has dealt with a wide range of diseases affecting crops, and noteworthy success has attended methods for overcoming a group of bacterial diseases with copper sprays which hitherto had appeared ineffectual. Ready means have also been devised for the control of moulds which stain plaster walls and others which attack fabric materials. Through the regular chemical, physical, and biological testing of sprays this Division renders sound service to the fruitgrowers of the Dominion.

The amount of collaboration between various Divisions of the Department has extended markedly during the year, almost every problem attacked involving joint effort on the part of officers from various branches. Noteworthy in this respect is the work on fruit research, where the Plant Diseases Division, in addition to doing work on disease control, has produced and tested large numbers of fruit-tree stocks, and handed these over to the New Zealand Fruitgrowers' Federation for multiplication and issue as certified stocks, thereby helping provide trees of known quality for the future orchards of the Dominion. In association with the Plant Chemistry Laboratory, this Division is starting the investigation of antibiotics: in particular, their value for controlling plant and animal diseases and the exploration of the New Zealand flora for possible new useful strains of antibiotics. The problem of yellow-leaf disease of phormium is being dealt with by the Plant Diseases, Botany, and Soil Survey Divisions, and preliminary results indicate the disease as occurring on soils where other plants appear to suffer from mineral deficiency. The relation of phormium to shortages of trace elements is being followed up. The Botany Division has now amassed a great deal of valuable information on the propagation, establishment, and management of phormium plantations, while the detailed economic characters of each variety now in use have been worked out and reported on. This new information provides much that will be useful in placing the phormium industry on a sounder basis in the future.

Various branches of the Department have been conducting researches on the use and application under New Zealand conditions of many of the newer chemical materials produced abroad, such as D.D.T., Gammexane, Sinox, &c., as these substances have distinct potential value in many spheres.

Wheat research has proved singularly valuable during recent years of difficulty and scarcity. Knowledge gained over the years has enabled the bread quality to be maintained at a high nutritive level, despite grain injury through bad harvests. When scarcity of wheat demands an 80 per cent. flour-extraction, a machine devised by the Institute will render this readily possible without loss of nutritive quality in the flour. A new high protein wheat bred by the Institute has continued to show its quality in extended tests.

Tobacco research has revealed a variety which possesses good resistance to black root-rot, a disease which is appearing now in certain types of soils, while promising results are attending some trials of a new type curing-kiln which is being made in collaboration with the Chemical Engineering Section of the Dominion Laboratory.

The Dairy Research Institute is proceeding to incorporation in order to enable it to function more readily in the interests of the industry it serves. Quality and manufacturing problems continue to be in the forefront of the investigations, as it is

realized that the fullest understanding of everything that affects quality is essential to the Dominion maintaining its position in the world's dairy markets in the strong competition inevitable in the future. Fundamental studies of the influence of feed, season, starters, and manufacturing processes on the fats, proteins, and carbohydrates of butter and cheese are being pursued. In addition, the influence of nutrition of the calf and the effect of certain hormone materials on the ultimate production of the dairy cow are being closely followed.

The provision made during the year for improved staffing for the Geological Survey was shown to be necessary by the wide range of economic problems with which the Survey was called upon to deal. Surveys of coalfields, clay, and radio-active mineral areas have demanded much attention and have indicated desirable avenues for new industrial developments. The unusual and prolonged eruption of Mount Ruapehu gave opportunity for geophysical investigations of volcanic activity. The new Volcanological Station which was opened at Rotorua during the year is already being asked to deal with many practical problems affecting the thermal regions. Its establishment will be particularly valuable for the opportunity it will provide for thorough study of the unique characteristics of this region, which must be understood before practical issues can be satisfactorily solved.

Research on building problems has made progress during the year, the qualities of pumice for concrete-manufacture being under study at the Auckland University College, and protection of timber against insect and fungus attack being dealt with at the Plant Diseases Division. The Dominion Laboratory has entered upon an extensive research programme dealing with the painting of certain classes of New-Zealand-grown timber which have proved difficult for satisfactory paint treatment.

In leather research attention has been focused upon work intended to improve the wearing-quality of sole leather, and a good deal of new light has been thrown on the relative importance of the factors existing in the original hide and those in its processing into leather, in so far as they influence the quality of the finished article.

The Woollen Mills' Research Association has had a successful first year since incorporation and has made good progress in thoroughly testing out on a mill scale the new wool anti-shrink process which was recently introduced to New Zealand from Torridon.

It is impossible to give briefly an indication of the results attending the many research projects being dealt with by the various branches of the Department. In an endeavour to make all new knowledge available to the widest number, the Information Section has continued to issue journals, bulletins, popular articles, and newspaper statements. These appear to be serving a good purpose judging by the number of inquiries which have been received for fuller information. It is the policy of the Department to issue its publications as rapidly as possible in order that the minimum of delay may occur in putting new knowledge into operation.

It has been the Department's policy to encourage development of research at all the University Colleges and at Cawthron Institute along lines appropriate to these institutions. It is pleasing to report that practical co-operation between the Department, the University Colleges, Cawthron Institute, and other State Departments has increased during the year. The ever-present shortage of suitably qualified personnel to undertake research work is being felt very much at present, and the resumption of the award of National Research Scholarships of higher value should provide a means for overcoming this difficulty.

During the war 172 members of the staff of the Department served in the Armed Forces. Of these, 142 have resumed duty, whilst 9 members are on leave without pay, chiefly for the purposes of furthering their education. Thirteen members are still in the Services and 8 have joined the J Force.

I have pleasure in acknowledging the loyalty, the zeal, and the high standard of achievement attained by the staff of the Department during the year.

E. MARSDEN,
Secretary.

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

BUILDING RESEARCH

Building Research Committee.—Mr. G. F. Wilson (Chairman), Mr. G. W. Albertson, Dr. J. C. Andrews, Mr. B. C. Ashwin, Mr. L. E. Brooker, Mr. R. A. Campbell, Mr. A. R. Entrican, Mr. F. W. Furkert, Mr. A. R. Galbraith, Professor C. R. Knight, Mr. L. J. McDonald, Dr. E. Marsden, Mr. J. Mawson, Mr. R. A. Patterson, Mr. C. W. O. Turner, Mr. F. J. A. Brogan (Secretary).

Research work under the direction of the Committee has continued along the lines of the previous annual report. No new projects have been commenced, but the Committee has during the year given consideration to what are the problems, the solutions of which are likely to yield results of immediate value to the building industry in New Zealand. It has not been possible to take any definite steps pending the appointment of a nucleus research staff, which should consist of a director, an architect, an engineer, and a chemist. When such appointments have been made it is hoped that the Department will be in a position to carry out a survey of the building industry and thus obtain detailed information on the problems which are at present facing the architects, engineers, and others who are intimately connected with it.

The following is a report of the work carried out on building problems during the year in various branches of the Department :

Plant Diseases Division, Plant Research Bureau

I. *Testing Toxicity of Preservatives*

(*a*) *Biological Evaluation of Toxicity.*—Two techniques have been developed for testing toxicity to *Anobium punctatum* of preservative chemicals. One, giving a quick measure of relative toxicity, involves transfer of part-grown larvæ to treated test blocks, which are cut open and recorded after four months. The second gives a measure of actual toxicity. Test blocks are exposed to large numbers of beetles, so that mass loadings are secured of newly-hatched larvæ. Results are recorded at the end of eighteen months.

(*b*) *Toxicity Studies of Thin Layers.*—Previous work has shown that part-grown larvæ are able to bore through considerable depths of wood treated with toxic materials, since they appear to possess the ability to select wood for ingesting. A series of experiments has been laid down to ascertain if newly-hatched larvæ are also able to do this, and to determine the protective value of thin layers of therapeutants such as are deposited by cold dipping processes.

(*c*) *Contact Poisons for House Treatments.* Work has been commenced on residual contact effects of therapeutants to *Anobium* beetles, the purpose being to ascertain if timbers of dwellings can be protected by application to the exterior of various therapeutants. Materials used will be those effectual as contact poisons four years after application, by which time all larvæ present at the time of treatment will have emerged as adults.

(*d*) *Mass Breeding of Testing Material.*—Quantities of beetles have been placed in cages to provide for mass breeding of larvæ and beetles required for test purposes. It is anticipated that sufficient numbers will have been bred in the laboratory for testing work during 1947–48 season, thus saving the labour and expense of collecting annually from infested timber derived from buildings.

II. *Biological Studies of* Anobium

Investigations have been completed on the anatomy, histology, and pH of the gut of *Anobium* larvæ. The studies made on growth-rate and frass-production of larvæ have provided information of particular value in developing biological methods of evaluating toxicities of therapeutants.

III. *Absorption Investigations*

An experimental pressure plant has been set up and is operating successfully. By its aid a method has been developed for evaluating absorption and distribution of preservative solutions in various timbers and woods of various densities and moisture content secured by use of several pressure systems. Pressure systems are being compared by the ratio of measured absorption to calculated absorption based on void volume. Those which give maximum penetration, good distribution, and low net retention of preservatives are being selected as most suitable for treating timber. Associated with this work is an investigation into absorption of ions on to wood, being carried out in collaboration with the Dominion Laboratory.

Dominion Laboratory

During the year the Laboratory has carried out chemical analyses and investigations required by the Committee. A Chemist has been appointed at the Government Laboratories, Auckland, to undertake the chemical work in connection with the investigations being carried out at the Plant Diseases Division.

Work has also been continued on the testing of paint materials, and a start has been made on the erection of test fences throughout the Dominion (see Dominion Laboratory Report, p. 77).

Dominion Physical Laboratory

Heat Insulation of Houses.—The thermal transmittance values of walls, ceilings, and floors of several State houses have been measured by a modified "guarded hot-box" method, and comparisons have been made between different types of constructions—*e.g.*, brick versus asbestos, cement sheet versus timber weatherboard, and ventilated versus nonventilated wall cavities and floor spaces. A report has been published giving some interesting data. Further work is at present being undertaken on a recently completed house with walls built of no-fines concrete.

Mould in Houses.—This project is nearing completion. Following a series of measurements of atmospheric conditions—temperatures and relative humidities—inside and outside of the houses and in the wall cavities, work has been completed on the calibration of the thermocouples and recorders used. A report is being drawn up on the measurements made.

Relating to this project, a technique has been developed for measuring the rate of ventilation of rooms, and a series of measurements is being made in several of the houses used in the above investigation.

Auckland University College: Building Research Panel

Light-weight Concrete Investigation.—The scope of this investigation so far has been limited primarily to studying the properties of concrete in which pumice has been used as the lightweight aggregate.

Pumice Concrete.—A number of experimental mixes have been prepared under laboratory conditions and a close study made of their physical properties—viz., moisture movement, drying shrinkage, moisture-absorption, permeability, density, crushing-strength, resistance to weathering, modulus of elasticity, &c. For the present, the investigation has been confined to studying the characteristics of concrete made with pumice from the Rotorua district, where extensive deposits of suitable pumice are known to exist.

As the chief drawback to a more general use of pumice concrete lies in its excessively large moisture movement, more emphasis has been placed on determining ways and means of overcoming this characteristic detrimental property. So far the tests have shown that it is possible to reduce the moisture movement to a certain extent by grading of the pumice aggregate, but not sufficiently to make it comply with the British Standard Specification for precast concrete blocks for walls. It is anticipated that with the provision of a temperature and humidity controlled mixing and curing room it will be possible to make recommendations as to the exact possibilities and limitations of pumice concrete as a permanent building material.

Precast Concrete Floor Units.—During 1944 and 1945 three types of precast concrete-floor construction have been subjected to a laboratory loading test, and all three methods of construction complied with the strength requirements as laid down by the New Zealand Standards Institute Code for domestic buildings. The results of these tests have been compiled into a report for publication.

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

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

Acoustic Testing of State Houses and Flats.—Tests were made on the sound insulation properties of various methods of construction used by the Housing Construction Department. The results of these tests indicate that in certain cases the sound insulation properties do not comply with those as recommended by the Department of Scientific and Industrial Research Building Research Establishment, England. A study has been made of these results with a view to making recommendations for improvements.

The equipment used for this testing required to be designed especially for the purpose and was readily adaptable for the testing of many types of building construction.

DAIRY RESEARCH INSTITUTE (N.Z.)

Dairy Research Management Committee.—Mr. A. Linton (Chairman); Sir Theodore Rigg; Messrs. T. C. Brash, R. A. Candy, G. A. Duncan, H. E. Johnson, A. J. Murdoch, W. Linton, W. E. Scott, G. M. Valentine; Dr. E. Marsden (Secretary); Professor W. Riddet (Director).

The Committee met at approximately two-monthly intervals during the year to review work in progress and projected. At each meeting the officers in charge of Departments discussed their work with members.

Particular attention has been devoted not only to problems experienced by the dairy industry, but also to problems that may arise from post-war conditions. In the prosecution of this, the Institute has had the ready co-operation of the Dairy Division of the Department of Agriculture, and it is especially indebted to the Division's Grading Officers at Wellington and Auckland for giving detailed opinions on the quality of both fresh and stored produce. It is also greatly indebted to the Division's United Kingdom officers for detailed reports on cheese exported.

A brief account is given herewith of projects undertaken during the year. A summary is also given of papers published during the year that relate to work completed in previous years and that could not be published earlier because of war conditions:—

Land-cress Taint in Cream and Butter.—It has been confirmed that cream from cows that have consumed land-cress, if added in the raw state to pasteurized cream, does not cause land-cress taint in this butter. This is, however, more of theoretical than of practical interest, since the addition of raw cream to pasteurized cream for buttermaking is not legal, as it defeats one of the main principles of pasteurization—viz., the destruction of pathogenic organisms in the cream—and it lowers the keeping-quality of the butter. Reports from a commercial factory that "cressy" cream can be treated at 180° F. in two vacreators in succession (instead of the more usual single treatment at 200° F.) without bringing up the cress taint have been checked by laboratory scale experiments, and by buttermaking trials at the Institute factory. The reports of the commercial factory have been confirmed, but it has been found that there is a critical temperature range at 170–185° F., and the actual effect of heating is dependent both on the time and the temperature of heating of the cream. An investigation is being made of the effect of the treatment of cream, at lower pasteurization temperatures, on the efficiency of pasteurization, and on the keeping-quality of the butter.

Moisture-control and Buttermaking.—The system in common use for calculation of the amount of water to be added to a churning of butter for adjustment of the moisture content during the process of manufacture has been found to be in error. The correct basis of calculation has been shown to be:—

$$\text{Weight of water to be added} = \frac{\text{desired moisture content} - \text{actual moisture content}}{100 - \text{actual moisture content}} \times \text{expected yield of butter from churn}$$

A chart based on this formula has been made available to a number of factories for trial purposes, and has been found to give correct results under ordinary factory-operating conditions. A report showing the derivation of the formula, and a full-sized chart have been forwarded for publication.

Parchment for the Wrapping of Butter.—The examination of some shipments of parchment, which were received from a new source of supply during the war and which proved unsuitable for the wrapping of butter, has indicated that additional information is needed on the properties required in a good parchment. The subject is of some importance to the formulation of a standard specification for parchment for the wrapping of butter, and is at present being studied in some detail.

Utilization of Buttermilk.—Information supplied by butter-factory companies on methods of utilization of buttermilk during the four dairying seasons 1940 to 1944 has been analysed. The average returns for disposal of the buttermilk from all the factories was 2s. 10·4d. per ton of butter manufactured. About 10 per cent. of the factories reporting utilized the buttermilk on factory-owned pig-farms, and the average return for buttermilk so utilized was 5s. per ton of butter. The four years under review were years of high prices for pig-meat, and of an assured market for all pig-meat produced. The returns are not commensurate with the food value of the buttermilk produced, which, when obtained from sweet cream, is suitable for use as human food. A study has been made of the information available on the methods of utilization of buttermilk. A small amount could possibly be used directly in cities for human consumption, or by bakeries. The most likely outlet is the drying of the buttermilk by the roller process. Buttermilk-powder contains about 10 per cent. of butterfat, and it is of more value for some purposes than skim-milk powder. The possible extent of the local market is explored in the report on the subject which has been forwarded for publication.

Vitamin A Potency of Butter.—A survey of the vitamin A potency of New Zealand butter is now being made on samples obtained at fortnightly intervals from twenty factories located in representative districts. It is too early yet to report on the results in detail, but it is of interest to note that the potency remained at a high level even in those districts where the drought conditions were prolonged and severe.

Temperature of Freezing-room Storage of Butter.—It has been shown that a slight improvement in keeping-quality of butter is obtained by storage at — 5° F. instead of the usual 14° F., but the difference was so small that any consideration of change to a lower temperature of storage would not seem to be warranted. The results indicate the importance of close attention to the conditions of storage in the pre-freezing period of holding at the factory and transport to the grading store. A report on the subject has been published.

Use of Parchfoil and Pliofilm for the Wrapping of Butter packed in Pinus radiata *Boxes.*—In view of the shortage of white-pine timber and the large prospective supplies of *Pinus radiata* timber in New Zealand, an investigation was made of the protective effect of parchfoil and Pliofilm for butter wrapped in *Pinus radiata* boxes. When butter was wrapped in the usual double thickness of parchment and packed in *Pinus radiata* boxes, a strong timber taint was evident in the butter within ten days. Parchfoil prevented development of both primrose colour on the surface and of timber taint in the butter, except at joins in the parchfoil wrapping. Sealing of butter in an envelope made from the rubber-base wrapper Pliofilm prevented development of primrose colour over a storage period of two years, but timber taint appeared on the surface after six

months, and was very strong after two years. Treatment of the *Pinus radiata* with Pliowax before assembly of the box did not prevent timber taint when parchment wrappers were used, but limited it to negligible proportions when a Pliofilm wrap was used with the treated box. Tensilized Pliofilm was not satisfactory with the untreated box with or without parchment.

Estimation of Iron and Copper Content of Butter and Butterfat.—The work on production of dry butterfat during the war years led to an examination of the methods of estimation of copper and iron in butter and in dry butterfat. A report detailing some improvements in the methods, and their adoption for routine analysis, has been forwarded for publication.

Wrapping of Cheese in Pliofilm.—Trials have been made of a method developed in the United States for the wrapping of matured cheese in Pliofilm. The method, if successful commercially, would make it possible to market wrapped 8 oz. or 1 lb. portions of matured cheese in the same manner as processed cheese. The results so far obtained indicate that the holding of the cheese in Pliofilm has a similar effect to the storage in cans. The packages did not encourage any appreciable growth of mould. It is not yet possible to report on the commercial prospects of the method.

Cheese-mite Control.—Further large-scale trials of the use of dichloroethyl ether for control of mites in cheese-curing rooms have been carried out. The curing-room in one factory was treated by brushing dichloroethyl ether onto the shelves. A complete kill of the heavy infestation of mites was obtained, and the room remained free from mites for eight months. Other experiments were made on the application of dichloroethyl ether as vapour, and also on the use of scale-boards treated with dichloroethyl ether for placing under the cheeses. These methods were less effective than application of the liquid to cheese shelving, but may be useful in certain cases. A paper giving a full account of the experiments is in the press.

Payment for Milk for Cheesemaking.—The "costed cheese" system of payment for milk for cheesemaking has been in use at the Tamaki Co-operative Dairy Co., Te Rehunga, for seven years. The system, which was developed at the Institute after an extensive investigation into the relationship of composition of milk to yield of cheese in commercial factories, makes allowance for the higher casein/fat ratio in low-testing milk and for the higher costs of manufacture of cheese from this milk. It had already been shown that these two factors tend to balance each other and that the errors of the straight butterfat system of payment were not so great as had been supposed. An analysis of the working of the system at the Tamaki Co-operative Dairy Co. over the years 1942 to 1944 showed that the total amount requiring redistribution each year on the costed-cheese system as compared with the straight butterfat system was £300 to £360, out of a total annual pay-out of £30,000 to £35,000. The overpayments and underpayments were appreciable only for a few suppliers. Following a study of the Institute's analysis of the system in operation at their factory the Tamaki Co-operative Dairy Co. has decided to revert to payment on straight butterfat for the 1946–47 season. A report on the subject has been forwarded for publication.

Use of Transparent Wrapping-materials for Packing Skim-milk Powder.—The suitability of materials such as Pliofilm, cellophane, and waxed paper for packing small quantities (2 oz.) of skim-milk powder has been investigated. Waxed paper was found to be useless, while the storage life of the powder in "moisture-proof heat-sealing cellophane" was also short. Pliofilm and wax-coated cellophane were equally good, and samples of skim-milk powder enclosed in sealed bags of these materials remained in good condition for six to nine months when stored at a temperature below 15° C. (60° F.) with relative humidity up to 85 per cent. At higher temperatures, however, even where the relative humidity was kept at 50–55 per cent., transfer of moisture through the wrapping-material was much more rapid, and at 30° C. (86° F.) the skim-milk powder did not remain in good condition for more than four weeks. Beyond this period there was a large increase in moisture content, decrease in solubility, and deterioration of flavour.

Mastitis Investigation.—The final reports of the work on effect of mastitis as indicated by the Hume modification of the bromthymol blue test on the composition and cheesemaking properties of the milk have now been forwarded for publication. Several reports on the work have already been published, but the preparation of the remainder was interrupted by war emergency work. A description has been given of the milking-machine bucket and claw devised at the Institute for the collection of complete deliveries of milk from individual quarters of the cow's udder. These devices have since been widely used by the New Zealand Dairy Board in an investigation of the yield of milk from quarters affected by mastitis.

The composition of milk from quarters affected by mastitis as compared with the composition of milk from a healthy quarter of the same udder has been studied both at Palmerston North and at Hawera. The changes in composition were similar to those reported by other workers—viz., a lower acidity, a lower chlorine content, a lower solids-not-fat content, a lower lactose content, a lower casein content, and higher total nitrogen content, and a softer curd in the milk from the positive quarter. The yield of milk from the positive quarter was on average 28 per cent. lower than the yield from the corresponding negative quarter.

Provided that the milk was pasteurized before use, bromthymol blue positive milk of normal appearance included in milk for cheesemaking had little effect on the quality of the cheese made from the milk in proportions up to 25 per cent. Use of the milk in the raw state caused the development of inferior flavours in the cheese. Even when the milk was pasteurized there was an effect on the rennet coagulation and in the appearance and moisture-binding properties of the curd during cheese-manufacture. The cheese milk containing 10 per cent. positive milk gave a softer coagulation with rennet and a paler curd. Inclusion of milk abnormal in appearance in milk for cheesemaking caused the production of inferior cheese.

Dairy-factory Drainage.—A final report on the investigation of the effect of dairy-factory drainage on the quality of the waters in some Taranaki streams has now been prepared for publication. When the dilution was at the rate of 1 in 4,000, all trace of the drainage had disappeared within 400 yards of the factory outfall. When the dilution was only 1 in 100, the effect of the drainage was evident at two miles, and did not disappear completely until approximately three and a half miles below the outfall. The general conclusion was that with reasonable dilution the discharge of dairy-factory drainage into a well-oxygenated stream has only a temporary effect on the quality of the water.

Standards for the Dairy Industry.—The Institute has taken a leading part in the work of the Dairy Products and Requisites Committee of the New Zealand Standards Institute in the preparation of standard specifications for the dairy industry.

Starters for Cheese-manufacture.—Six unrelated single-strain cheese cultures are now used very widely in cheese-factories. The commercial demand for starters in New Zealand is satisfied to a large extent by the Institute Laboratory. A significant proportion of our efforts is devoted to maintenance of these cultures in a state of maximum activity by a regular replating procedure and to a search for other unrelated cultures. A strain which was obtained from England about a year ago has so far not been attacked by a bacteriophage in New Zealand. This suggested that strains unrelated to our present collection are more likely to be obtained from abroad rather than isolated from local material.

The various devices designed by dairy instructors, factory-managers, and commercial firms to protect starters from air-borne infection are being kept under observation in commercial factories as opportunity offers. Most of them desire to avoid the expenses of a special isolated starter building by making it possible to prepare the bulk starter within the factory. Large cotton-wool-filled filters fitted to sealed starter-cans are the simplest of the protective devices and seem to be remarkably effective, so much so that it is actually possible to prepare bulk starter successfully in the factory provided that starters are used on the rotational system. The isolated starter building is still, however, most effective and convenient because it enables the whole operation of starter preparation to be carried out under ideal conditions.

The rotational system under which the starter used is changed from day to day is still proving successful in commercial practice in obviating failures due to phage present in the milk-supplies.

It has been found that sometimes a phage can exist in streptoccal culture in symbiosis with the bacterium and that where this happens the streptococcus is protected from the action of contaminant phages by the presence of the symbiotic phage. The discovery of this important principle opens up a new possibility in the protection of starter cultures from air-borne infection, but it is too early to say whether practical use can be made of the phenomenon.

Investigation on Cheese-factories in the Hauraki Plains District.—For the whole of the past dairying season an officer of the Institute staff has been stationed in the Hauraki Plains district and has maintained constant touch with six factories within a small radius. The principal object of investigation was to determine whether there was any special problem peculiar to the district in connection with starter management. It has been suggested in the past that starters were more liable to failure in the South Auckland district than in other cheese-producing areas. Experience this season has shown that there is no special starter problem in the Hauraki Plains district. Provided that starter cultures are handled correctly and given adequate protection from airborne contamination, they are just as readily maintained there as elsewhere.

Contrary to experience in other districts, however, stabilization of starter cultures did not lead to an immediate improvement in cheese-quality. In collaboration with Cheese Instructors of the Dairy Division of the Department of Agriculture, some attention was given to this problem. Unfortunately, the latter part of the season was a drought period, and the resulting abnormality of the milk made progress impossible. Two factors which may have a bearing are milk-quality which was poor in some factories, and system of manufacture of the cheese. There are indications that a system of manufacture rather different from that most successfully used in other districts may be necessary in the South Auckland district. These lines will need to be followed up next season.

Standardized Cheese.—Further comparisons this season of whole milk cheese and standardized cheese made from similar milk have confirmed previous findings that there is no technical reason why the quality of cheese containing 52 per cent. of fat in the dry matter should not be quite as high as that of whole milk cheese. As has been previously reported, it is necessary, of course to modify slightly the system of manufacture when standardized milk is being used because the cheese curd tends to lose its moisture more readily than does the corresponding whole-milk curd.

Effect of Hydraulic Pressing of Cheese on Openness.—During the past two seasons experiments on cheese-pressing have been carried out in commercial factories in collaboration with the Dairy Division, Department of Agriculture. Similar cheeses pressed in hand-screw presses and in constant pressure hydraulic presses were compared at fourteen days and three or four months for openness in texture. The results showed quite clearly that constant pressure at 150 lb. per square inch overnight practically eliminates mechanical openness in normal, well-made cheese. The type of press used has, of course, no influence on slit openness, which may develop after the cheese has been pressed.

Cleaning of Milking-machines.—The experiments described in the last annual report have been repeated this season with modifications. The results indicate that it is possible to clean a milking-machine satisfactorily and to produce high-quality milk regularly without the use of boiling water. The essential features of the cleaning process used this season were—

(*a*) Immersion of the teat-cups and rubber milk-tubes in 0·5 per cent. caustic-soda solution between milkings :

(*b*) Cleaning of the overhead milk-pipe and releaser by a water rinse, a treatment with detergent solution at 150° F. and a final water rinse :

(*c*) A rinse of the whole assembled machine immediately before use with a solution containing 400 parts per million of available chlorine.

Last year the hypochlorite rinse was used after as well as before milking. The objectionable scale which formed in the pipes after some months last season appears to have been due to the after-milking rinse, since this season there was very little scale. It should be emphasized that these trials were carried out under optimum conditions in the Massey College milking-shed. Without further trials on ordinary farms it is not possible to determine whether in the hands of the farmer the method described would have the same margin of safety as the normal "boiling water-caustic soda" method.

Phosphatase Test.—From time to time difficulty has been experienced with gradual decomposition of the phenyl-phosphate buffer used in the phosphatase test. Solutions more than a few days old gave positive blanks in the test, due presumably to the presence of free phenol. It was found that the water used for making up the buffer substrate was the critical factor. Even distilled water from some water-supplies was not satisfactory. Attempts are still being made to clarify the position by defining the necessary characteristics of the water to be used.

Biological Assay of Vitamins.—Assistance has been given to the Plant Chemistry Laboratory on the bacteriological side of the assay of vitamins of the B complex.

Dairy Cow Nutrition.—Characteristic of New Zealand dairying is the fact that, on the predominately grassland dairy-farms of the country, cows are subject to marked changes in the amounts of available food. For a number of years the effects of variation on the levels of feeding at various times in a cow's working lifetime have been studied at the Institute.

In continuation of this broad investigation of the effect of various levels of feeding on the health and production of dairy cattle and on the manufacturing qualities of the milk, the experimental herd is being used, starting from the 1945–46 season, for the study of the effects of high and low levels of winter feeding. The herd of fifty-six animals was divided into two similar groups of dry animals at the end of May, 1945. From this time until calving the cows in one group (high plane) were fed as well as possible on winter pasture, hay, and large quantities of silage, whilst the other group (low plane) received very little pasture, plus a small quantity of hay. After calving, all cows were fed similarly and as well as possible for the whole of the following lactation period. The trial was thus designed to determine the influence of plane of nutrition during the last two–three months of pregnancy on the subsequent performance of the animals.

The difference in feeding levels prior to calving was responsible for a marked difference in the condition of the two groups of calving. Over the average pre-calving period of eighty-one days, the low-plane group lost an average of 81 lb. body-weight, while the high-plane cows gained an average of 47 lb. Despite this wide difference in the condition of the dams, there was no significant difference in the birth-weights of the calves of each group, nor in the early growth of the two groups of young animals. The length of pregnancy was not affected. Any difference in the health of the two groups favoured the high plane animals in that more cases of ketosis and retention of afterbirth occurred in the low-plane group. There was no apparent difference in the incidence of mastitis, milk-fever, or grass staggers. The season's data on the production and composition of milk are not yet complete.

At intervals through the season the milk from the two groups of cows has been kept separate on several days and made into cheese to see whether any differences in behaviour in the vat were detectable. No difference was observed until March (about seven months after the difference in feeding treatment ceased), when, during a prolonged dry period the milk from the low-plane cows gave a softer rennet curd which was more difficult to bring to the desired state of firmness in the cheesemaking process. The difference in the final cheese was, however, only slight.

The properties of the butterfats from the two groups of cows showed some slight differences, but further work is required before these differences can be definitely related to the feeding conditions of the animals. The vitamin A potency of the butterfats also showed slight and persistent differences throughout the year. This experiment will be continued during the season 1946–47. Those cows remaining in the herd will be retained in their respective groups from season to season for the duration of the trial.

Dairy Calf Nutrition.—In the past year a study was made of the growth development and health of dairy calves reared on two different levels of skim-milk. The object of the work was to determine a satisfactory and economical level of skim-milk feeding for calves given whole milk for three to four weeks, and then skim-milk and good pasture only until weaning. In previous years Jersey calves had been raised satisfactorily without meal when skim-milk was fed daily on the basis either of 12 or 15 per cent. of the live-weight with maximum amounts of 2 gallons. The two levels contrasted in the 1945–46 season were 15 and 10 per cent. with maximum daily amounts of 3 and 2 gallons respectively. The results showed that under the conditions of the exepriment—*i.e.*, where the young animals were well managed and rotationally grazed over good pastures—feeding skim-milk on the basis of 10 per cent. of live-weight daily with a maximum of 2 gallons for Jersey calves resulted in the production of fine, healthy animals which were in no way inferior to those which had received the higher level of skim-milk. The data which has been accumulated in the study of dairy cattle growth at the Dairy Research Institute enables a feeding schedule based on live-weight to be readily converted into one, which may be of more practical application, based on age.

Hormone Studies.—The influence of thyroid-potent iodinated casein on the dairy cow is receiving further study. In particular the effect on the cow's own thyroid of feeding this material is being observed. Making use of cheesemaking equipment, another large batch of thyroprotein has been prepared in order that supplies of this material may be available as required for experimental work.

It has been shown that the thyroid hormone may influence the yield and fat content of milk. However, little is known about its effect on the non-fatty solids in milk. As thyroid activity tends to be relatively low during hot weather, and it is under these conditions that the solids-not-fat content of milk is frequently depressed, a study is being made of the variation in non-fatty solids of milk with experimentally produced differences in thyroid activity. High thyroid activity is being stimulated by feeding thyroprotein to milking cattle, and low glandular activity by the administration of thiourea which blocks the formation of the thyroid hormone.

Miscellaneous.—(*a*) *Dairy Cattle Growth :* In continuation of a long-term study, the growth-rates of young Jersey and Friesian stock and the variation in body-weight of mature cows of the same two breeds have been followed and recorded during the 1945–46 season.

(*b*) *Mastitis :* As clinical cases of mastitis occurred in the Massey College dairy herds they were treated by irrigating the affected quarter with anti-biotic solution. This treatment was most successful in cases of streptococcal mastitis, but only partially effective where the infection was staphylococcal. In order to determine the penetration of solutions used in this way in the treatment of mastitis, udders from cows slaughtered soon after irrigation are being examined.

Pasteurization and Bottling of Milk.—The Institute has continued on behalf of the Department of Health to pasteurize and bottle milk supplied to schools in the Manawatu district.

Dissemination of Results of Work.—The annual meeting of dairy-factory managers and first assistants was held at the Institute on 8th, 9th, and 10th May. This was attended by about a hundred representatives from all parts of the Dominion. Addresses were given by the principal research workers on work completed and in progress. Discussions arising from these were most useful to both those engaged in the manufacture of dairy products and the research workers.

As indicated in last year's annual report, the Institute during the year started the publication of a bulletin to keep those engaged in the manufacture of dairy products in touch with new developments originating both in New Zealand and overseas. This has been named the *Dairy Research Institute (N.Z.) News Circular*, and is being issued quarterly. Two issues already published have been well received.

FOOD RESEARCH

Advisory Committee on Food Composition.—Mr. F. R. Callaghan (Chairman); Drs. Muriel Bell, Elizabeth Gregory, C. R. Barnicoat, B. W. Doak, F. H. McDowall; Messrs. R. L. Andrew, R. A. Calder, E. W. Hullett, and L. W. Tiller (Secretary).

With the end of the war the Food Preservation and Transport Advisory Committee terminated its activities, but in view of the world-wide significance now attached to food and nutrition it was felt essential that attention should be given to the position as affecting New Zealand. A basic requirement in dealing with food and nutrition problems on a world-wide scale is a detailed knowledge of the composition of the foodstuffs produced and consumed in each country. This is recognized by the Food and Agriculture Organization of the United Nations (F.A.O.), and New Zealand as a signatory to the constitution of the F.A.O. will be expected to undertake the analysis of its principal foodstuffs.

Research on food for human consumption in New Zealand is conducted in several widely distributed laboratories—*e.g.*, Wheat Research Institute, Dominion Laboratory, Plant Chemistry Laboratory, Otago Medical School—and the best approach was felt to be to co-ordinate the activities of the various bodies by means of a Committee on which each was represented. The Committee has met and has decided on the broad allocation of the various fields of research that will have to be covered. It is found that fairly complete information is already in existence on the composition of main classes of dairy-produce, and the Dairy Research Institute is undertaking its compilation.

From time to time, general food problems connected with canning, dehydration, and other forms of processing and preservation are referred to the Department and are dealt with by the appropriate officers. It is worth recording that faulty fabrication or closing of tinplate food-cans has been found responsible for several failures that have been investigated.

FRUIT COLD STORAGE RESEARCH

Refrigerated Gas Storage of Apples

Jonathan.—Work on this variety was completed in the previous season with a further successful demonstration on a 500-case scale. The results can now be confidently translated into commercial practice.

Sturmer.—The studies on this variety were again on the comparatively small experimental scale and were essentially a repetition of last year's work. The same temperatures and gas mixtures were used as in 1944, with the object of verifying the previous good results.

Considerably more breakdown and core-flush developed than in the previous year, especially at the temperatures 38° F. and 39° F. No superficial scald developed during the current year. Wilt was rather more widespread over the samples, but could not be considered commercially significant. No appreciable amounts of any disorder appeared before December, and all gas-stored samples were considerably better than the corresponding air-stored controls.

Two gas mixtures of the sub-normal oxygen type have been selected for trial under semi-commercial conditions. They are 7·5 per cent. carbon dioxide with 7·5 per cent. oxygen, and 5 per cent. carbon dioxide with 5 per cent. oxygen, both at 39° F.

Superficial Scald on Granny Smith Apples

Samples of fruit from five orchards reported as consistently producing Granny Smith apples particularly liable to superficial scald were wrapped in oiled paper immediately after picking, subjected to seven variants of pre-storage treatment, and then stored at a temperature of 32° F. The pre-storage treatments consisted of immediate storage after picking and storage after the fruit had been held from one to six weeks at air temperature. No superficial scald appeared in any sample in storage until mid-January—that is, until long after the fruit had passed its optimum storage period. When removed from storage and held at air temperature for seven days, however, practically 100 per cent. of all samples developed scald by November.

The amount and intensity of scald developing in storage in mid-January varied on similarly treated samples from different orchards, so no definite conclusion could be drawn as to the value of any particular period of delay for even the partial control of this disease.

The usual commercial practice in the harvesting of the Granny Smith is to pick and leave the fruit from fourteen to twenty-one days before packing in oiled wraps and despatching to cool store. The experimental samples, as noted above, were picked and packed the same day. In experiments conducted over the preceding three years it has consistently been observed that when the variety has been wrapped in oiled paper within a few hours of picking it has been free from scald in storage, and it seems clear that the common occurrence of scald in commercially stored fruit is due to failure to adopt this practice. It has therefore been recommended to the Marketing authorities that wrapping in oiled paper immediately after picking should be adopted commercially for the Granny Smith variety, even if storage is delayed.

By November, considerable damage was caused in storage by breakdown and core-flush. Although the greatest control of these diseases was obtained by delaying the storage of the fruit for six weeks, this cannot be considered a practical method of control. The long period of delay increased fungus and pit, though damage from the latter was slight, and the fruit itself had become so yellow as to be completely unmarketable. Granny Smith apples begin to turn yellow after fourteen days' delayed-storage treatment, but no appreciable control of either breakdown or core-flush is obtained by this short period of delay.

As a result of experiments carried out over the last four years, it is concluded that no advantage can be derived from the delayed storage of Granny Smith.

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

Further samples of the Granny Smith variety, from both Hawke's Bay and Nelson, were stored this season to ascertain the effect of rootstock and intermediate variety on the incidence of core-flush in cold storage. All samples from Nelson developed more core-flush than in 1944, although taken from the same orchards as in that season. In the Hawke's Bay samples the amounts were practically the same for the two years.

Striking differences in the influence of rootstock and intermediate had been found in 1944, and the season under review provided full confirmation of the previous results. Two features were the severity of core-flush in fruit from trees worked directly on to Northern Spy rootstock, and the great measure of control in fruit from trees worked with Reinette du Canada as an intermediate. All other rootstocks and intermediates produced amounts of core-flush varying between these two extremes. Delicious and Dunn's Favourite as intermediates again gave very high amounts of core-flush. It was unfortunate that fruit from trees on Malling Nos. XII and XVI rootstocks could not be obtained this year, as both these stocks produced fruit almost free from the trouble in 1944.

No definite conclusions can be drawn as to which varieties should be avoided when reworking trees to the Granny Smith variety, but it would appear that, as regards core-flush at least, Northern Spy is an unsuitable rootstock for this variety.

Effect of Fertilizers on Cold-storage Quality of Apples

The season under review was one of light crop in biennial-bearing varieties, and because of the small amount of suitable fruit available for storage experiments it is not necessarily possible to attach great significance to the results obtained with Cox's Orange Pippin and Dunn's Favourite.

Cox's Orange Pippin.—Fruit from trees receiving phosphate (P), nitrogen (N), and potash (K) kept, on balance, as well as that from the untreated control trees. It had rather more internal breakdown, but less storage-pit and less superficial scald.

N disastrously increased breakdown and fungus, but somewhat reduced pit and scald. Incidental to the fertilizer trials, an experiment on the date of picking gave results differing in several respects from those obtained in previous years. Breakdown dropped to a minimum and pit rose to a maximum in early March, at about the third and fourth weekly pickings, with a late picking showing results rather similar to the earliest two.

Ammonium sulphate caused much more breakdown and fungus than did dried blood, so this finding has now held for two years. Since equal weights of each fertilizer have been used throughout the experiment, it has taken eleven years for the rather higher nitrogen level of the ammonium-sulphate trees to be reflected in the storage quality of the fruit. It is now proposed to increase the application of dried blood to bring all trees to a uniform level of nitrogen.

Dunn's Favourite.—The untreated control fruit kept decidedly better than N or PNK fruit, between which there was comparatively little difference this season. The nitrogen caused a substantial rise in breakdown and superficial scald. The sample from a nitrogen application-rate experiment was too small to give data of any significance beyond indicating that in a season of light crop the storage quality is adversely affected by N, as indicated above. In a lime *v.* no-lime experiment the breakdown, fungus, and pit were not affected by treatment, but scald was rather higher on the limited sample.

Jonathan.—This variety yielded a heavy crop and consequently the fruit kept very well in storage. Fruit from trees receiving 2 lb. ammonium sulphate in addition to a basic dressing throughout of P and K kept as well as that from trees with no nitrogen. With 4 lb. ammonium sulphate, however, there was an appreciable increase in breakdown, fungus, and lenticel spot.

In an experiment in which potash is used in addition to a base treatment of P and N, the only marked difference was in respect of breakdown incidence, which continued to be less in fruit from potash-treated trees, despite the larger size of this fruit.

Delicious.—The only loss in this variety was through fungous rots and wilt, and neither was significantly affected by the manurial treatment of the trees from which the storage samples were taken.

Sturmer.—The outstanding feature was again the high incidence of breakdown and fungus in fruit from trees receiving nitrogen only. Most of the fungus was of a secondary nature on tissues damaged by breakdown. When the N was balanced by P or P and K, the storage quality was equal to that of the untreated controls.

Cold-storage Quality of Coloured Strains of Apples

Cox's Orange Pippin.—The results with three samples of Bledisloe Cox and three described as Red Cox were again somewhat variable, and with one exception proved inferior to the standard type of Cox. The exception was a Red Cox, taken initially from Hawke's Bay, and this showed a rather marked resistance to breakdown, although it had not done so in the previous season.

Jonathan.—This year the relative performances of the red and pink types were reversed from their position last year, although differences were small. On balance, neither showed any superiority over the standard type, and at least with the Pink Jonathan there is a heavy marking-down on the score of external appearance.

Delicious.—A wide variation in storage quality was shown by the eighteen red types of Delicious under test, and this season several were equal or even superior to the standard type. The sample of Hawke's Bay Red Delicious was particularly good. In view of the early stage of this trial, however, no great significance can yet be attached to the results.

Dougherty.—The two red strains this year showed rather better storage-quality than the standard type, but since the latter had to be drawn from a different orchard the comparison is of doubtful value. The most that can be said is that the red types stored extremely well.

Effect of Rootstock on Cold-storage Quality

Cox's Orange Pippin.—The crop was too light to permit the taking of storage samples.

Jonathan.—Results were more closely in line with the 1943 data than with the 1944 data, but the position of M XV had improved. M XII and M XV showed consistently good storage quality in every replication of the trial. With M I and Northern Spy there was considerable lack of agreement among replicates, but there was a general trend toward more breakdown, fungus, and superficial scald than in the other two stocks.

Delicious.—There were no statistically significant differences in the storage quality of Delicious on Malling types I, XII, and XV or on Northern Spy.

Granny Smith.—Core-flush was more severe in fruit grown on Northern Spy stock than in that on M I, XII, or XV. This agrees with independent observations reported above in "Influence of Rootstock and Intermediate Scion on Core-flush in Granny Smith." M XII fruit was more severely affected by superficial scald than any of the others. Taking all disease factors into consideration, M I and M XV conferred better keeping-quality than either M XII or Northern Spy, between which there was little difference.

FRUIT RESEARCH

Advisory Committee.—Sir Theodore Rigg (Acting-Chairman); Dr. G. H. Cunningham; Messrs. W. Benzies, H. H. Booth, F. R. Callaghan, W. K. Dallas, G. C. McMurtry, A. Miller, A. Osborne, G. D. Taylor, and L. W. Tiller (Secretary).

The Advisory Committee has been reconstituted, with a reduction in size, and at the same time an increase in the representation of the fruit industry. The industry's nominees now represent pip-fruit, stone-fruit, and citrus growers and are drawn from Auckland, Hawke's Bay, Nelson, and Central Otago.

An important development, practically completed at the end of the financial year, was the purchase of an orchard and general farm property in the Earnscleugh district, of Central Otago, to fill the long-recognized need of a research area for the study of problems peculiar to that area. Frost fighting will claim first priority, with irrigation, disease control, and soil problems featuring prominently in the research programme. A satisfactory solution of the frost problem will make possible the development of large areas for commercial stone-fruit culture.

In the ensuing sections is presented a summary of the principal results of research conducted by the several participating organizations.

Research Orchard, Appleby

(*a*) *Long-term Manurial Investigations.*—These experiments continue to demonstrate the necessity for balanced manurial treatment of apple-trees on the Moutere Hills soil, and show clearly the economic advantage of such treatment. In the following summaries the average increase in crop over the untreated trees is indicated, in pounds per tree per year, calculated over the whole period of treatment. The average annual cost of the fertilizers used is also given. To simplify the presentation the chemical symbols P, N, and K are again used to indicate treatment with superphosphate at 4 lb. per tree, ammonium sulphate at 2 lb. per tree, and sulphate of potash at 1 lb. per tree, respectively.

Cox's Orange Pippin: N trees have averaged 42 lb. more fruit than the controls, at a cost of 4·3d. per tree per year, and PNK trees have averaged 78 lb. more fruit than the controls, at a cost of 10·0d. The present relative positions of the treatments are shown by the fact that over the past two seasons the N trees have averaged 91 lb. and the PNK trees 116 lb. more fruit per tree than the controls. Since the commencement of the trial the yield of untreated trees has declined heavily, whereas that of PNK trees has considerably increased. PK has been little better than the controls.

Dunn's Favourite: This variety has proved rather less responsive to manurial treatment, but nevertheless treatment has proved advantageous. N trees have averaged 16 lb. and PNK trees 32 lb. more fruit per tree than the controls.

Delicious: N trees have yielded 37 lb. and PNK trees 69 lb. more than the controls. The costs per tree are as for Cox's Orange Pippin.

Sturmer: P by itself has given no significant crop increase, although the trees themselves show no die-back, in contrast to some of the untreated trees and some of the N trees. N has given an average increase of 52 lb. per tree, PN 83 lb. per tree, and PNK 98 lb. per tree, for respective costs of 4·3d., 7·0d., and 10·0d. per tree. Over the past two years the average increases are respectively 53 lb., 116 lb., and 135 lb. per tree per year.

(*b*) *Short-term Manurial Investigations.—Dunn's Favourite:* Treatment with 2 lb. ammonium sulphate, additional to a base dressing of P and K, has given an average increase of 47 lb. per tree per year for an extra cost of 4·4d. The interpretation of the crop records from trees receiving 4 lb. ammonium sulphate is rendered difficult by the absence of pre-treatment data. While they appear to show a further increase of crop, this result is of doubtful significance, even though the response to the extra nitrogen is readily apparent in the foliage colour of these trees. In a heavy-liming experiment, trees receiving ground limestone at the rate of 2½ tons per acre every second year have averaged 32 lb. more fruit per tree than unlimed trees, at a cost of 2·3d. for lime. A base dressing of P, N, and K was used throughout. The response appears to be an indirect nitrogen effect induced by better cover-crops on the limed area.

Jonathan: A comparison of 0 lb., 2 lb., and 4 lb. ammonium sulphate, with a uniform base dressing of P and K, continues to point to 2 lb. as the optimum rate of application. Under this treatment an average of 48 lb. more fruit per tree per year has been obtained for an extra outlay of 4·4d. Two sulphate of potash applications of 12 lb. per tree, followed by 1 lb. in each of the succeeding ten years, have given an average increment of 55 lb. of fruit per tree per year for an expenditure averaging 7·1d. per year. At the same time, the colour and size of the fruit are better than from trees without potash. An experiment to determine whether there is an optimum period of the year for the application of N is still showing no measurable differences. A study of concentrated versus more disperse distributions of N is beginning to suggest that a greater response is secured by concentration within a 3 ft. radius from the trunk. More data will be needed, however, before a recommendation can be made.

(*c*) *Rootstock Trials.*—Although the trees in this trial are now eleven years old from date of planting, it is still evident that the ultimate relative positions of the Northern Spy and various Malling stocks have not yet been reached. The following must therefore still be regarded as progress notes covering the 1945 crop.

Cox's Orange Pippin: The yields on M I, M XII, and Northern Spy did not differ significantly from one another, but that on M XV still lagged behind.

Jonathan: M XII went well into the lead this season. Northern Spy failed to give a significantly higher yield than M I and M XV.

Delicious: Yields from the various plots were rather variable and the only statistically significant difference was that M I gave a higher yield than M XII.

Granny Smith: Northern Spy and M I gave higher crop weights than M XII or M XV. The differences between Spy and M I or between M XII and M XV were not significant.

(*d*) *Varietal Trials.*—Further observations have been maintained on a large number of red strains of Cox's, Jonathan, Delicious, and Dougherty, and a few fruits have been obtained from some of the hybrid varieties now growing on the orchard. Most of the strains have so far been disappointing, in that their colouring is not typical of the parent variety and, as noted under "Fruit Cold Storage," their keeping-quality is generally inferior.

(*e*) *Spraying Trials.*—These are dealt with under the Plant Diseases Division section of this report.

PLANT DISEASES DIVISION, AUCKLAND

I. *Pomology*

(*a*) *Roostocks.*—(i) *Apple:* Sturmer on Sturmer roots has given outstandingly heavy crops in comparison with trees on Northern Spy and East Malling rootstocks. The accumulated crop total (average per tree) for the sixth to ninth years was 357 lb. for the former, compared with 289 lb., 233 lb., and 228 lb. respectively for M XII, Northern Spy, and M I. The trees are growing on a heavy clay loam. In a similar trial on volcanic soil, but including for comparison trees on Northern Spy only, Sturmer on Sturmer roots has shown the same marked superiority in crop. It is probable that the larger trees on M XII, not yet in full bearing, will eventually overtake those on Sturmer roots, but the position of the latter in relation to trees on Northern Spy is likely to remain unaltered.

Cox's Orange Pippin has, up to the ninth year, cropped most heavily on M I and Northern Spy, but the latter are being rapidly overhauled by the more vigorous trees on M XII and M XVI.

Yields of Jonathan on M XII are now higher than on Northern Spy.

In the trial of Dougherty on twelve rootstocks laid down in 1941, the trees have made excellent growth and will be allowed to carry their first crop next year.

Eight-year-old Gravenstein trees on roots of the same variety have borne their first appreciable crop this year, the yield being approximately 30 per cent. less than that of comparable trees on Northern Spy. The former are superior in growth and are as yet free from the "gnarling" disease which has appeared in the trees on Northern Spy stock.

Differences in resistance to excess soil moisture have been shown by three apple rootstocks in a block of young Delicious at the Oratia Experimental Orchard. Following two wet years, losses have ranged from 50 per cent. for trees on Northern Spy to 12 per cent. on each of the stocks M XII and M XVI.

(ii) *Plum:* Investigation of rootstocks for English and Japanese plums has been commenced this year with the propagation of eight different stock types, to provide material for budding with scion varieties later.

(iii) *Citrus:* Results have been prepared for publication dealing with performance of five-year-old Washington Navels on various stocks, including double-worked trees. In this trial, sour orange, alone or in combination with other rootstocks, proved incompatible with the scion. Of rootstocks worked directly with the scion variety, citronelle produced the largest and trifoliate orange the smallest trees, those on Island sweet orange being intermediate in size. Double-working with a more vigorous stock considerably increased tree size on the dwarfing trifoliate-orange root. On the other hand, vigorous stocks were little affected by interposing a dwarf stock between them and the scion. Taking into consideration both growth and flower formation, trifoliate-orange rootstock with an intermediate stem-piece of either Cleopatra mandarin or Island sweet orange appears very promising, at this stage of the trial, as a stock for Washington Navel.

Four-year-old Lisbon lemons on citronelle stock have made slightly better growth than comparable trees on Island sweet orange. Growth on sour-orange stock is much inferior.

(*b*) *Varieties.*—(i) *Apple:* Laxton's Exquisite, Laxton's Epicure, Ellison's Orange, and Monarch are the most promising of new varieties under test.

(ii) *Peach:* Crop weights in the trial of new varieties have again been recorded.

(iii) *Citrus:* New varieties of citrus and also a number of species of citrus and related genera, which may prove of value for breeding or as rootstocks, have been received from the Bureau of Plant Industry, United States of America.

(iv) *Sub-tropical Fruits.*—(1) Persimmon: Many of the eighteen varieties of Japanese persimmon planted in 1940 are now fruiting. Observations have been made on flowering, fruit set, premature drop, fruit type, and tree characters.

(2) Feijoa : A study of some seventy seedlings of *Feijoa sellowiana* revealed great variability in fruit type and indicated that for commercial culture only grafted trees the scions of which have been taken from trees bearing fruit of good type should be planted. Attempts to propagate the feijoa from cuttings in the open were not successful. Conditions were unfavourable, however, owing to the prolonged drought.

(3) Avocado : Seed of various types of avocado received from the Department of Agriculture, Fiji, is being grown to provide rootstocks for named varieties.

(4) Guava. The yellow guava (*Psidium guajava*), grown from seed supplied by the Citrus Experiment Station at Riverside, California, is making poor growth and is probably insufficiently hardy for this climate.

(5) Other Sub-tropicals : A range of other sub-tropicals is being raised from seed forwarded by the Bureau of Plant Industry, United States of America. Germination has been good, and the plants will in due course be set out to test their suitability for local conditions.

(*c*) *Plant Hormones.*—Indolyl-butyric acid (15 parts per million) considerably increased callus formation in softwood cuttings of sweet cherry, but failed to induce rooting. Tests of a commercial preparation for the prevention of pre-harvest fruit drop gave negative results with the Jonathan apple. Work is being continued.

(*d*) *New Zealand Fruitgrowers' Federation Nursery.*—Further supplies of rootstocks were sent to the federation nursery at Levin during the year. Technical advice has been given on development of the nursery and on tree propagation. The work of district Bud-selection Committees has been closely supervised. Trees of some fifty varieties of apple, pear, peach, plum, cherry, and apricot have been certified for the provision of buds for the nursery.

II. *Plant Diseases Investigations*

(*a*) *Disease Control.*—(i) *Codling-moth of Apple :* Studies are being continued on the seasonal cycle and biology of this pest in the research orchard at Hawke's Bay. In the 1945–46 season two generations developed, the second during the month of February.

(ii) *Crown-gall :* In 1941, peach-trees were inoculated with the bacterium to ascertain if the disease was of economic importance in the Dominion, and the experiment has now been concluded. All inoculated trees showed typical galls, whereas adjacent check trees were free. Infected trees were stunted, made poor growth, and averaged two-thirds the weight of the checks.

(iii) *Citrus-canker :* The bacterium was recently isolated from two citronelle trees growing in waste land in the vicinity of Kerikeri. Fortunately, infection was confined to an old abandoned plantation not in the commercial area. The disease has also been found in two small non-commercial orchards in Gate Pa district, Tauranga.

(iv) *Verticillium-wilt of Apricot :* The causal fungus (*V. dahliae*) has been isolated from apricot wood taken from wilted trees in various orchard areas in Central Otago, trees in all cases growing in land previously planted in tomatoes, one of the hosts of this organism.

(v) *Green-crinkle of Apple :* The condition, not uncommon in apples and pears, closely resembles "false sting," recorded from Canada as being of virus origin. In New Zealand it has been shown to be carried in scion wood, but as yet no evidence has been secured to indicate that it is caused by a virus. Further work is in progress.

(vi) *Bitter-rot :* The causal fungus (*Glomerella cingulata*) has been isolated from fruits of the hedge plant *Acmaena floribunda,* commonly used as a shelter hedge in Auckland Province. The record suggests the inadvisability of using the plant for shelter-belts around orchards containing apples and pears.

(vii) *Bacterial-spot of Plum :* Further trials were carried out on the varieties Doris and George Wilson with Bordeaux 3–6–100, lime sulphur 1–80, and Fermate 3–100. Fruit infection at picking was as follows : bordeaux, 5·3 per cent. ; lime sulphur, 30 per cent. ; Fermate, 28 per cent. ; and checks, 32 per cent. Bordeaux again caused appreciable foliage damage.

(viii) *Dicky-rice Weevil on Citrus:* The present method of control by banding is difficult to apply, ineffectual unless properly carried out, and liable to cause tree injury if the material is applied season after season at the same point on the bark. Further, it is unknown whether or not the weevil population is adversely affected by the practice. With a view to providing an alternative control, several experiments have been undertaken using sprays of D.D.T., cryolite plus summer oil, Gammexane, and lead arsenate. Preliminary results showed that D.D.T. at 0·1 per cent. concentration gave 100 per cent. control, cryolite, banding, and Gammexane from 99 per cent. to 98 per cent., and lead arsenate 94 per cent., indicating that a promising alternative method of control lies in spraying with one of these.

(ix) *Bordeaux Sprays for Delicious:* As a result of the work of the past and previous seasons, recommendations have been made for field applications on this variety for control of ripe-spot and black-spot.

(*b*) *Testing of New Therapeutants.*—(i) *D.D.T. and Gammexane:* Trials on a field scale have been carried out in apple orchards in Auckland, Hawke's Bay, and Nelson. From these the following conclusions may be drawn:—

(1) Codling-moth control is readily secured with D.D.T. even at dosages as low as 0·05 per cent. Gammexane is less effectual.

(2) Leaf-hopper is readily destroyed by both, but relative toxicities have not yet been ascertained.

(3) Woolly-aphis: Evidence indicates that D.D.T. does not combat this pest though it readily destroys the parasite *Aphelinus mali*. Gammexane, on the other hand, appears to give effectual control.

(4) Red-mite populations have increased where D.D.T. has been used. Gammexane again has proved toxic to the pest and might develop as an efficient agent of control.

(ii) *Dithane and Fermate:* Both have given encouraging results in control of black-spot. At 2 lb. per 100 gallons, Dithane is more effectual than the standard spray treatments of lime sulphur and colloidal sulphur. Although causing less foliage injury, it russets fruits at this dosage, but not to an extent which would affect the grade of fruit.

Fermate at 2 lb. per 100 gallons gave black-spot control comparable with that secured with standard spray-programmes. Though it caused less foliage damage than the standard programme and did not produce russet, residues were conspicuous and difficult to remove.

(*c*) *Certification of Therapeutants.*—Certification lists have been maintained, and adjustments made to standards of materials where necessary. All samples of certified products taken for check analysis have shown that the initial standards have been maintained.

Attention has been given to methods of preparing D.D.T. as dusts and sprays for horticultural and agricultural use. It has been ascertained that micronized D.D.T. dusts of highly effective field performance can be prepared in New Zealand.

Cawthron Institute, Nelson

(*a*) *Magnesium-deficiency Investigations.*—Observations have been maintained on the experimental areas of Cox's Orange Pippin, Jonathan, and Sturmer apple trees at Braeburn and Tasman to determine the present effect of treatments applied in the 1939–40 and 1940–41 seasons. Since then no further magnesium applications have been made, except on certain Jonathan trees. In all cases ground dolomite has shown more lasting effects than either magnesium sulphate or magnesium carbonate. The sulphate is now the least satisfactory, although in the first few years following treatment it was quite effectual. The use of 6 lb. dolomite per tree in each of two successive seasons has

given as good a control as one dressing of 12 lb. per tree. Two 12 lb. applications have given slightly better results than one. The present (1946) season is the seventh since treatments were first applied, and it is apparent that some have almost reached the end of their effective life. This may be considered satisfactory when account is taken of the severity with which some of the trees were initially affected.

Fruit and leaf samples have been taken, but analytical data for the 1945–46 season are not yet available.

(*b*) *Chlorosis in Leaves of Delicious Apple.*—A chlorosis of the tip leaves of new growth of Delicious trees has been noted in various parts of the Nelson District for some seasons past. Last season there was a severe outbreak, but very little has been seen to date this season. Analysis of leaf samples taken several seasons ago has not afforded any definite explanation of the phenomenon.

(*c*) *Copper-spray Residues.*—A number of apple samples from the Appleby Research Orchard was analysed for copper at the request of the Plant Diseases Division. The analyses suggest that the skin of Sturmer holds copper much more tenaciously than that of Dunn's, and that there is slight penetration of copper into the flesh of both varieties.

(*d*) *Vitamin C in Apples.*—Further work has been done on the vitamin C content of cool-stored apples. Samples of seven varieties, taken from several orchards on more than one type of soil, were cool stored within a few hours of picking, with control samples taken for immediate determination of vitamin C content of whole fruit, skin, and flesh, and of acidity of expressed juice. In general the vitamin content of the flesh decreased more rapidly during storage than that of the skin. Sturmer again showed the highest value (29 mg. per 100 g. whole fresh fruit) and maintained its potency very well in storage, falling only to 27 mg. per 100 g. after six months. With Cox's Orange Pippin, Jonathan, Granny Smith, Delicious, Statesman, and Red Statesman there was both a more rapid and a greater percentage loss. The acidity, irrespective of its original level, fell to two-thirds to one-half of the initial value during commercial storage.

(*e*) *Die-back of Apple-trees.*—The fungi associated with die-back in apple-trees have been studied in the Annesbrook Orchard, Wakatu, and in six orchards at Tasman and Mahana. The trouble is generally found in mature trees over thirty years of age, and in most cases is associated with poor root development or with severance of roots during cultivation. It is most serious on the thin Moutere Hills soils, but isolated cases have been noted in orchards with moderately deep soil of satisfactory fertility.

Many fungi can be isolated from trees killed by die-back, but six are of common occurrence—viz., *Valsa leucostoma*, *Diplodia* sp., and *Physalospora obtusa* on the upper branches, and *Polystictus versicolor* (heart-rot), *Stereum purpureum* (silver-leaf), and *Physalospora* sp. (black-rot) on main limbs and trunk. The latter group is thought to be of greater significance than the former. The evidence suggests that soil factors and mechanical injury to trees are the primary agents, and that *Stereum* and *Polystictus* then make rapid headway, finally causing death of the trees.

(*f*) *Control of Black-spot.*—Dead leaves under Glou Morceau pear and Dougherty apple trees were given an Elgetol spray in early spring just prior to spore discharge. Test and control trees subsequently received the usual fungicidal sprays. Observations made in mid-October and early November showed that control trees were infected earlier and rather more severely than trees with the Elgetol ground-spray.

(*g*) *Insect Pests.*—A field survey of the codling-moth parasites that were imported from Canada and bred at the Cawthron Institute has indicated that they are not yet sufficiently established to effect any control of the pest.

Observations on woolly aphis show that in certain cases the parasite, *Aphelinus mali*, fails temporarily to give effective control. Aphis has now extended its host range to another plant.

Possibly owing to the very dry summer, maturing apples in parts of the Moutere Hills were damaged to a small extent by the ovipositing of cicadas.

(*h*) *Subterranean Clover for Soil Improvement.*—An inspection was made of an area of subterranean clover growing as a cover-crop in a private orchard. Analysis of soil samples at a time when nitrogen should be in optimum supply showed that the topsoil under clover contained 15·7 p.p.m. nitrate nitrogen and 24·1 p.p.m. ammoniacal nitrogen, as compared with 4·6 p.p.m. and 7·2 p.p.m. respectively on the adjoining clean-cultivated portion of the orchard.

(*i*) *Rootstock Trials at Annesbrook Orchard.*—The soil in this orchard is a clay loam of medium fertility. On this area Double Vigour stock (vegetatively propagated French Crab seedling) has given better results than Northern Spy stock with the varieties Jonathan, Statesman, and Sturmer.

(*j*) *Raspberry Fertilizer Experiments.*—In view of the low potash status of many raspberry soils in Nelson, two fertilizer experiments have been laid down in commercial gardens in the Tadmor Valley. So far, a "complete" mixture used at 7¼ cwt. per acre has given the best result, and extra potash has given no further improvement.

(*k*) *Raspberry Disease Survey.*—This survey in the Tadmor–Tapawera district has been continued. The more important fungi found on unhealthy or dying plants are silver-leaf (*Stereum purpureum*), root-rot (*Rosellinia* sp.), *Nectria*, and cane-wilt (*Leptosphaeria coniothyrium*). Inadequate soil drainage or damage to roots by grass-grub and cultivation implements is in certain cases responsible for weakening the plants, thus favouring the development of disease.

(*l*) *Raspberry Bud-moth.*—A small plot of raspberries at the Cawthron Institute has been infected with bud-moth with a view to detailed studies on the behaviour of the insect and its control.

Miscellaneous

Apple Dehydration.—The Fruit Section of Head Office has collaborated with the Chemical Engineering Section of the Dominion Laboratory in providing technical advice and assistance to the Internal Marketing Division in connection with the commercial dehydration of apples.

INDUSTRIAL PSYCHOLOGY DIVISION

Advisory Committee.—Mr. H. E. Moston (Chairman); Drs. F. S. Maclean, E. Marsden; Messrs. J. Ferguson, D. Lagan, E. Langford, D. I. Macdonald, N. S. Woods, R. T. Wright, D. Sandys Wünsch, L. S. Hearnshaw (Director).

Functions of the Division

The Industrial Psychology Division exists to serve New Zealand industry, and it attempts to do this in three ways—firstly, by research to elucidate problems upon which practical industrialists are unable with the resources at their disposal to arrive at any solution; secondly, by education to disseminate the results of the work carried out by industrial psychologists; and, thirdly, by direct assistance and advice, to help firms and other organizations that ask for such aid. This report outlines the ways in which this threefold programme has been carried out during the past year.

Research

(1) *The Girl Worker in Industry.*—This research into the attitudes and problems of the girl worker in industry, which commenced last year and was referred to in last year's annual report, has been completed during the year, and it is hoped that the report will be published in book form during 1946.

The report is divided into three main sections:—

(*a*) The first discusses the girl worker herself, her interests, and characteristics;
(*b*) The second discusses her attitude to her work, working-conditions, and working companions; and
(*c*) The third discusses how employers, trade-unions, and social workers can assist the girl worker.

(2) *Social and Welfare Activities.*—The war had a twofold effect on social and welfare activities sponsored by firms for their employees. Firstly, those firms, comparatively few in numbers, which had undertaken a programme of social and welfare activities before the war found that wartime conditions—long hours, a large proportion of temporary employees, &c.—made it far harder to keep these activities going. Secondly, many firms, owing to their need to attract and retain staff, became interested in the provision of social and welfare activities for the first time. This investigation was planned to ascertain from a representative sample of firms what social and welfare activities had been or were being undertaken, what the response from the employees was, and what, in the opinion of the managements of the firms, was the value of this type of activity. We approached the investigation with an open mind, quite prepared to find that under New Zealand conditions these activities were not really justifying themselves, but also prepared to recognize benefits from them both to the employees of the firms and to the firms themselves. In the course of the investigation thirty-two firms were visited, and of these, twenty-four had some form of group activity. This figure includes a wide range varying from firms with a single sports team or only an annual ball to those with a well-organized and efficient system of social activity. In five of the remaining eight firms the management were contemplating the possibility of starting some such activities. A short report is to be issued.

(3) *Music in New Zealand Factories.*—In Christchurch and Auckland 115 factories were contacted with reference to music at work. Of these, 51 had music played during working-hours, and 8 had previously had it, but for various reasons abandoned it. Besides obtaining details from the managements we also questioned 304 girls on their attitudes to music at work. We were unable to get a representative sample of male opinion. Whether or not men dislike music at work, employers in New Zealand seem to consider it unnecessary to provide a musical accompaniment to their labours.

The popularity of music at work among girls is overwhelming. Only 9 out of the 304 girls questioned disliked music. And this in spite of rather poor reproduction (over one-third of the firms were dissatisfied with their systems of reproduction) and reliance on not always very suitable radio programmes. More than half the girls wanted music all day: in fact, in about half the firms it was played all day. Nearly all the employers questioned thought music a good thing. They said that the girls liked it, that it diminished talking and made discipline easier to maintain, and that possibly (there was some doubt and a lack of reliable evidence on this) it increased output.

A report is in preparation embodying the results of this investigation, together with an account of the detailed experiment referred to in our second annual report.

(4) *Management Policies.*—The aim of this investigation, which is still in its initial stages, is to collect from managements themselves their own experiences on the handling of staff and their own ideas on staff policies. After meeting and talking with the managements of many firms one is impressed by the stores of practical wisdom often acquired by the average manager in the course of his experience. At the same time it is surprising how personal this wisdom is. It is rarely communicated to other managers and the divergencies of outlook on many common problems are marked. A first-class idea put into practice with excellent effect by one manager may be unknown to the manager of the factory next door, or, alternatively, if he has heard of it, he may be convinced that it is entirely impracticable.

It is impossible not to feel that the art of management would progress if this personal wisdom could be pieced together into a common tradition. In a sense, of course, the scientific-management movement is an attempt and a fairly successful attempt—to

do this. But scientific management has tended to think mainly in terms of the large firms, and its formulæ are over-elaborate for the typically small New Zealand concern. Moreover, it has been more successful in its treatment of production and organization than in its handling of personnel.

Our investigation is concerned with the ordinary smallish New Zealand firm, with New Zealand conditions, and with the personnel function of management. We are interested in ascertaining what techniques of management are meeting with success, what experiments have been tried and found wanting, and, above all, the underlying attitudes of mind—if you like, the philosophy, even if it is not clearly or systematically formulated—which are all important.

An investigation of this kind is not easy to carry out; but we believe that with the co-operation of managements results of general interest will eventually be obtained.

Education

Lecture courses on industrial psychology were delivered in the course of the year in Wellington, Christchurch, and Auckland. The enrolments in the three centres exceeded two hundred persons. In Wellington, in addition to the lecture course, a discussion course on "The Will to Work" attracted a mixed group of factory-managers, foremen, Government servants, and trade-unionists, and led to some interesting and often entertaining exchanges of views.

In addition to these regular lecture courses, addresses have been given by invitation to a number of organizations.

The bulletin, issued quarterly, has continued to receive a wide circulation. Now that peace has returned we hope to increase the size of the bulletin, and also to invite contributions to its pages.

Service

During the year surveys and investigations were carried out, or other services performed, for nineteen firms and organizations. In addition, advice and information were supplied to thirty-eight other concerns in response to requests. The topics covered in the surveys and investigations are discussed under seven main headings.

(1) *The Recruitment of Labour.*—At the present time many firms and other employing bodies are finding it hard to obtain the labour they require. This applies particularly to firms employing female and juvenile labour. A full investigation of this problem was carried out for one large non-industrial organization, and a briefer investigation for one factory situated in a small town.

In the latter case the problem was virtually insoluble except over the space of years, as the factory had grown too large for the town in which it was located. But even so we considered that some steps could be taken by the management to alleviate the position by making the work more attractive in ways likely to appeal to prospective employees, and by taking steps to improve the social status of factory employment.

In the other organization, where a fuller investigation was carried out, the main grievance of the existing workers and the main objection of prospective applicants reduced itself to the question of their status in the organization compared with that of the non-manual workers employed. There were very few complaints about working-conditions, which were, on the whole, good. There were a few justifiable complaints about amenities and some about the amount of lifting which had to be done in certain departments. But these did not constitute the main reason for the acute difficulties experienced by the concern in recruiting staff.

In any large organization there are perhaps inevitably different grades of employee corresponding to differences of function performed. For instance, in a large industrial concern there are executives, office staff, perhaps laboratory staff, and both skilled and unskilled workers. At the present time in New Zealand factories there may be no great differences in wages or conditions of employment between these grades. Differences in status however, are still emphasized in numerous minor ways, and these differences cause one class of work to be regarded as inferior. This sense of inferiority colours the attitude of persons to the job, and is a major factor in deterring recruits.

In the organization where our investigation was carried out the following points were noted :—

(*a*) Class distinctions may be revealed in *personal attitudes*. A girl worker may be conscious that a girl from the office speaks differently to other office girls than she does to workers. Although the difference may be slight, it need be none the less obvious to a sensitive girl :

(*b*) Class distinctions may be revealed in *material circumstances—e.g.*, inferior cloak-rooms, inferior uniforms, inferior crockery in the canteen :

(*c*) Class distinction may be revealed in *manner of address*. Several girls objected to being called by their Christian names, while the office staff, &c., were all " Miss .... " :

(*d*) Class distinctions may be revealed in the *policy of the supervisors*, who in small ways treat the various grades differently, and frame rules designed to prevent easy mixing :

(*e*) Class distinctions may be revealed in *behavour outside working-hours—e.g.*, non-recognition of a worker on the street :

(*f*) Class distinctions may be revealed in *the attitude of people outside*. All these factors add up to what may be called the *atmosphere* of the organization—an atmosphere of class distinction and social hierarchy.

The net effect of these minor distinctions is to make the worker's status seem an inferior one in the eyes of the worker herself, in the eyes of those " higher-up " the ladder, and in the eyes of the community. Although other grades of work may be no more remunerative, not intrinsically more interesting, and often socially less valuable, they are preferred by the young person entering a career. This is perhaps the major reason for the unpopularity of manual work. It should not be impossible to remove some of these minor distinctions and gradually to improve the status of the manual worker. If this could be done there is reason to believe that manual jobs would be less starved for recruits. Although the task of improving the status of the worker would not be easy, as social forces of a deep-seated character are sometimes involved. a management that was determined to do so should be able to achieve a certain measure of success.

(2) *Staff Selection.*—Vocational examinations involving the use of psychological tests were carried out for seven private firms and one Government organization during the year as follows :—

(*a*) The vocational examination of several applicants for machine-shop apprenticeships :

(*b*) Vocational examinations of a prospective production manager and of a prospective personnel supervisor (female) :

(*c*) The examination of eight candidates for an important position in connection with staff training in a large organization :

(*d*) The testing of all the applicants for work at a new branch clothing-factory with a view to allocating them to the most suitable jobs in the workroom. None of the applicants had any previous experience, and the tests were therefore a considerable help in placing the applicants :

(*e*) The examination for two firms of problem juveniles who were suspected of being vocational misfits :

(*f*) The examination of seven applicants for supervisory positions and one applicant for the position of instructress at a clothing-factory.

(3) *Training.*—A plan for a training school was drawn up in some detail for one clothing firm with the aim of substituting the systematic and thorough instruction of beginners for the haphazard trial-and-error methods which are the rule.

(4) *Working-conditions.*—Investigations into working-conditions were carried out for four concerns:—

(*a*) A general survey of working-conditions in a large office. The genuineness of a number of complaints made by the staff was established. Lighting was poor in parts of the offices. Fluorescent tubes had been allowed to fall in efficiency owing to the non-replacement of over-age units, until the light values were far below standard. Ventilation was exceedingly poor, the mechanical system installed giving only one change of air per hour and leaving the air stagnant over large areas of the office:

(*b*) Lighting systems were examined in two technical workrooms where staff had complained of eyestrain and fatigue. In both cases defects in installation were noted, in one case insufficient intensity, in the second case improper placing of the light sources, as well as insufficient intensity:

(*c*) The ventilation in the press-room of a dry-cleaning establishment where complaints had been received was examined. With high temperatures and humidities a plentiful supply of fresh, moving air was required to make conditions satisfactory.

(5) *Fatigue.*—A brief investigation of alleged fatigue of operators on a special job was made. Although the job was of a responsible, and in some ways of an exacting, nature, it was not considered to induce fatigue to any serious extent.

(6) *Incentives.*—An examination of the incentive system in operation in one firm showed the extraordinary difficulty of fair rate setting when a large number of operations is involved, and the great importance of good production planning to ensure the constant flow of work to the operatives. In the factory where the investigation was carried out the bonuses earned by the girls differed enormously from week to week. The average girl did 80 per cent. more work on her best week than on her worst. In the extreme case a girl apparently did 574 per cent. more on her best week than on her worst. The proportion of girls able to earn a bonus at all was low, being only 32·3 per cent. in 1944 and 45 per cent. in 1945. It is generally considered that an incentive payment is most effective when it permits at least two-thirds of the staff to earn some bonus. An interesting feature that emerged from the investigation was the popularity of non-financial incentives, particularly competition between sections in attaining given targets of production.

(7) *Morale Investigations.*—Two investigations centred round morale and the problem of human relationships generally. One of these concerned a small group of women workers; the other a very large organization employing men only.

Investigations of this kind are carried out mainly by interview or informal conversations, if possible spread over a period of time so that the employees can become thoroughly familiarized with the investigation. The aim is to collect viewpoints from employees themselves as well as from the management. Employees usually welcome the opportunity to speak in confidence to an outsider who is prepared to listen patiently. Although statements cannot always be taken at their face value, an experienced investigator is generally able to reach sound and useful conclusions, and, suitably edited, these are often of much value to a management.

In the case of the small group of women workers morale was fairly good. Although working-conditions were on the whole rather poor, the girls constituted a relatively happy working group with a favourable attitude to the firm. This could be accounted for by several factors—the relative freedom permitted the employees, the popularity of the immediate supervisors, and the communal nature of the work, which was done by small groups. There was a number of older women employed who introduced the steadying element in the workrooms. Most of the complaints were of a minor nature, the inadequate heating of two departments was the most serious.

In the larger concern topics considered included personnel management, joint consultation, and social-welfare amenities. The value of a full-time personnel officer was stressed to co-ordinate all matters relating to personnel and to assist individuals

in their personal problems. Regular consultative meetings between the management and union officials were recommended to replace irregular meetings called at the request of the union when grievances arose. These irregular meetings, which were always centred around grievances, took place in a strained atmosphere, and the manager informs us that the system of regular meetings works far better. Improvements in social amenities and welfare facilities were recommended, as the concern was situated in an isolated district with few community resources.

(8) *General Surveys.*—A general survey of the working-conditions and personnel problems of a group of factories was asked for jointly by the employers and the union of the industry in question. Five establishments were visited, and a report presented on their joint problems.

Relations with other Bodies

The Manufacturers' Research Committee serves as a link between the Department and manufacturing industry, and the association of the Industrial Psychology Division with this new committee has naturally been a close one. The Executive-Secretary of the Manufacturers' Research Committee has been co-opted a member of the Industrial Psychology Advisory Committee. The Division has also performed certain services for the Manufacturers' Research Committee. In particular, a memorandum on industrial legislation dealing with health and welfare was prepared.

Relations with the Vocational Guidance Centres have also remained close and cordial. In Christchurch Dr. Winterbourn has divided his time between the Vocational Guidance Centre and the Industrial Psychology Division. In Auckland Mr. Churton assisted the Centre with psychological examinations. In Wellington Mr. Hearnshaw has been elected President of the local Vocational Guidance Association, and the Division has assisted the Association in the preparation of a memorandum on juvenile labour for the Wellington Manufacturers' Association.

Contact has also been maintained with the New Zealand Standards Institute on certain problems connected with the design of office equipment.

Satisfactory relations have continued with both employers' and workers' organizations.

Requests for information about the work of the Division have been received from Great Britain, the United States of America, Canada, Australia, India, and Palestine.

NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION

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

Leather Research Association

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

The interest both in New Zealand and overseas in the results of the work which has been and is being done by this research association shows that the activities are being directed along lines of value to the industry generally as well as for the tanners of New Zealand.

Quality of Sole Leather.—The real quality of sole leather is measured by the amount of actual wear which can be obtained from a sole of a given thickness. The length of time which a sole may last before the inevitable hole appears varies according to the conditions of wear. This does not mean that the quality varies, but that the life of a sole, as measured in days of wear, varies according to the conditions under which it is worn. If sole leather is to be sold on a real quality basis, then some test, chemical or physical, must be devised which can quickly test its quality, as defined above, in relation to terms of actual wear. Unfortunately, up to the present no such test has been devised. Consequently, the assessment of the quality of sole leather still depends on the personal opinions of seller or buyer. Considerations of colour, feel, and weight may indicate certain desirable features, but so far these have not been correlated with wearing value.

The specifications for boots and shoes issued by the New Zealand Standards Institute establish a minimum thickness for the sole of each type of footwear. This implies that wear value is related to thickness—*i.e.*, for stronger wear a higher thickness is specified. In other words, wear per unit thickness is one way of designating the real quality of sole leather. Now, if the sole made from a piece of hide is made thicker by one process than by another without increasing the wear life of that sole, then the real quality of the thicker sole is less than that of the thinner one, as the wear per unit thickness is less.

It has been found as a result of actual wear tests in New Zealand that rolling does not affect the wear life of a sole, but does reduce the thickness. As the wear life remains the same, the wear per unit thickness is increased by rolling, or, in other words, the quality is increased. One aspect of quality is therefore bound up in the reduction of thickness produced by rolling. So far it has not been possible to obtain any reasonable indication of the reduction of thickness produced by rolling from compressibility results. As the weight of hide substance in a piece of leather will not appreciably alter by being rolled, the weight of hide substance per unit thickness will be increased in proportion to the change of thickness produced by rolling.

One suggestion has been made, therefore, that a test for quality of sole leather might be the weight of hide substance per cubic centimetre of leather. The implications of such a test are very far reaching, involving the original raw hide and all the tanning processes which may affect the thickness of the finished leather. The results so far obtained by the application of this suggestion appear to fit in with the results of actual wear tests. They also provide a reasonable explanation for at least the greater part of the extra wear which is given by chrome sole leather.

Field Trials.—As stated above, any quick test which may eventually be adopted to determine the quality of sole leather must be correlated with the results of actual wear tests. In order to provide the necessary data for this to be done, field trials are essential. These have been carried out during the past year, and the thanks of this Association are due to the Army Department and to those persons who have co-operated again in this important work. The tests are of necessity very slow, but results are being obtained which are of great value in establishing those processes which affect the real quality of leather. As stated above, one result so far obtained is that rolling does not affect the wear life of a sole, but does affect its real quality.

Effect of Perspiration on Upper Leather.—The very difficult problem of how to minimize, if not prevent, the rotting action of perspiration on upper leather has been the subject for many investigations overseas. The composition of perspiration varies considerably with the health of the individual and the nature of the conditions which produce excessive perspiration. Another factor which is of great importance is the fitting of the shoes. Of the many shoes examined the uppers of which have cracked during wear, the majority have been associated with too tight a fit. Such tight fitting not only increases the amount of perspiration produced by the foot, but also imposes greater strains on the leather, which will crack more readily when weakened by perspiration. Results have been obtained in the laboratory tests carried out during the year which are now being tested in actual service. As with the wear trials, these field tests require a long period to carry out, and until laboratory and wear tests are correlated no definite conclusion can be established.

Hydraulic Washers.—The tunnel for the hydro-electric scheme at Lake Tekapo is being cut by hydraulic rams, which work under a pressure of 6,000 lb. per square inch. Ordinary hydraulic washers failed, because the oil which was used in the rams dissolved out the wax which was used to impregnate the leather and so make it impervious to the oil. It was necessary to find a wax which was only very slightly soluble in the oil under the conditions of working. This has been done, and also a more suitable type of leather has been substituted for that which was being used. The first set of washers made along the lines suggested has given very satisfactory service and are still in use.

General.—The Research Association has again kept in touch with the tanneries by regular periodical visits, by the testing of leather and liquors, and by investigating problems in connection with leather which arise in the shoe-factories. This constant contact with leather-manufacture and its use in shoe-factories has been of great benefit to both industries.

Shoe Research Association

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

The complicated and ingenious machines used by the shoe industry are outstanding evidence of what can be achieved when the results of research work are applied to an industry. The machines are accepted, sometimes in spite of opposition by sceptical persons.

The application of the results of research to an industry implies two things—firstly that there are results to apply, and secondly that the industry is willing to apply them. Spectacular results may not always be achieved, but if the industry maintains not only its interest in research, but also its confidence in the application of the results, then eventually success will be achieved. The results achieved by the New Zealand Shoe Research during the year have maintained and increased the interest of the manufacturers in research and the results of the application of the findings have been of great benefit to the industry. Although nothing spectacular has been achieved, steady progress has been obtained during the year.

Quality of Sole Leather.—Up to the present, quality in sole leather has had to be measured by the shoe-manufacturer in terms of the thickness of the leather. As has been shown in the report of the Leather Research Association, the real quality may not be directly proportional to its thickness. Hence if the theory that quality in sole leather may be assessed in terms of hide substance per unit volume can be related to actual wear values, then a great step forward has been made.

Shoe Comfort.—In these days of high-pressure salesmanship it is sometimes very difficult to distinguish between features which are based purely on a phase of selling value and those which are based on the actual facts of shoe comfort. During the year results have been obtained which show that the foot cannot distinguish between, or that it very easily adapts itself to, differences in the flexibility of the sole. This is especially the case with a lady's fashion shoe, in which the height of the heel precludes the flexing of the sole to any marked extent. The foot can distinguish between a light- and a heavy-weight shoe and between a flexible and less flexible upper. These features are more important for shoe comfort than the flexibility of the soles. Factors affecting the flexibility of shoes have been investigated and the principles involved have been applied to actual shoe-manufacture during the year.

Factory Lighting.—In the last annual report reference was made not only to the importance of efficient lighting, but to the effect of colour schemes to enhance the effect of lighting. The beneficial effects of painting the walls a pastel shade and the benches another colour, &c., have been obtained in several factories. From the workers' point of view, if eyestrain is to be minimized, every method of improving lighting should be used. For example, windows require to be periodically cleaned, lamp bulbs and shades kept free from dust and dirt, the actual lights must be in the proper place to give the necessary illumination at the point of work, shadows must be minimized and glare eliminated. Great strides in these directions have been made in the last two years in the shoe-factories in New Zealand, but there is still room for improvement.

Drying.—At various stages some of the components of the shoe have to be treated with water or some other solvent to bring them into a suitable condition for working. This implies that water or the solvent has to be removed when the process for which they were so used has been completed. This treating with the solvent ensures better workmanship and so is necessary, though sometimes it is not efficiently carried out. If the

removal of the solvent or water is not carried out, its presence may interfere with or reduce the efficiency of the next process. Unless proper drying plant is installed at suitable points in the factory, the drying may take too long a time and so delay the progress of the shoes through the factory. Efficient drying, therefore, is an important aspect of shoe-manufacture enabling as it does, better workmanship and also a more regular progress of the shoes through the factory. During the year the Department's Chemical Engineer designed and erected a pilot drying plant suitable for the conveyor system of shoe-manufacture. This has aroused a large amount of interest and has drawn attention to the importance of suitable drying.

Factory Problems.—The practical aspect of shoe research is the help that it is capable of giving to the investigation of factory problems. The confidence of the industry in its Research Association is reflected in the number of problems so submitted for investigation. During the year the number of problems submitted was the second highest during the life of the Association, the record being held by one of the war years. On this basis the work carried out has again fulfilled the objects for which the Research Association was formed.

Pelt Research Association

The continued confidence of the freezing-works, associated with pelt research, in the activities of the Association has been manifested by the results of the past year's efforts. Not only have alterations in processes been discussed, but also the layout of plant and machinery. Changing conditions have demanded that processes should be modified to some extent, and this has been done without sacrificing the quality of the pickled pelts. This has been possible because the fundamental principles underlying the processes are known as a result of the work carried out during the past years.

An investigation of the curing of calf-skins was commenced during the year and the results so far obtained indicate that progress is being made to improve the quality of the skins.

MANUFACTURERS' RESEARCH COMMITTEE

Committee.—Drs. E. Marsden (Chairman), J. C. Andrews, R. O. Page; Mr. D. F. Sandys Wünsch (Council of Scientific and Industrial Research); Messrs. A. Dennison, S. T. Hudson, D. T. Clifton-Lewis, F. Morgan, R. J. Rastrick, L. W. Tattersfield (New Zealand Manufacturers' Federation); and Mr. R. T. Wright (Secretary - Executive Officer).

The Committee is representative of the industries and main districts of New Zealand.

Mr. F. Johnson, Assistant Secretary, Department of Industries and Commerce, acts in a liaison capacity.

Meetings of the Committee have been held at approximately bi-monthly intervals.

Scientific Testing and Servicing.—Following the policy enunciated in last year's report, the Committee has promoted in every way possible the scientific servicing of and provision of scientific testing for all industries and industrial units requiring assistance. Splendid assistance to industry has been undertaken by the scientific workers in all branches of the Department which have been called upon, and commendable enthusiasm in applying scientific knowledge and methods to industry has been shown by these officers. Particular reference must be made to the aid rendered by Dominion Laboratory and its branches, by the Dominion Physical Laboratory, Lower Hutt, and by the newly established Auckland Industrial Development Laboratories, the latter having been established especially to cater for the needs of industry. Care has been taken in all circumstances to avoid overlapping with any scientific or technical services available within industry. As further trained staff and equipment become available, it is hoped to extend the services available to the large number of small units in New Zealand industry which are unable to provide adequate scientific facilities for themselves.

The following are indicative of the type of assistance being rendered, under the ægis of the Committee, by the various Divisions of the Department :—

(*a*) Advice on bacterial contamination of ice-cream plant.

(*b*) Substitutes for gum copal in match-manufacture.

(*c*) Advice on suitable adhesives for mass production of pasteboard boxes.

(*d*) Assistance on resin-impregnation of plaster of paris and synthetic resin improvement of laminated articles.

(*e*) Investigation of paint discoloration in factories.

(*f*) Supply of adhesives for cellophane packing of foodstuffs.

(*g*) Improvements in drying process of gummed tapes.

(*h*) Information on formulæ for stock-licks, bone-flour, &c.

(*i*) Assistance to cordage factory on batching oils and oil emulsions.

(*j*) Repair of mercury switch in footwear factory.

(*k*) Metallurgical examination of bars for fibre comb in cordage factory.

(*l*) Advice on control instruments for humidity, air-flow, and moisture content of leather.

(*m*) Assistance on control of insect pests in food-factories.

(*n*) Arrangement for duplication of precision component of German machine. (Note.—This work was beyond the scope of private engineering firms.)

(*o*) Assistance on lay-out of a new factory.

Research Associations.—The Committee has, following the necessary Government approval, sponsored the formation of co-operative research associations within industries. Equal contributions to the funds of each association are to be made by industry and the Government, and the activities of such associations are to be controlled by management committees representative of industry and the Government. The pottery and ceramic industry has formed a research association during the year, and another industry is awaiting only formal approval of some units engaged therein before forming a research association.

Publicity and Information.—During the year the Secretary-Executive Officer has addressed the manufacturers' organization throughout New Zealand on the need for the application of science to industry and has stimulated or awakened the interest of industrialists in these matters. Information in regard to facilities available to industry through the Committee has been published in the manufacturers' own journals, in the press, and in a brochure entitled "Science in Industry." In conjunction with the Information Section, arrangements were made with the Department of Industries and Commerce for the joint publication of the *Industrial Bulletin*, which was previously issued by that Department. The *Bulletin* is now being issued in an attractive printed form. Qualified officers in the Dominion Laboratory have abstracted technical information from appropriate journals for dissemination to industry. It is hoped to extend this service in respect of scientific achievements within local industry.

Window displays were sponsored through several divisions of the Department during the "New Zealand Made on Parade" Week, organized by the Canterbury Manufacturers' Association in Christchurch during September, 1945, and also at Timaru during the period of the New Zealand Manufacturers' Federation Conference in March, 1946.

The resources of the Department's libraries and overseas liaison officers have been freely placed at the disposal of manufacturers, and endeavours are being made to develop the exchange of technical and industrial information especially with United Kingdom, Australia, and the United States of America.

The Committee has no scientific or technical officers of its own, all industrial projects being carried out in departmental or research association laboratories.

Fuel technology, involving investigations into the efficiency of fuel consumption in industrial boilers and suitable portable methods for the measurement of steam flow and of industrial temperatures, is passing the experimental stage, and it is hoped shortly to offer this additional service to manufacturers.

The Committee has maintained close contact with the New Zealand Institute of Chemistry (in regard to the placing of chemists in industry), the Federation of British Industries Industrial Research Secretariat, and the British Industrial Design Council, appropriate information being made available to industry.

As the immediate need to provide scientific and technical facilities for industry is being satisfied as fast as suitable staff and equipment will permit, the Committee anticipates being in a position during the coming year to give closer attention to its wider functions.

NEW ZEALAND WOOLLEN MILLS' RESEARCH ASSOCIATION (INC.)

Director: Dr. F. G. Soper

Committee.—Messrs. W. R. Carey (Chairman), H. Lee, T. C. Ross, W. L. Wood, J. Revie; Drs. E. Marsden, R. O. Page; and Professor F. G. Soper (Director).

Incorporation.—The present year is the first as an incorporated society. The activities of the Association have continued smoothly and satisfactorily under the new method of administration. In this connection the setting-up of a Local Research Committee in Dunedin under the chairmanship of Mr. T. C. Ross has been highly advantageous, allowing of decisions on routine business and discussion of work carried on in the laboratories at approximately six-weekly intervals. Help and facilities continue, as before, to be given by the Head Office of the Department of Scientific and Industrial Research, and any information obtained by the officers of the Department thought likely to be of interest to wool-manufacturing research is made available.

Unshrinkable Finishes.—During the present year 274 shrinkage tests have been carried out in the laboratories. As pointed out last year, the firms which utilized regularly the services of our research laboratories for routine testing of shrinkage properties of wet chlorinated fabric are those who are employing a mill chemist. It can now be reported that one firm not employing a mill chemist is also forwarding regularly samples for routine testing. The research staff finds that when firms do not have regular shrinkage tests carried out their non-shrink finish is not reliable in quality.

Assistance has been given to two more members in installing dry chlorination plants. Four such plants should be operating in New Zealand before the end of the year. Specifications have been drawn up for a certification trade-mark of "Wool Anti Shrink" for association with wool manufactured goods treated by this process or other such process as shall later be agreed on as giving equal results.

A resin process for conferring non-shrink properties has been investigated and material sent to the United States of America for treatment, and the samples on their return have now been shown to most members of the Association.

Research into Dyeing Processes.—Dyeing research has continued along two lines. The first has been the study of metachrome dyebaths mainly by pH measurements in dyehouses; the second has been a study in the laboratory of methods of dyeing after chrome blacks. The latter has not made the progress hoped for when the investigation was started. Difficulties have been encountered in the measurement of the strength of wool fibres, but a new line of attack is now being made.

In studying metachrome dyebaths in dyehouses an important discovery was made by Mr. Peryman that under commercial dyeing conditions the use of ammonium sulphate is not a reliable method of neutralizing alkali in scoured wool or for controlling the pH of the dye liquor. This defect in ammonium sulphate is apparently due to the difficulty in volatilizing ammonia from the commercial dye liquor, a difficulty which hardly arises in small-scale laboratory dyeings.

The importance to the dyer of a knowledge of the pH of his dye liquors led a number of firms to seek pH meters for their dyehouses. Unfortunately, deliveries from overseas were slow and the cost high. Efforts were made to have a suitable instrument built in New Zealand, and these efforts resulted last December in the production of a mains-operated pH meter, built largely by the Physics Department of the University of Otago, which performed well under test. Arrangements have been made for the commercial production of these instruments in Christchurch.

Manufacturing Trial of Hairy Wool.—In co-operation with the Wool Metrology Laboratory, Lincoln College, a start has been made on the further manufacturing trial of hairy wool of 58's quality at the Kaiapoi Mills. Further work on the mill trial has been planned to commence shortly.

Combing Trial on Exported Scoured Wool.—On behalf of the Department of Scientific and Industrial Research a test of the travelling properties of scoured wool is being made, with special reference to the combing properties of the wool after travel. The scouring of 58's quality wool has been supervised at the Bruce Mills. This wool is having a double journey to England and back. Plans have been made for the combing trial on its return.

Tests of the Insecticides D.D.T. and 666 for the Protection of Wool against Carpet Beetles.—The advent of these new insecticides was thought to offer hope of solving a problem which has engaged the attention of the Research Association since it was founded—namely, the elimination of losses in yarn stores due to damage caused by moths and carpet beetles.

As detailed in our Bulletin No. 40, D.D.T. has been found ineffective against carpet beetles on woollen yarn containing the usual amount of batching-oil, but about 0·2 per cent. D.D.T. on clean woollen goods gives promise of adequately protecting the wool. Some preliminary experiments with a purified form of 666, known as Gammexane, suggest that less than 0·3 per cent. Gammexane will protect the wool even in the presence of 10 per cent. batching-oil. These experiments are being continued.

Textile Education.—Many textile processes in the future will require the services of fully-trained graduates in the mills. The textile engineering training will probably have to be undertaken overseas, but it is unlikely that any one man will be able in the future to cover all the knowledge required in a woollen-mill. Following discussion at the last executive meeting on the desirability of establishing a post-graduate diploma course in colour chemistry and textile science (which is of interest not only to the woollen-mills, but also the artificial-silk industry, to dyers and dry-cleaners, colour printers, and laundries), the position has been further explored.

Service to Members.—Quarterly bulletins have continued to be prepared and circulated, as well as journals sent on loan from the library. Six reports on work in progress have also been circulated to date during the present year giving a brief statement of the work carried out.

The Chief Chemist made two rounds of visits to members' mills, on one occasion carrying test equipment which he used for a study of dyeing and wool scouring.

A range of technical service problems has continued to be dealt with in the laboratory. Examples of these were determination of grease and alkali contents of scoured wools and cloth, fibre fineness measurements on wools, strength tests on yarns and an investigation of the cause of deficient rubbing fastness of tops dyed afterchrome black.

PLANT CHEMISTRY LABORATORY

Director: Dr. J. Melville

The new building, which replaces the one destroyed by fire in 1940, is nearing completion and should be ready for occupation in May, 1946. It comprises four general and two special purpose laboratories with the necessary ancillary units, and in every way meets the requirements of modern biochemical research. Except for some few items of continental origin, the equipment which was lost by fire has been replaced during the war years and will be in keeping with the new laboratory. It is most gratifying that, after five and a half years of wholly inadequate and unsuitable accommodation, the staff will again have satisfactory working conditions.

Dehydration.—Since the cessation of hostilities the work on this project has been confined to rounding off certain phases of fruit dehydration. The fate of sulphur dioxide added to fruit during the dehydration process has been under investigation, and substantial progress has been made. Some work on vegetable varieties with regard to vitamin content and other nutritional qualities has been continued.

Vitamin Work.—Microbiological assays for several vitamins of the B complex in milk (in collaboration with the Dairy Research Institute) and other materials have been continued.

Hormone Weed-killers.—A number of experiments with the new hormone weed-killers, 2–4 dichlorophenoxyacetic acid (known commercially as 2-4D) and derivatives have been laid down. These weed-killers are very selective in action and are well tolerated by most grasses, whereas they are very toxic to a number of dicotyledons. A number of weeds common in lawns can be very readily controlled and also pasture weeds such as buttercup. Incomplete experiments with perennial weeds such as Californian thistle, convolvulus, blackberry, and gorse are showing considerable promise. The indications suggest that complete control may be obtained with three treatments.

Nitrogenous Metabolism of Green Leaves.—Our work on nitrogen metabolism which was discontinued during the later years of the war has been resumed with the same object as before—viz., a more accurate characterization of the constituents of the green leaf and their variation under different environmental conditions. The investigation is one of considerable complexity and will extend over a long period of time.

Antibiotics.—The Director spent five months in the United States of America studying the new field in chemo-therapy opened up by penicillin, and as a result authority has been granted for the establishment of an antibiotic unit within the organization of this Laboratory. Microbiological work will be done at Plant Diseases Division in Auckland, while a pilot-scale fermentation plant of 100-gallon capacity, together with the necessary chemical plant for the extraction and purification of the active materials, will be established in Palmerston North. The professional staff has been appointed, and it is hoped that the plant will be in operation by October, 1946.

Special attention will be paid to those materials which appear to have particular value against plant and animal disease.

Conservation of Pasture.—The Grasslands Division has now completed seven consecutive years' work on silage making, and this Laboratory has collaborated by carrying out the numerous analyses required for determination of losses, feeding value, &c. The high losses in digestible nutrients occurring under the best conditions warrant a fuller investigation of the changes which take place during the process.

PLANT RESEARCH BUREAU

Plant Research Bureau Committee.—Mr. A. H. Cockayne (Chairman), Sir Theodore Rigg, Professor E. R. Hudson, Professor G. S. Peren, Mr. E. J. Fawcett, Mr. R. B. Tennent, Dr. E. Marsden, Mr. C. A. Marchant, Mr. Alan Grant, and Mr. F. R. Callaghan (Secretary and Chief Executive Officer).

The Plant Research Bureau Committee at its forty-ninth meeting on 21st February, 1946, recommended to the Council of Scientific and Industrial Research that "the Plant Research Bureau Committee be disbanded and the Chief Executive Officer be held responsible to the Council for all recommendations regarding funds and programmes and conduct of plant research." At a meeting of the Council of Scientific and Industrial Research held on 22nd February the recommendation of the Plant Research Bureau Committee was approved.

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

Name.	Location.	Director.
Agronomy Division ..	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 ..	Tiritea, Palmerston North ..	Mr. E. Bruce Levy.
Plant Diseases ..	Owairaka, Auckland	Dr. G. H. Cunningham.

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

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

AGRONOMY DIVISION, LINCOLN

Acting-Director: Mr. R. A. Calder

PLANT-BREEDING

During the war period it was possible to undertake only a limited amount of breeding-work, but with the return of staff from overseas, activities in this direction will be extended.

Oats.—The main objective in the oat-breeding work is to develop high-yielding, good-quality oats which might be resistant to lodging. The variety Resistance has been used as the stiff-strawed parent.

Resistance × Onward: Of the eighteen hybrid lines grown last year, ten were retained for further trial this year, and of these seven are to be retained for the coming year.

Resistance × Algerian: Of the fifty-seven hybrid lines grown last year, twenty were retained for further trial this year, and of these ten are to be retained for the coming year.

An additional series of F_6 hybrid lines derived from crosses between Resistance and Grey Winter and Resistance and Alaska is to be grown for observation and selection during the coming season.

A further objective is the development of improved rust-resistant varieties, and a series of F_2 hybrid lines, in the establishment of which the resistant variety Victoria was used as one of the parents, is to be sown for observation and selection.

Barley.—A recent development has been the initiation of a barley-breeding project, the purpose of which is to develop a high-yielding malting variety of good quality which might be more suited for heading than the standard varieties. Maja, Kenia, Victory, and Wong, which are comparatively stiff-strawed varieties, have been crossed with Spratt Archer, Plumage Archer, Chevallier, Golden Archer, Gisborne, Pioneer, and Campton. An attempt is being made to propagate the F_1 plants in a specially adapted glasshouse during the winter in order that F_2 seed may be available for sowing in the spring.

Garden Peas.—The chief aims in the garden-pea-breeding work are—

(1) The development of an early variety superior in yield to William Massey (Kelvedon Wonder). During the past season several hybrid lines from the following crosses were grown both in a hand-sown yield trial and as spaced plants for further selection:—

(*a*) William Massey × (Greenfeast × Greatcrop).

(*b*) William Massey × [(Greenfeast × Greatcrop) × Harrisons Glory].

None of the lines was as early as William Massey, but several were only a few days later in maturity and gave higher yields.

A further extensive series of crosses was made.

(2) The development of a Greenfeast (Lincoln) type resistant to pea mosaic, using a mutant form found in Greenfeast as the resistant parent. Some of the most promising lines from the following crosses were included in a hand-sown yield trial using Greenfeast as control:—

(*a*) Greenfeast mutant × Greenfeast.

(*b*) Greenfeast mutant × (Greenfeast × Greatcrop).

(3) The development of a variety suitable for canning at the green-pea stage. Onward has been crossed with William Massey, Greenfeast, and Greencrop, and during the past season F_1 plants were propagated.

Field Peas.—Partridge peas are grown quite extensively in Canterbury, and breeding-work is being undertaken with a view to developing a type with shorter straw, ripening more evenly, and possessing higher-quality seed than the standard variety; commercial Partridge has been crossed with Black Eyed Susan, Mammoth Blue, and Dutch Blue, but the hybrid material is still in the early stages of investigation.

Kale.—The practice of growing chou moellier (marrow-stem kale) as winter forage both for cattle and for sheep is now being widely adopted. This crop, however, as it matures tends to shed its lower leaves and thereby is reduced in value. As it was considered that some improvement in this respect might be effected by breeding methods, chou moellier was crossed with several allied types. Of the hybrid material investigated, selections from the crosses chou moellier × thousand-headed kale and chou moellier × cabbage show some promise. Trials of these types were undertaken during the year at Lincoln, Gore, Palmerston North, and Gisborne and were sufficiently satisfactory to warrant increasing the hybrid forms for further extensive trials.

Swedes.—During the past season aphis infestation of brassicas was unusually severe, and swedes, particularly, suffered considerable damage. An observational trial had been sown to compare the behaviour of New-Zealand-grown varieties with that of imported lines, and whereas such varieties as Grandmaster, Superlative, and Crimson King were very heavily infested with aphides, the hybrid type, Dryland (Grandmaster × Sensation) and Sensation, showed considerable resistance, particularly in the early stages. This result tended to confirm the opinion that the Dryland variety might be a useful swede for Canterbury, and arrangements have been made to have it multiplied for further extensive trials. It has also been crossed with Superlative in an endeavour to eliminate the fangy nature of the bulb.

Linen Flax and Linseed.—The breeding-work on these crops is being maintained and it has for its objective the production of a high-grade fibre flax and a high-grade seed flax that are resistant to rust and to wilt. Rio, a linseed variety, has been used mainly as the resistant parent.

Lucerne.—The development of a lucerne type which would be more satisfactory for grazing than existing varieties would be an important advance. The spreading species, *Medicago glutinosa*, has several characteristics which fit it for such a purpose, but it also has several unsatisfactory features. It has been crossed with *M. sativa*, therefore, in an endeavour to combine in one type the better characteristics of both species, and during the past season approximately two thousand plants derived from this cross were planted out for observation and selection.

Potatoes.—The potato-breeding work is being maintained on a restricted basis until the return to the Division of an officer who has been stationed for some years at a Potato Research Station in Great Britain. Fifty-five hybrid lines were included in a yield trial and several in small increase plots. Most of these are from crosses between Katahdin and other imported commercial varieties, local commercial varieties, or *S. andigenum*, but most of them show signs of infection to a more or less degree with one or other of the virus diseases. Three lines were entered in the certification trials, and two of them, both derived from a cross between Katahdin and *S. andigenum*, show some promise.

Maize.—A maize-breeding project has been commenced in Poverty Bay. During the year forty-five hybrid lines were received from America and were sown for trial purposes on an area near Gisborne. These are being kept under observation, and if any particular one proves to be superior to varieties used locally it will be necessary to consider the following points :—

(1) Whether sufficient of the hybrid seed itself should be imported each year for local use ; or
(2) Whether the inbred lines from which the hybrid type has been created should be introduced, maintained, and used to provide the necessary hybrid seed for local use.

In addition, a second cycle of inbreeding has been started with this material and also a first cycle on some local varieties in an endeavour to produce our own inbred lines from which might be raised our own hybrid seed. Approximately one thousand self pollinations were made during January–February.

Tomatoes.—A reinvestigation of hybrid vigour in tomatoes is being undertaken.

Crop-introduction

During recent years it was not possible to introduce a very wide range of crop varieties. Some recent introductions of interest, however, have been—

(1) *Barley.*—Malting Types: Pioneer, Campton, and two hybrid lines from the National Institute of Agricultural Botany, Cambridge.

Feed Types: Prefect from the N.I.A.B., Wong from America, and Smooth Awned Cape from Australia.

These are all very promising varieties.

(2) *Oats.*—S. 84, S. 147, and S. 172 from the Plant Breeding Station, Aberystwyth, 10/3 (Resistance × Grey Winter) from the N.I.A.B., and Royal Scot and Spitfire from Gartons Ltd., Great Britain.

These are all milling types. S. 172 is of particular interest in that it is a short, stiff-strawed variety which should be highly resistant to lodging.

(3) *Ryecorn.*—Three Giant Winter types from Great Britain, Black Winter and South Australian from Australia, and Horton Fall and Balbo from America.

These are being tested with a view to isolating a type which might be satisfactory for green feed purposes.

(4) *Garden Peas.*—Several varieties were obtained from Great Britain, Australia, and America. None of these appear to be of particular importance, apart from a few of the English varieties which, through not very high yielding, produce exceptionally large pods and may be useful for crossing purposes.

(5) *Lupins.*—Several strains of blue, yellow, and white lupins have been received from Germany through the Imperial Bureau of Plant Genetics. Some of these are sweet and some bitter, and one at least is a non-shattering form.

(6) *Lucerne.*—Sixty-two distinct varieties or strains have been introduced from Australia and America for comparison with Marlborough and the pedigree strain developed at the Division.

(7) *Linseed.*—The three varieties, Bison, Walsh, and Golden Viking, recently introduced from America were compared in a drilled trial with New-Zealand-grown stocks of Rio and N.Z. Commercial.

(8) *Potatoes.*—Mohawk received from America and a line of Up-to-date free from virus X obtained from Australia are under trial.

(9) *Sunflowers.*—To determine whether sunflowers can be propagated successfully under Canterbury conditions, the varieties Southern Cross, Pole Star, Mars, Saturn, and Californian Manchurian were introduced from England and grown in a hand-sown trial. All varieties flowered and set seed satisfactorily, but the plots, though harvested, have not yet been threshed.

Pure-seed Production

The following crop varieties were grown for the production of pure seed either for certification purposes, for distribution to merchants, or for increasing for large-scale trials:—

(1) Wheat: Cross 7, Fife Tuscan, Solid Straw Tuscan, College Hunters, Hunters II, Dreadnought, Tainui, 7801.
(2) Oats: Gartons Abundance, Binder, Algerian, S. 17 (Gartons Abundance × Ruakura).
(3) Barley: Spratt Archer, Plumage Archer, Chevallier, Wong, Pioneer, Smooth Awned Cape
(4) Garden Peas: Greenfeast (Lincoln), Onward, William Massey (Kelvedon Wonder), Greencrop (Greenfeast × Greatcrop), Pioneer.
(5) Rape: Giant.
(6) Kales: Giant chou moellier, medium-stemmed chou moellier, thousand-headed kale.

(7) Lupins: Sweet Blue, Sweet Yellow, Sweet White flowering.
(8) Linen Flax: Stormont Gossamer, Stormont Cirrus, Liral Prince, and three Russian rust-resistant varieties introduced last year.
(9) Mangels: Yellow Globe.
(10) Carrots: Holmes Improved.

On behalf of Grasslands Division—

(11) Grasses: Perennial, Italian, and short-rotation rye-grasses, timothy.
(12) Clovers: Montgomery Red, Broad Red, White.

Other Activities

(1) *Weed Control.*—Further trials with Sinox confirmed previous results—*i.e.*, that it gives excellent control of weeds in linen flax when correctly used, but that we cannot as yet define sufficiently accurately the conditions of use to enable us to recommend its general use for this purpose.

Preliminary trials have been made with Methoxone and Weedone received late in the season. As the real efficacy of these hormone weed-killers against deep-rooted perennial weeds cannot be assessed for some months, no report is yet available.

(2) *Linen Flax Manurial Trial.*—A comprehensive manurial trial was undertaken. This was designed to determine, in terms of total crop yield, line fibre yield, and seed yield, the effects of applying several fertilizers alone or in combination.

(3) *Green-manuring Trials.*—A trial was carried out to determine the effect on the yield of wheat of ploughing in lupins at different stages of maturity. The results obtained were in favour of delaying the ploughing-in of the lupins until the crop was at the full pod stage, but further evidence is necessary before any recommendation could be made.

(4) *Cultivation Trial.*—Two trials, one observational and one replicated, have been arranged to determine the effects on subsequent crops of different methods of cultivation. As the basic operation, discing is to be compared with shallow ploughing and with deep ploughing.

(5) *Vegetable Work.*—In order to obtain additional information concerning varietal behaviour preparatory to the establishment of a Vegetable Research Section, a further series of vegetable varieties was grown. This included cabbage, cauliflower, brocolli, Brussels sprouts, spinach, carrots, parsnips, red beet, onions, lettuce, radishes, swedes, and sweet corn.

(6) *Grassland Section.*—This is under the control of the Grasslands Division and the following series of investigations is being undertaken:—

(*a*) Trials to determine the comparative performances of several hybrid rye-grass types, either alone or in mixtures, under two distinct grazing techniques.
(*b*) Trials to determine the changes in a normal sward which may be brought about by the "return" or "no return" of animal dung and urine with super plus lime superimposed at three different rates of sowing or with no fertilizer added.
(*c*) Seed-production trials with cocksfoot.
(*d*) Single plant studies and plot trials of grass and clover breeding material.

BOTANY DIVISION

Director: Dr. H. H. Allan

Staff and Accommodation

Owing to extreme shortage of staff it has not been possible to expand the work of the Division to cope fully with many urgent problems that have come before it during the year. In particular it has not been possible to render the full service to Catchment Boards that they desire. The Division still suffers also from being housed in quarters not originally designed for its purposes, and not capable of being really suitably modified. Even with an inadequate staff the present quarters are insufficient in space.

Identification and Advice

This work continues to serve Government Departments, public bodies, educational organizations, and the general public. Over two thousand specimens have been identified and reported on. Advice on numerous botanical matters has also been afforded. Increasing assistance has been asked for and given in the examination of vegetable material, especially seeds, in the stomach contents of game birds from departmental and other sources. The seed herbarium has been augmented to assist this work and now contains some three thousand five hundred packets of specimens.

Herbarium

Many valuable accessions have been added, mainly by the efforts of members of the staff, and the herbarium has been reorganized as far as possible under the present conditions. As an adequate herbarium, suitably housed and arranged, forms the essential basis of much of the work of the Division, the disabilities of the present quarters are severely felt.

Vegetation Surveys

Three weeks were spent studying the vegetation of the southern fiords from Preservation Inlet to Doubtful Sound, and the results are being prepared for publication. It is a pleasure to record how willingly all members of the exploratory party helped the botanical section. A preliminary survey was made of an area at Whangaroa for the Nelson District Committee, with a view to suggesting lines of work in reafforesting the area with native trees. Further survey work was done in the neighbourhood of Tarndale and Lake Tennyson. Work was also continued for the Wairarapa Catchment Board.

Weed Investigations

A survey of nassella areas in Marlborough revealed a serious increase in the areas densely covered with nassella since the 1941 survey. Scattered infestation now covers 60,000 acres, as compared with under 5,000 acres in 1941.

Weed surveys have been made as follows: Upper Hutt to the Summit Station, an area treated by the experimental weed train; Ahuriri lagoon, in connection with renovation proposals; Southland, especially the phormium areas; Napier to Hastings; Hauraki Plains, with special reference to the incidence and control of reed sweetgrass (*Glyceria aquatica*); Bay of Plenty, with special reference to the honey-producing flora. Throughout these surveys special watch is kept for potentially serious weeds.

Linen-flax Investigations

These were undertaken in co-operation with the Soil Bureau, and a full report is in the press. Six varieties, of which Norfolk Earl was the best, showed a moderately good fibre picture. Top-dressing with ammonium and potassium sulphates gave a small but significant increase in fibre diameter. A tentative grouping of soil types in relation to fibre quality was made as a result of the examination of crops in the Geraldine and Fairlie districts.

Peat and Pollen Studies

Work has been done on the Mungaroa and the Hauraki Plains peat deposits. A paper has been prepared on a particular peat profile at Waitakaruru in an area under pasture showing copper deficiency. Keys to material found in New Zealand peat deposits have been prepared to facilitate the investigations, and are being tested.

To enable work to be done on economic problems needing a knowledge of pollen, a large reference collection of pollen slides has been built up. Slides exposed daily on the roof of the Wellington Hospital have been received for identification, and a full record of the species found, and their seasonal abundance, kept. Results indicate that three pollen seasons occur, dominated by tree, grass, and herb pollens respectively. A number of pollens definitely associated with hay-fever have been found in the slides, including pollen of the indigenous species of *Coprosma*.

Samples of honey have been examined for pollen content, and the relative abundance of the different species noted. Pollen of tutu (*Coriaria*) was observed in samples of unmarketable honey, and other lines of investigation have confirmed that the deleterious factor was honeydew collected by bees from the leaves of tutu.

Poisonous and Medicinal Plants

Material from a number of indigenous and exotic species has been gathered for studies on their toxicity to farm animals being made at the Animal Research Station, Wallaceville. Leaves of pigeonwood (*Hedycarya arborea*) and pukatea (*Laurelia novae-zelandiae*) proved toxic to sheep. Strathmore weed (*Pimelea prostrata*) did not prove toxic to sheep.

As there appears to be no indication that any extensive production of medicinal plants is likely to be undertaken in New Zealand, work has largely been in maintaining nucleus stocks of the more important species. The selection of *Datura stramonium* and *Atropa belladonna* have been tested with a view to further elimination of the less productive strains. Selections of various species of wild rose and sweetbrier from local and British sources have been tested, and those richer in vitamin content are being retained.

Phormium Investigations

Fibre and milling tests have been continued, and full reports made. The variety 56 proved of sufficient quality to justify more extensive planting. It gives a strong yarn, and is favourably reported on for rope-manufacture. Ngaro can be utilized for warp yarn, but is more suited to cordage than textile purposes. Leaf from the cross *Phormium colensoi* by *P. tenax* produced a soft pliable fibre of considerably finer thread than Ngaro, with excellent spinning qualities. It works up into excellent sewing-twine. A large area has been established for further trials, and specially selected plants are being propagated for testing.

A survey was made of phormium areas in Southland and a detailed report submitted.

Yellow-leaf has become a serious problem on the Moutoa Estate, and a comprehensive scheme of investigation is under way, aiming at discovering the cause of the disease and methods of control. This work is a co-operative effort with the Soil Bureau and the Plant Diseases Division. All possible aspects of the problem are being studied.

Work on seedling production is in progress to test glasshouse against open-bed methods, to ascertain the relative germination of different strains and the longevity of seed.

Tussock Grassland Renovation

Seeds of species likely to be of value have been sown in the various experimental plots. Special work has been done on the plot at Molesworth Station. This area has been studied in detail and permanently charted to ascertain the rate of renovation of the tussock and associated grasses, the effects of grazing, the results of spring and autumn burning, the role of scabweed, and feasible methods of sowing down. A number of species from South African and American sources have been sown. The most promising so far are several American species of blue-grass (*Agropyron*), but there is little to indicate that these will be superior to the native blue-grass (*Agropyron scabrum*), which has also been sown. Variegated lucerne gave promise, but was eaten out by rabbits that entered the enclosure. A nursery area has been established near the homestead to supplement the sowings made on the plot. Promising species are being propagated at the Waiwhetu Experimental Area, and good harvests have already been obtained of native blue-grass and certain bromes. A paper has been prepared giving the history and results of regrassing trials on tussock country throughout the South Island.

Erosion Control

Further vegetational survey work has been done in the area controlled by the Wairarapa Catchment Board. A nucleus line of shipmast locust supplied by the Soil Erosion Council has grown vigorously, and will now be multiplied. Athel-tree (*Tamarix aphylla*) has also grown well and will shortly provide a good series of cuttings for propagation. Further supplies of seed of kudzu-vine have come to hand.

Seaweed Investigations

Fundamental studies on the taxonomy and ecology of species of economic importance have been continued and papers prepared for publication. The seaweed herbarium has been considerably augmented. Further field studies have shown that there remain areas yielding valuable quantities of agar-weed that have not yet been drawn on, but that there may be difficulty in organizing collection.

Taxonomy and Ecology

The taxonomy of the indigenous grasses is receiving detailed study, and a paper is in preparation on the species of *Danthonia*. Work is also being carried out on the taxonomy and ecology of scabweed and related species, and on the different varieties of blue-grass (*Agropyron scabrum*).

ENTOMOLOGY DIVISION

Director: Dr. D. Miller. Associate Director: Mr. J. Muggeridge

Grass-grubs (Odontria spp.)

The establishment of the field station at Ashburton in connection with the grass-grub project has reached the stage where contracts have been let and plans approved for the erection of the laboratory accommodation.

Field surveys have been carried out to determine the fluctuation of grass-grub populations during infestations. A study is being made of the influence of varying soil moisture and relative humidity upon grass-grub and egg development. Experiments are being carried out on the influence and possible use of insecticides for control of the larvæ.

As a result of a preliminary survey made during May and June, 1945, into the possibilities of securing parasites from Australia, an officer has been stationed in the south coastal region of Victoria to carry out a detailed study of the subject.

A consignment of the parasitic nematode (*Neoaplectara glaseri*), which infests *Popillia japonica* and other soil insects in the United States of America, was received in 1945 by courtesy of the Rockefeller Institute for Medical Research. This nematode has been tested against the larvæ of *Odontria zealandica* and proved positive, though it is possible that field experiments will reveal that the rather dry soil conditions in the Canterbury area may militate against its use. On the other hand, the nematode has been found to attack the destructive subterranean grass-caterpillar (*Oxycanus*), and since this insect tends to occur in heavier and moister soils the parasite may be more effective against the caterpillar than against the grass-grubs.

Experimentally *Bacillus popilliae*, the causal agent of "milky disease" of *Popillia japonica* in the United States, was found to attack the larvæ of *Odontria zealandica*. However, it has been discovered that a similar but distinct bacillus already occurs in New Zealand and is responsible for a milky disease of *O. zealandica*. The relative virulence of the two organisms in relation to the host, and the temperature ranges within which they are active, have to be investigated.

A comprehensive monograph has been prepared on the taxonomy and distribution of the New Zealand Melolonthidæ, both beetles and larvæ having been dealt with.

Tussock Deterioration

In connection with this problem, attention is given to the possible influence of insects. Observations in the McKenzie-country reveal that the larvæ of the noctuid moth (*Persectania ewingi*) are the only type of insect universally present in significant numbers. This insect is periodically epidemic on pastures in Tasmania and as a crop pest in lowland Canterbury. At the present time there is not the evidence to show that insects are an important factor in tussock deterioration, but special attention is being given to *P. ewingi* in order to secure data on its place in the problem and as a guide for more extended study.

Red-legged Earth Mite

This mite (*Halotydeus destructor*), a serious pest of subterranean clover in western Australia and of vegetables in South Africa and southern Australia, has become established on the reclaimed Ahuriri Lagoon area at Napier, where it has caused severe damage to spring vegetables. Though the mite has probably reached the subterranean clover at Roy's Hill, there is no evidence of damage there so far. This pest is likely to be a problem where vegetables are grown on light soils, but is unlikely to become of importance in the case of subterranean clover as it is, for example, under the specialized climatic and pasture conditions of Western Australia. A sodium-arsenite chaff bait developed in Australia showed some promise of effective control when frequently applied.

Cheese-mites

The experimental study into the control of cheese-mites (in co-operation with the Dairy Research Institute) has been completed. Waxes, dusts, and fumigants were tested. It was found that mites were able to penetrate a covering of wax and reach the cheese, while dusts proved ineffective as barriers to mite-infestation, the high humidities normal in cheese-stores being an inhibiting factor. In the case of the fumigants both ammonia and methyl bromide are effective acaricides, but the former is unsuitable largely on account of ready absorption by the cheese, while the latter is expensive and lacks the persisting qualities characteristic of dichloroethyl ether. This last was found to be the most satisfactory acaricide in all respects, including cost. Though dichloroethyl ether is effective when applied as a vapour, it is more conveniently applied as a liquid, and its influence is more lasting by that method. Under such circumstances the dosage, applied to the shelving of the curing-room, is at the rate of 1 lb. per 1,000 cubic feet of room space; another equally effective method is to stand the cheese on treated scale-boards.

In the experiments on the inter-relationship of mite species attacking cheese successive counts at regular intervals from the same mite population have shown that the relationship follows a well-defined curve. An attempt is now being made to demonstrate that a similar relationship exists in population samples taken from a number of different cheese-factories. So far the same general trend in preliminary figures is apparent, though inconsistencies are naturally more marked. Observations have been carried out upon conditions associated with mite infestations in cheese-factories and produce stores.

A comparative morphological study of the developmental stages of *Tyrophagus longior* and *Tyrolichus casei* is being carried out, while a systematic work has been prepared on the several species of mites encountered during the investigation.

Timber Borers

A new and effective technique has been developed for simplifying the analyses of data concerning the egg-laying of *Anobium*.

Preliminary tests with the following wood preservatives have been completed: zinc chloride, chlorinated naphthalene, zinc naphthenate, pentachlorphenol, Tanalith, and Celcure. Water-soluble preservatives did not prevent *Anobium* from ovipositing,

while, in lower concentrations, there is a tendency for larval tunnelling to be prolonged. Though oil-soluble preservatives were found to be highly toxic to beetles, *Anobium* larvæ tunnelled for a period of over four weeks in timber completely penetrated by the preservatives.

In tests with the brush application of oil-soluble preservatives it was demonstrated that one coat for every quarter-inch of timber thickness gave satisfactory control of *Anobium* and *Calotermes brouni*.

Diamond-back Moth

During the past few seasons field surveys of the main cruciferous crop areas in both Islands have been carried out to ascertain the influence of the introduced parasites (*Angitia cerophaga* and *Diadromus collaris*) in controlling the diamond-back moth. The last of the surveys has been completed and a full analysis of the data is now being made. The indications are that the parasites have proved extremely effective, though control in the South Island does not appear to have yet reached the same high level that occurs in the North Island. Even so, the results are excellent. In some *foci*, however, odd crops still show a pronounced infestation of the moth larvæ, and the factors responsible for this have yet to be studied.

White Butterfly

As the occasion allowed, the larval parasite (*Apanteles glomeratus*) of the white butterfly has been distributed from Nelson, where it is well established, to other parts of the Dominion.

GRASSLANDS DIVISION

Director: Mr. E. Bruce Levy

Establishment

Plans for the new grasslands building at Palmerston North have been revised and submitted to the Architect, Public Works Department, for draughting for incorporation into the 1947–48 building programme.

During the war the staff loyally put up with very great inconveniences in temporary accommodation consisting of Army huts, Public Works Department hutments, seed-cleaning store, implement-shed, covered-in glasshouses, and men's quarters.

The task of removal to, and remodelling of glasshouses on, an appropriate site has been undertaken during the year, and these four houses and potting-sheds are almost completed.

A combined implement and wool shed, feeding-shed, office, store, and yards has been erected at Lincoln Substation, and this building will greatly faciliate the work there.

The linen-flax-factory site and appropriate buildings have been taken over at Gore, and a substation is now established there.

The acquisition of these substations are links in a chain of such in order to give coverage of soil and climatic conditions throughout New Zealand, both for the purpose of breeding, selecting, and testing new strains and as focal points for the encouragement of the use of the improved strains through New Zealand.

Plant-breeding

Breeding of improved grasses and clovers to cater in the ultimate for a complete agronomic coverage of the farming systems throughout New Zealand and allied climatic countries overseas has progressed a stage further towards our goal during the year. The rye-grass coverage has been extended to include Western Wolths rye-grass for one-year leys and special winter supplementary feed, and Long-rotation rye-grass for leys up to six to eight years' duration. Thus pedigree strains in Western Wolths rye-grass, Italian rye-grass, Short-rotation rye-grass, Long-rotation rye-grass, and true perennial rye-grass give a complete agronomic range as far as these species and varieties are concerned.

A pedigree leafy cocksfoot and a pedigree leafy timothy have been added to the grasses, and both these will find a ready place in short- and long-rotation pastures.

Short-rotation rye-grass is already filling a long-felt want, and glowing reports of its performance in the field are coming to hand. The factor of persistency is still receiving attention, and whereas the first selections were somewhat lacking in persistency under very hard environmental conditions, this deficiency is being remedied in the latest selection now being increased.

Pedigree Broad Red clover, pedigree Montgomery Red clover, and pedigree White clover, are readily finding a place in temporary, short-rotation, long-rotation, and permanent pastures. The trade in pedigree seeds continues to expand, and these must soon have a very great influence on production and are bound to encourage a plough-up and resow policy as soon as normal conditions return to the farm.

Blind-seed Disease.—Breeding for resistance to blind-seed disease in the rye-grass family has been continued, and for this work the new Gore Substation will be of very great value. One thousand single plants containing all rye-grass types and the parental material of all bred plants were put out at Gore, and those which seeded last summer have been separately harvested and threshed. Germination tests are being made, and it is hoped, by handling large numbers of plants in open-air conditions in a climate that is patricularly favourable to the development of the disease, that some resistant plants will be isolated to serve as nucleus material for the building-up of a resistant strain. At present blind-seed disease threatens to ruin the rye-grass-seed trade in many parts of New Zealand, and evidence during the past three to four years appears to indicate that the disease is spreading into districts that could normally be relied on to produce high-germinating seed.

Testing of Selected Types.—A feature of the plant-breeding programme is the testing under broadcast pasture-sward condition of promising types that may ultimately form improved strains or become incorporated into the standard pedigree line of seed.

The broadcast sward is also used to check up on the behaviour and production of nucleus lots of seed before these actually go forward to the seed-increase stage. One-tenth-acre areas are sown, and these are regularly grazed by sheep, measurement of production being made simultaneously by frame enclosures. These tests are being conducted at Palmerston North, Lincoln, and Gore, and it is later hoped to establish substations in other climatic zones in New Zealand.

During the year plots of Western Wolths rye-grass, Italian rye-grass, Short-rotation rye-grass, perennial rye-grass, and mixtures of the two latter have been laid down. Similarly, types of cocksfoot, timothy, and red clovers have been established for comparative measurement work under broadcast and grazed conditions.

This autumn a series of short-rotation pastures were laid down at Palmerston North and at Lincoln, and a spring sowing of these will be made at Gore. In this later series the new Long-rotation rye-grass is included.

The trials of the rye-grass hybrid types that make up the blend for the Long-rotation rye-grass have done very well at Palmerston North and at Lincoln over the last two years. It is anticipated that this strain is destined to play a very useful role throughout both the North and South Islands.

A further development is the testing of bred pedigree seeds for the possible improvement of hill country grasslands. Some 15 acres have been differentially sown to incorporate bred strains as single dominates within the mixture.

Strain Ecology

The study of pedigree seeds and their behavour under many conditions of soil, climate, and grazing management has been renewed in full collaboration with the Department of Agriculture. In this work this Division provides seed in weighed-out plot lots to officers of the Department of Agriculture, who make all arrangements to sow them out and report on progress. Periodical inspections are made by officers of this Division.

Nucleus-seed Production.—The season was again a most unfavourable one for seed-production in the Manawatu, and the late spring put all the crops back. Sufficient seed, however, has been produced to sow the necessary increased areas at Lincoln. A small area of Long-rotation rye-grass was harvested for trial purposes.

Testing for Certification.—The number of samples for plot testing again increased this season, and with the inclusion into certification of more and more species and strains of those types that cannot be determined by any laboratory method this increase in plot testing is to be expected.

In certain cases where contamination in the field was suspected single plant analyses of these lines were made. Contamination in some of these lines was definitely proven.

Field Ecology

Influence of the Animal in Pasture-production.—The outstanding feature of the grazing trials at Lincoln, where return and non-return of animal residues was being studied, was the marked differential response in the species of the sward. Where full return of residues was permitted under an intensive system of grazing, the rye-grass was so stimulated as to subdue very greatly the red clover in the sward. On the other hand, where the rye-grass was weak owing to non-return of stock residues the red clover abounded and in the summer period the non-return plot yielded double the summer production as compared with the full-return plot. This indicates a very important aspect of farming in Canterbury, where special treatment should be meted out to those pastures designed to produce summer feed.

In comparative manurial trials at Lincoln under non-return and full return of stock residues, the animal has had more influence in soil-fertility building and in production than has the artificial manures applied in both cases.

Pasture-measurement Technique.—Some useful results have already been obtained from the series of trials at Lincoln and progress towards the evolution of a technique that can give a reliable measure under the influence of the grazing animal has been made. The trials to date rather indicate that there is no simple technique that can give reliable data from small plots within a common enclosure. Where sufficient land is available, the separate per treatment enclosure with moveable frames within the enclosure gives good results with a modicum of simplicity in carrying out. The minimum size of these enclosures is $\frac{1}{10}$ acre and the minimum size of the frames is 10 ft. by 10 ft.

Dry-matter Economy under Four Systems of Farm-management.—There are now established at Palmerston North four small farm systems, thus—

(1) All-grass farm, bringing in extra stock to consume *in situ* excessive feed in the spring.
(2) All-grass farm, with conservation of excess spring feed as hay and silage.
(3) All-grass farm, with use of special-purpose pastures, spelled pastures, and specially manured pastures for out-of season grass.
(4) Grass plus supplementary crops for out-of-season feed.

An effort is being made to determine the most efficient system as to (1) the total production of dry matter and (2) the most economical exploitation of dry matter under the four systems.

From work on hay and silage that this Division has carried out over the past eight years there appears to be a serious dry-matter loss in any system that calls for preservation of feed. From an analysis of these results the surmise is that the hay-silage farm will produce less and there will be a loss of soil fertility as compared with any of the other systems. The question is, can this farm loss be measured, and, if so, is it significant?

Digestibility and Nutritive Value of Feeds.—During the year, both at Palmerston North and at Lincoln, feeding trials have been conducted with fodders on behalf of the Agronomy Division to arrive at relative digestibility and nutritive value. The trials are still proceeding. The institution of a satisfactory feeding technique for this work applicable to fodders and pasture plants is being sought for more intensive feeding trials on improved grasses and clovers.

Cocksfoot-seed Production.—Trials at Lincoln and at Eiffelton have been continued and the results of the last three years are in course of compilation. Interest in the investigation lies in the need for the cocksfoot plant to conform to certain specific ecological conditions wrapped up largely in the matter of light intensity to the crown of the plant and in an adequate supply of nitrogen. The diminution of dead bottom by mechanical means, by a certain grazing intensity, by burning, or by special manurial or chemical applications to facilitate and hasten decomposition of the dead leafage, is a special feature of the investigation.

Herbage Dissection.—All pasture trials for production are on a dry-matter basis, and in the case of species trials within a mixture the basis is single species production also on a dry-matter basis. The work involved in making these analyses on a species basis is very great and the use to which this service is put is on the increase.

Turf-production

Aerodromes.—With the end of the war the attention to aerodromes will diminish. The work is becoming more and more of a routine nature, and the aerodrome field staffs are now becoming so apprised of the technique of aerodrome-turf maintenance that little more time need be given aerodromes from a research point of view. Several of the staff who were full time on aerodromes during the war are now returning to their former research work.

Greenkeeping Research.—The Division is regularly approached for advice on the establishment and maintenance of all manner of playing-greens, and more and more sports clubs look to this Division as an outcome of the results from the greens research work which has been conducted in collaboration with the New Zealand Golf Council and local Greens Research Committee.

Soil Conservation

Soil conservation must be regarded as a prerequisite to land use wherever farming over an extended period of time is being practised. The hill country in the North Island has now been felled upwards of sixty years and the log and stump phase will soon be a thing of the past. Forest trees originally prevented large-scale erosion. Their stumps served to anchor the surface soil after the forest had been cut and burnt. These stumps are now rotting and it is possible that the grass turf itself is not sufficient to prevent another cycle of accelerated erosion such as took place in the early sculpturing of the hills and valleys prior to the vegetative cover gaining the upper hand. Now that the vegetative cover is gone, a cycle of accelerated erosion could occur again with devastating effects not only to the hills, but also to the fertile plains that were built from soil and debris of some prior period of accelerated erosional activity.

The research task is seven-fold :—

(1) To stop further downward scour in the valley bottoms.
(2) To heal head erosion up the valley.
(3) To align the stream down the middle line of the valley.
(4) To safeguard the valley bottoms where erosion has not yet occurred.
(5) To repopulate the hillsides with trees, spaced at varying densities per acre according to the degree of slope.
(6) To study the relationship of spaced trees and the pasture sward.
(7) To thicken up the grass sward by top-dressing, by oversowing seed of additional species and strains of these, and by regulated grazing management.

This Division, in collaboration with the Manawatu Catchment Board and the Poverty Bay Catchment Board, has already taken the initiative to implement the building of debris dams and the planting of gullies. Experimental sowings of grasses, clovers, and shrubs on eroding surfaces and on weak grassland turfs have been made on some 150 acres in the Poverty Bay area and 50 acres in the Manawatu district. A programme of hillside plantings with spaced trees has been initiated at Te Awa, where some 20 acres have been so planted. Arrangements are in hand to plant additional trees this coming winter and to top-dress most of the areas already surface sown with seed.

Preliminary botanical analyses of the present swards have been made from which later improvements may be gauged.

Pollen for Medical Institutes

This service has been continued and 462 grams of pollen were supplied during the year.

Meteorological Station

The equipment of this station is now complete and climatological data is recorded daily.

PLANT DISEASES DIVISION

Director: Dr. G. H. Cunningham

I. Plant Diseases Investigations

(*a*) *Turnip-mosaic.*—Further investigations on resistance of swede varieties have confirmed the high resistance of Sensation and shown that the new variety, Dryland, produced by the Agronomy Division, is almost equally resistant.

(*b*) *Aphid Survey.*—A survey of potato crops in Manawatu, Rangitikei, and Hawke's Bay districts was carried out for the Department of Agriculture. Its purpose was to ascertain if any region suitable for production of seed tubers was free from aphides which carry virus diseases.

(*c*) *Pea-mosaic.*—Work of breeding garden-pea varieties immune to this virus has been continued in collaboration with Agronomy Division. Of eighteen crosses tested, one only proved susceptible.

(*d*) *Cucumber-mosaic.*—Work is being carried out to ascertain if any cucurbits grown in New Zealand are resistant to this virus. All commercially grown varieties proved susceptible. Varieties of pumpkin, marrow, and squash are also being tested.

(*e*) *Tree-tomato Mosaic.*—A virus disease has been demonstrated on this host. It has been found to be transmitted by aphides. The identity of the virus is being investigated.

(*f*) *Spotted-wilt.*—The natural host range of this virus has been extended to include calla lily at Auckland and garden pea at Christchurch.

(*g*) *Tomato Viruses.*—During the year an additional two virus diseases have been discovered on tomato. Their identity is being investigated.

(*h*) *Leaf-mould-resistant Tomato.*—Work is being continued on breeding a dwarf tomato resistant to the fungus *Cladosporium fulvum*. Several crosses have been produced which are of good quality and yield well but have not yet been tested for resistance to leaf-mould.

(*i*) *Yellow-leaf.*—A comprehensive investigation has been commenced into cause and possible control of this disease of *Phormium tenax*. Yellowing follows death of roots and rhizomes. Over nine hundred isolations from diseased material have been made which yielded various fungi and bacteria. Inoculations have been made with these, but results are not yet available. The symptoms have been produced under artificial conditions without use of any pathogen, suggesting the disease may be of physiological origin.

(*j*) *Head-smut of Maize.*—Investigations have shown the fungus is both soil and seed carried.

II. Therapeutants

(See also Fruit Research Report, p. 20.)

A. *Improvements in Disease Control*

(*a*) *Anthracnose of Beans.*—Further work has been carried out to ascertain effects of Bordeaux mixture and Cuprox sprays on control of the fungus *Colletotrichum lindemuthianum* attacking dwarf beans. Results are not yet available.

(*b*) *Halo-blight of Beans.*—Similar investigations into control of this bacterial disease have been continued. Results were affected by the abnormally dry season Copper sprays reduced infection to a low percentage. One copper product caused appreciable leaf injury.

(*c*) *Passion-fruit Diseases.*—Further experiments have been carried out in control of grease-spot (*Phytomonas passiflorœ*) and brown-spot (*Alternaria passiflorœ*). Four applications of Bordeaux 3–4–50 at monthly intervals during the winter gave almost complete control of both diseases, though owing to the dry season brown-spot infection was slight.

(*d*) *Mealy-bug of Grape*—Preliminary investigations have been made into effects of D.D.T. and Gammexane on control of this pest of grapes grown under glass. Promising results were secured with D.D.T., and work is being continued.

(*e*) *Bean-weevil.*—Work on use of various powders for control of weevil in stored beans has been continued. Materials used were the inert hydrated lime, kaolin (New Zealand clay), copper compounds, copper carbonate, and Cuprox, and insecticides D.D.T. and Gammexane. Most effectual control was secured with Gammexane, which at a concentration of 0·001 per cent. gave almost complete control. Even three months after treatment excellent control was secured when weevils were added to treated seed. Fair to good control was secured with the other products, save hydrated lime, which was of indifferent value at a concentration of 4 per cent. W/W.

(*f*) *Cabbage-pests: Control Experiments with D.D.T. and Gammexane.*—Comparative trials between these new insecticides used in the form of dusts were made for control of white butterfly and diamond-back moth. Results show that D.D.T. is of outstanding value for control of both. Virtually complete control was secured with a dust containing approximately 0·75 per cent. D.D.T. applied at from 7½ lb. increasing to 18 lb. per acre. A dust containing 0·29 per cent. Gammexane gave only slightly less control than the D.D.T., but was superior to derris dust containing 0·5 per cent. rotenone.

(*g*) *Carrot-aphis.*—Gammexane proved superior to D.D.T. at equivalent dosages in control of this pest. Nicotine sulphate (40 per cent.) at 1 gallon in 600 gallons of water gave control equal to that secured with Gammexane.

(*h*) *Comparative Tests of Dithane, Cuprox, and Bordeaux for Control of Late-blight of Potatoes and Tomatoes.*—On potatoes results with Dithane were disappointing, late-blight infection being appreciably higher than on plants sprayed with copper compounds. On tomatoes the disease did not develop owing to the dry season; it was shown, however, that foliage damage was appreciably greater in plots sprayed with Dithane.

B. *Soil-disinfection Studies*

(*a*) *Damping-off.*—Work has been continued on investigations into control of *Verticillium* by soil disinfection with various chemicals. Formalin gave good control at concentrations of 1–50 to 1–80; paraformaldehyde at 1–25 and 1–50. Chloropicrin gave good control; D.D. was satisfactory, whereas other materials tested gave poor results.

(*b*) *Eelworm.*—Similar trials were made for control of eelworm in the soil. Good results were secured with D.D., satisfactory with chloropicrin, and—when used at three times the concentration of the above—carbon disulphide, D.D.T., and Gammexane gave poor results.

(*c*) *Grass-grub.*—Satisfactory control of grass-grub in lawns was secured with chloropicrin, D.D., and carbon disulphide. Inconclusive results were secured with D.D.T. and Gammexane.

C. *Therapeutant Testing*

Methods are being developed for bio-assay of insecticides by establishment of a Drosophilid fly technique, and by semi-field trials.

III. Pomology Investigations

(See Fruit Research report, p. 22.)

IV. Timber Preservation Investigations

(See Building Research report, p. 8.)

V. Miscellaneous

(*a*) *Fabric-proofing Investigations.*—Canvas: An extensive series of investigations has been completed on methods of proofing canvas, &c., against attacks of fibre-destroying fungi. In the result a technique for testing has been devised, suitable chemicals ascertained, and their dosage rates defined. During the course of the work it became evident that several test organisms should be used, since of the four chosen by New Zealand and overseas workers (*Stachybotrys*, *Metarrhizium*, *Chaetomium*, and *Memnoniella*) the first was more tolerant to copper soaps than the others; *Metarrhizium* more tolerant to pentachlorophenol than the others. Additional to the chemicals previously examined (chlorinated phenols, copper and zinc soaps and naphthenates, &c.), zinc hexoate, cadmium naphthenate, and two plastic resins have also been tested.

Rope: Numerous tests have been made to ascertain those effectual in proofing rope and cordage from attack by fungi, chemicals being incorporated with the product during manufacture. Of the products tested, copper naphthenate at a concentration of 0·5 per cent. metal proved to be most effectual. Cordage treated with creosote showed a loss of 30 per cent. in tensile strength.

(*b*) *Testing of Household Insecticides.*—Equipment is being prepared for testing household fly sprays, dusts, &c., both with a view to fixing toxicity standards and for future certification of satisfactory products. Work in developing a technique for breeding adequate numbers of test flies is being completed, and as soon as chambers have been installed large-scale investigations will be carried out.

(*c*) *Moth-proofing of Fabrics.*—Similar equipment is being developed for providing methods of treating fabrics to protect them against insect attack. Work at present has been directed towards breeding quantities of insects for testing purposes.

(*d*) *Effects of D.D.T. on Bees.*—To ascertain toxicity effects on bees of D.D.T. sprays applied to apple-trees, eight beehives have been placed in the orchards at Oratia and Owairaka at varying distances from blocks of sprayed trees. In the former the orchard was kept cultivated and free from weeds, in the latter weeds were allowed to grow to ascertain if bees would collect lethal quantities of D.D.T. from weed flowers beneath trees. Care was taken to apply the sprays only when all petals had fallen. Preliminary results have shown that the bee colonies progressed favourably, few, if any, losses occurring that could be attributed to poisoning with D.D.T., yet codling-moth control was equal to that secured in other parts of the orchards.

(*e*) *Lucerne Culture.*—Cultures for 165,000 lb. of lucerne seed were distributed to 1,460 farmers, an increase in 60 farmers over those using cultures the previous season, but a decline of 23,700 lb. of seed treated and sown.

(*f*) *Experimental Areas.*—Oratia: Good growth of all trees has been maintained, save in the Delicious apple block. The latter suffered from the wet winter experienced, many dying. Shelter-belts were completed, but a number of the latest plantings died in consequence of the dry summer experienced.

Owairaka: The exceptionally dry summer and early autumn has caused failure of many experimental crops, indicating the need for an emergency irrigation system. Several additional permanent hedges were planted. All others have grown well and now give adequate shelter.

A lean-to type glasshouse, designed expressly for therapeutant testing has been completed, save for installation of heating and cooling equipment. These must await redesign of the entire glasshouse heating system by staff of the Auckland Industrial Development Laboratories.

Piping has been procured to drain storm-water from the lower part of the farm and allow of the present open drain being filled in, thus facilitating cultivation.

Several sources of peat have been located, and samples tested for glasshouse potting-soils have proved satisfactory. Arrangements are being made to secure adequate supplies delivered to the farm.

TOBACCO RESEARCH

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

During the past year four meetings of the Tobacco Research Committee have been held. Reports presented by officers associated with the many aspects of tobacco research were received and programmes of future work were considered and laid down. General matters connected with the development of the tobacco industry and the progress of the Research Station received attention.

Climatic conditions during the past growing season have been extremely variable. Rainfall during the growing months was much below the average, January and February together totalling only 1·69 in. The position was further aggravated by the unusual prevalence of strong south-west winds which further depleted the already limited supply of soil moisture, as well as causing damage to some of the lower leaf. When rain did fall in March it produced a new growth, causing a delay in harvesting. The daily temperature range was unusually high. Although some day temperatures were high, night temperatures were low, bordering on frosts on several occasions. The Station crop was irrigated twice during the season, and therefore soil moisture was not a limiting factor. The leaf is thick and somewhat harsh, and the percentage of bright leaf will not be high, but the yield should be above the average. The 1944–45 crop was a light one, only 10,795 lb. being produced from 13 acres.

The research work this season, as in previous years, has been a co-operative effort carried out jointly by officers of the Cawthron Institute and the staff of the Research Station. The Institute work has included tobacco-disease surveys, investigations into the control and spread of various diseases, chemical studies dealing with the intake of plant nutrients, the chemical composition of cured leaf, and the chemical analysis of leaf from the field trials at the Station. Soil surveys of the Waimea Plains have also been continued. The Research Station has concentrated on the field side, which has included all types of fertilizer investigations, variety trials, seed-production work, plant-breeding, and mosaic investigations.

Soil Sterilization

In addition to the soil for Station requirements, a total of 316 yards for twenty-three growers was steamed during the past season. Most of this was used for the production of bed-raised seedlings. This is considerably more than twice the amount treated the previous season, and indicates that growers are becoming increasingly alive to the advantages of steam-sterilized soil in the raising of healthy seedlings. Continued wet weather during August made it difficult for some growers to get their soil sufficiently dry for sterilizing. Had it not been for this, the quantity treated would have been greater still, several orders being cancelled for this reason.

Fertilizer Experiments

1944–45 Season.—The trials were conducted in a season which was relatively cool and unusually wet with less than average sunshine. In an experiment to determine the optimum quantity of fertilizer to use per acre the applications were varied from 800 lb. to 1,400 lb. by intervals of 200 lb. Best returns were obtained from 1,200 lb. Although a further increase was obtained from 1,400 lb., it was hardly sufficient to offset the cost of the extra fertilizer. Increase in yield appeared to be due mainly to increased size of leaf, quality remaining fairly uniform throughout. This is a further confirmation of previous seasons' recommendations that an application of 1,200 lb. per acre is the most suitable for soils of the Station type.

Where the proportions of nitrogen and potash in the fertilizer were varied, the lowest yield came from the plot receiving the least nitrogen. Increasing the nitrogen above 4 per cent. resulted in a falling off in leaf quality. Varying the percentage of potash had little effect on yield but a marked effect on quality, the plots receiving the

most potash producing the best leaf. Where different types of phosphate were applied at the same rate per acre, superphosphate outyielded both serpentine-superphosphate and basic superphosphate for the second year in succession. The addition of dolomite to the fertilizer had a beneficial effect on both yield and appearance of leaf. In the rotation experiment comparing tobacco after rye-corn ploughed under with continuous tobacco, there was no significant difference in either yield or quality. Where various methods of applying the fertilizer were tested out, the best results were obtained by applying half in the furrow under the plant and the remaining half along the row about three weeks after planting. This is confirmed by the average of five years' results and can be taken as a definite recommendation for conditions similar to those at the Station. Applying all the fertilizer in the furrow before planting resulted only in a slight reduction in yield. Those plots receiving the fertilizer in side bands were slow to come away and yielded considerably less than either of the other treatments. In an experiment to determine the best time to apply the second portion of the divided fertilizer, results indicated that seasonal conditions play a big part, but that in general if the second application is delayed later than mid-December there is a risk of unduly delaying the maturity of the crop, although the yield may not be adversely affected. Where the nitrogen was supplied to the fertilizer mixture in various forms, the experiment once again demonstrated that seasonal conditions greatly affect the result, and that therefore a mixed fertilizer is necessary to meet varying weather conditions and to regulate the supply of nitrogen through the season.

On an area to demonstrate the effect on the plant of the absence of the chief plant-food constituents from the fertilizer mixture, some striking results were obtained. Omitting the nitrogen resulted in a marked drop in total yield and in size of leaf. While absence of potash had little effect on yield, it produced leaf of very poor quality. No phosphate caused a definite reduction in yield, although it took three successive seasons of such treatment to bring about the result. Once again the best yield and quality were produced by the low calcium mixture. In a spacing experiment with all rows 3 ft. 6 in. apart, a 2 ft. spacing of plants in the row produced better yield and quality than a wider spacing of the plants.

The results of the 1945–46 season will not be available until after the crop is graded, but the general trend of growth is outlined in the following observations. Under the dry conditions prevailing there was little or no leaching of fertilizer. Increasing the quantity of fertilizer up to 1,400 lb. produced corresponding increases in growth, but even the lowest level, 800 lb., produced an excellent crop. Increasing the percentage of nitrogen in the mixture resulted in heavier growth accompanied by delayed maturity, while extra potash resulted in better-quality leaf. Of the various types of phosphate used, superphosphate appeared to be the most satisfactory. In a new experiment in which the percentage of phosphate in the mixture is varied, no differences were apparent in this, the first, season. Where the effect of lime on flue-cured tobacco was under trial a special low calcium mixture appeared to be better than the standard fertilizer, while additional lime appeared to retard the early growth.

Seed-bed Experiments

These experiments have two objectives: (1) to provide information on the merits of various seed-bed treatments in the raising of seedlings, and (2) to observe the effect of various seed-bed practices on the incidence of mosaic in the field. For soil sterilization and control of weeds no chemical treatment approached steam for effectiveness. Although chloropicrin, formalin, and urea were superior to the untreated beds, they gave only partial control of weeds and so far cannot be recommended. In a trial to determine the optimum time and steam pressure for steam sterilizing, satisfactory results were obtained from a pressure of 90 lb. for periods of ten and fifteen minutes. Using a lower pressure or reducing the steaming-time resulted in only partial control of weeds and could not be considered satisfactory. In fertilizer trials for seedling beds, $\frac{3}{4}$ lb. to 1 lb. of tobacco fertilizer per square yard proved the most suitable for unsteamed soil, the lower amount being used on the more fertile soil types.

Chemical Composition of Tobacco with different Fertilizer Treatments

In the 1944–45 season increasing the quantity of the standard 3–8–8 mixture from 800 lb. to 1,400 lb. per acre exerted no very distinct effect on the amounts of lime, magnesia, potash, and phosphate in the dry matter of the cured leaf.

Serpentine-superphosphate and basic superphosphate plus dolomite gave the highest magnesia and lime contents, while superphosphate plus dolomite gave the higher potash content in the cured leaf.

In the deficiency experiment, absence of potash in the fertilizer gave a low potash content, but absence of phosphate did not appreciably affect the amount of phosphate in the cured leaf. The no-nitrogen mixture showed the highest potash content in the cured tobacco.

Ageing Experiments

The lots of leaf put aside in the last three seasons have been sampled periodically. Some appreciable variations in moisture content have been found.

In a new experiment to examine more closely the changes in moisture content of leaf in bond store, distinct differences in moisture content were found in samples taken from different positions and at different depths in the case. These were of the order of 1 per cent. to 2 per cent.

Intake of Plant Nutrient

The comparative trial in which tobacco plants of the same origin are planted on the medium sand of the Tobacco Research Station and a light-phase silt loam of a neighbouring farm has been continued in the 1945–46 season. Nothing like the difference in growth that was found between the two areas last season has been displayed this season.

Yields of dry matter for the season have not been completed, but the following data give an indication of the trends of the growth of the plants on the two areas :—

Date.	Medium Sand.		Silt Loam.	
	Dry Matter.	Dry Matter.	Dry Matter.	Dry Matter.
	lb. per Acre.	Per Cent.	lb. per Acre.	Per Cent.
16/1/46	446	14·1	253	13·2
30/1/46	1,387	14·1	853	15·1
11/2/46	2,461	16·8	1,723	14·5

On both areas the plants were set out on 3rd December, 1945. The Research Station plot on the medium sand came away quicker, and harvesting of ripe leaves began on 11th February, but the first harvest was not taken from the silt loam until 26th February. As was found last season, the Research Station plants tend to have a higher dry-matter content than those from the silt loam.

In the 1944–45 season the dry matter in pounds per acre in the plants on 7th February, 1945, was as follows : medium sand, leaves 975 lb., stalks 639 lb. ; silt loam, leaves 1,119 lb., stalks 733 lb. These plants had by then absorbed the following amounts of plant nutrients :—

——	CaO.	MgO.	P_2O_5.	K_2O.	N_2.
Medium sand—	lb.	lb.	lb.	lb.	lb.
Leaves	18·1	4·5	7·0	37·6	20·6
Stalks	6·5	2·4	3·0	24·2	6·3
Silt loam—					
Leaves	41·2	4·9	5·5	45·0	28·7
Stalks	10·1	2·3	3·4	30·9	11·8

These data show very clearly the greater absorption on the heavier soil of lime, potash, and nitrogen. Magnesia and phosphate were absorbed in approximately equal amounts. This increased absorption is passed mainly into the leaves. On the heavier soil some very high figures for lime content were obtained—*e.g.*, ripe leaves contained up to 8 per cent. CaO, as against less than 3 per cent. on the medium sand. Magnesia, potash, and nitrogen in the leaves and nitrogen and lime in the stalks were relatively high, but potash was lower in the stalks on the silt loam.

Nutritional Studies

Tobacco plants were grown at the Institute in cylinders filled with a coarse river sand and fertilized with mixtures made from standard commercial ingredients to provide a complete 4–8–8 mixture at 1,200 lb. per acre, and mixtures with no nitrogen, no potash, no phosphate, double nitrogen, and double potash contents. Plants were also grown without any fertilizer. The latter, together with the no-nitrogen plants, made very poor growth, being yellow and stunted. Where no phosphate was supplied, the plants were stunted with leaves of deep blue-green colour which later developed a copper-brown coloration and a small number of light-chocolate coloured spots. The heavy nitrogen application produced the largest plants with dark-green leaves, while extra potash did not greatly affect the amount of growth. No deficiency symptoms appeared on the plants without potassic manures, as the river sand contained considerable reserves of this plant-food.

Tissue tests on the ends of the midribs showed relatively low potash and phosphate contents on the no-potash and no-phosphate plants. The extra potash did not appreciably increase the potash content, but markedly increased lime and magnesia contents. Probably because of their very restricted growth, the plants not receiving nitrogen showed relatively high soluble nitrogen figures; magnesia was low in these plants. Plants with no fertilizer gave only very small amounts of soluble nitrogen, low potash and phosphate, and normal lime and magnesia figures.

Soil Analyses

Nitrate-N and ammonia-N were determined on a number of soil samples from the Tobacco Research Station. One interesting point was that the nitrate and ammonia contents under irrigation were lowest in a coarse sand, increased on a medium sand, and highest on a fine sand.

Urea gave relatively high soil-ammonia figures, in keeping with the green appearance of the plants on the urea-treated plots, as compared with those grown on plots receiving nitrate of soda or sulphate of ammonia.

Disease Investigations

This work has comprised surveys of tobacco-seedling beds and gardens in different parts of the district for mosaic disease, black root-rot, and angular leaf-spot. Studies on the incidence and spread of mosaic both in seedling-bed experiments and in the field were continued.

(1) *Mosaic Investigations.*—These have comprised a survey of mosaic in representative gardens throughout the tobacco-growing districts and a continuation of seedling-bed experiments with a view to securing more information on the incidence and transmission of mosaic.

(*a*) Survey of Mosaic in Tobacco Gardens: An examination was made, during the second and third weeks of January, of twenty-nine gardens belonging to growers at Dovedale, Stanley Brook, Riwaka, Umukuri, Motueka, Pangatotara, Orinoco, Graham Valley, Braeburn, and Upper Moutere. Five plots of two hundred plants each were examined in each garden. In the Dovedale - Stanley Brook sector, six growers had less than 10 per cent. initial mosaic, two had 15 per cent., and one had over 50 per cent.

In the Riwaka, Umukuri, and Motueka locality, eight growers had less than 10 per cent., two growers had 20 per cent., and three growers more than 20 per cent. of initial

mosaic. In the other localities, only one grower had more than 20 per cent. mosaic. Owing to dry weather the detrimental effect of mosaic both on growth of plant and quality of leaf was much more pronounced than in the previous season. In general, the survey showed that the improvement in mosaic control was being maintained, but there are several gardens where high infections occur almost every year.

(*b*) Influence of Soil Disinfectants and Fertilizers on the Incidence of Mosaic: Experiments designed to test the value of steam and various soil disinfectants have been continued at the Tobacco Research Station. Steam, urea, chloropicrin, formalin, and D.D. treatments in the tobacco-seedling beds gave reduction in the amount of initial mosaic in the field when compared with corresponding results obtained from unsteamed soils.

The use of fertilizer for the seedling beds in amounts exceeding $\frac{1}{2}$ lb. per square yard was associated with great increases, on unsteamed soils, of mosaic in the field plantings. Further evidence was obtained concerning higher mosaic incidence with pricked-out seedlings than with bed-sown seedlings.

(*c*) Effect of Fertilizers on Mosaic in the Field: Counts of mosaic were again made over the more important manurial plots at the Research Station. No evidence was obtained concerning any marked effect on the incidence of mosaic resulting from the use of increased quantities of fertilizers in the manurial treatment of tobacco or from variations in the proportions of nitrogen, phosphate, and potash contained in the manure. With few exceptions, probably due to chance infection, the amount of initial mosaic on all the manurial plots was less than 5 per cent.

(2) *Black Root-rot.*—Surveys of this disease have been made both in the seedling-beds and the gardens of tobacco-growers in many different localities. In the examination of tobacco-seedling beds, ten cases of black root-rot were found, five of which were new cases where the disease had not previously been observed. On the other hand, four beds which had been attacked by the disease last year were free from obvious infection this season. In the surveys of tobacco gardens, five new cases of the disease were noted this season, distributed as follows: Riwaka, 2; Motueka, 1; Dovedale, 1; and Upper Motueka Valley, 1.

(3) *Damping-off Disease.*—Owing to the cold wet weather experienced in September, damping-off disease was prevalent in tobacco seedlings raised by some of the nurserymen. Greater freedom from damping-off was associated with free ventilation of the glasshouse. It is suspected, however, that inadequate steam treatment of the soils used for the tobacco seedlings is an important factor resulting in the spread of damping-off disease.

Several sprays were tested for the control of the disease, but only in the case of pin-point infection were effective results obtained. Shirlan A.G. gave the best result, but a complete control was not secured.

(4) *Angular Leaf-spot.*—In view of the rather wide distribution of this bacterial disease in tobacco gardens last season, a close watch was maintained both in the seedling tobacco beds and in the gardens of tobacco-growers. In the first half of November the seedling beds of thirty growers located in different parts of the tobacco-growing districts were examined for angular leaf-spot. In four cases heavy infection was found while nine cases of slight infection were noted.

A survey of angular leaf-spot in tobacco gardens was commenced in January, 1946, but practically no "spot" was found. Under these circumstances, the survey was postponed until early March, when it was anticipated conditions would be more favourable for the development and ready identification of the disease. Some forty-three gardens, distributed throughout the tobacco-growing districts, were included in the survey.

In contrast to last season, when the disease was rather prevalent, the present survey revealed little sign of the disease. In thirty-six of the gardens visited there was complete freedom from injury in the mature tobacco leaves. In the remaining seven cases the infection was light, being confined to small leaves at soil level. Even gardens planted with seedlings from tobacco beds known to be infected with the

disease showed little or no infection in the mature tobacco plants. This result must have been greatly influenced by the drought which persisted through the latter half of January and throughout the whole of February.

(5) *Collar-rot.*—Experiments relating to the control of collar-rot (*Sclerotinia* fungus) in seedling beds at the Tobacco Research Station have been continued. Chloropicrin, formalin, copper sulphate, and D.D. were all tested as soil treatments, and Bordeaux mixture was tested as a spray on the tobacco seedlings. None of the treatments gave a control of the *Sclerotinia* fungus which had previously been inoculated into the soil. Copper sulphate, however, appeared to reduce the amount of infection.

In another experiment carried out in boxes at the Cawthron Institute, further chemicals were tested for the control of the fungus, but no treatment proved entirely satisfactory. Best results in reducing infection on the tobacco seedlings were obtained from copper sulphate (used as a soil treatment prior to pricking-out the tobacco seedlings) and from Shirlan A.G. (used as a spray on the seedlings eight days after pricking out).

Seed production and Plant-breeding

Seed supplied to manufacturing companies continues to show an increase, being 42 lb., compared with 36 lb. in the previous season. The seed supplied is from once-tested single plant selections, as experience shows that such a check is essential before seed is distributed for commercial use. Plant-breeding to obtain mosaic-resistant varieties is progressing. Some very promising types which have many of the characteristics of the flue-cured parent were grown, and these have again been back crossed to the commercial type. Progress has also been made in breeding varieties resistant to black root-rot. Promising resistant types were selected from the hybrid material and back crossed to the flue-cured parent. Two American varieties resistant to black root-rot confirmed under trial the good results obtained last season and can now be recommended for any areas suspected of being infected with the disease. A third variety tried out for the first time this season has also shown definite promise, as also has a new variety from Canada.

Fire-cured Tobacco

Moderate success was obtained last season in the growing and curing of a small area of fire-cured tobacco. Another area has been grown this season and the crop in the field is much better than the previous one. With the experience gained in curing it is hoped to produce a much better sample of leaf.

Kilns and Curing

Much information was gained last season by officers of the Dominion Laboratory about the physical conditions pertaining in a kiln during curing. This has been followed up during the past season by making radical changes in the arrangement of flues in a kiln and by introducing a fan to obtain positive circulation of the air. A wealth of additional information has been gained, and indications are that definite improvements in the flue-curing process are possible.

Soil Survey of Tobacco Lands

Tobacco soil maps for the Brightwater - Spring Grove section of the Wai-iti Valley have been prepared and copies made available to the Tobacco Research Station, tobacco-manufacturers, and the Tobacco-growers' Federation. Soil mapping has been continued in the Wakefield-Belgrove sector, and this part of the Wai-iti district will shortly be completed. A commencement has been made with soil mapping in the Motupiko-Tapawera district, where there is a considerable area of soil texturally suitable for flue-cured tobacco.

Owing to lack of staff it has not been possible to revise the tobacco maps showing the exact distribution of tobacco in the Nelson District, but a study of the acreages applied for by growers which were made available by the Tobacco Control Board shows the following changes: 1944/45, 3,367½ acres; 1945–46, 3,557½ acres.

WHEAT RESEARCH INSTITUTE

Advisory Committee.—Mr. R. J. Lyon (Chairman), Mr. C. E. Boon, Mr. A. E. Brownlie, Mr. F. R. Callaghan, Mr. J. Carr, Mr. H. E. Fairey, Dr. R. O. Page, Mr. W. O. Rennie, Mr. P. W. Smallfield, Mr. P. R. Talbot. Chief Executive Officer: Dr. O. H. Frankel. Chief Chemist: Mr. E. W. Hullett.

Wheatgrowing

Threshing Returns.—In the harvest of 1945, Cross 7 increased further by 5·83 per cent. and Fife Tuscan by 1·24 per cent. of the wheat area at the expense of Tuscan and Hunters. The percentages of the main varieties were as follows: Cross 7, 65·3 per cent.; Tuscan, 14·1 per cent.; Fife Tuscan, 8·6 per cent.; Dreadnought, 6·4 per cent.; Hunters, 2·7 per cent.; Tainui, 1·5 per cent.

New data collected by the Government Statistician have enabled the Institute to analyse the harvesting methods used in the harvest of 1945. Of the wheat area, 81·57 per cent. was harvested with header-harvesters (direct-headed and wind-rowed), 11·71 per cent. with threshing-mills, and 6·72 per cent. with tin mills. The proportion of header-harvesting in any one district was mainly determined by the varieties used, the climate, and the soil type. Header-harvesting was most prevalent in Fife Tuscan (94·4 per cent.), least in Dreadnought (22·6 per cent.); of the main wheat districts, Mid-Canterbury, with 96·5 per cent., had the highest proportion of heading.

Wheat-breeding

New Varieties.—Two of the advanced lines now show distinct promise. 78, 01 (Tuscan × Tainui) has consistently given higher yields than Cross 7. 140, 014 (Cross 7 × Tainui) has again excelled in baking-quality. Its protein content of 14·0 per cent. against Cross 7 with 11·0 per cent. and Marquis with 11·5 per cent. is indeed remarkable. Both these new wheats will receive extensive tests in widely distributed trials laid down by the Department of Agriculture. Seed-supplies are being built up. A number of other promising wheats are also at an advanced stage.

Genetic Research.—In the course of the last few years a number of research projects were started with the object of shedding light on the inheritance of economically valuable characteristics of the wheat plant, and on the processes which occur in plant populations under the influence of selection. Such information would prove of direct value in the breeding-work undertaken by the Institute. The following is a list of projects being undertaken at present, some of which are approaching completion: a series of studies on methods of selection and their effects, biometric and genetic population studies on different generations from the same cross, inheritance of weight of grain and its relation to other yield characters in tetraploid and hexaploid species, inheritance of shattering of grain, cytogenetic studies of fertile and partially sterile A-type speltoids, and spontaneous chromosome fragmentation as a regular, high frequency phenomenon.

Cereal Chemistry, Milling, and Baking

Moisture Testing.—The usual testing facilities were made available for farmers. Stations were established in Palmerston North, Blenheim, Christchurch, Ashburton, Temuka, Timaru, and Dunedin. The Seed Testing Station and the New Zealand Wool Manufacturers' Research Association again made their facilities available at Palmerston North and Dunedin respectively.

The weather during the 1946 harvest was very favourable in most districts, with the result that a relatively small number of wheat samples was submitted for test.

The only district where trouble with damp wheat was experienced was Invercargill.

Sprouted Wheat.—The unfavourable harvest of 1945 caused a large proportion of wheat lines to sprout. The effect of sprouted wheat on the baking performance of the flour is a very high activity of starch-splitting enzymes. The dough behaves almost normally, but during the initial part of the baking process starch is broken down into sugars and gummy products, and these cause the crumb of the bread to be doughy and, in severe cases, sticky.

The nature of the effect made remedial measures in the bakeries difficult, but a bulletin giving suitable advice was sent to all bakers, and, it is believed, was of assistance.

In order to keep the incidence of the damage to flour at a uniform and manageable level, millers made extensive use of the Institute's wheat and flour testing services. This and the use of imported wheat and flour were the measures which were mainly responsible for minimizing the amount of damaged flour produced.

Whenever any baker experienced serious difficulty the Institute arranged with the Wheat and Flour Controller for sound flour to be supplied for blending purposes. The excellent co-operation existing between the Controller and the Institute was in this way an important factor in limiting consumer complaints.

Chemical and Research Work.—The chief activities of the chemical staff were on the chemical aspects of sprout damage in wheat and flour and on the determination of vitamin B_1 in cereal products.

Milling of High-vitamin Flour.—This work was held up for some time because the staff was busy with work connected with sprouted wheat. The new milling-machine mentioned in the last report was duly installed in a commercial mill and, after a number of practical difficulties had been overcome, has worked satisfactorily for many months. The vitamin B_1 content of the white flour produced was raised to about 2·5 μg per gram. This is a satisfactory level and compares well with the average of about 1·7μg per gram for other mills. The method has been demonstrated to millers, and many have stated that they will use the new machine as soon as it is available. This is being arranged.

Extension Work

As in previous years, the Institute has continued to collaborate with the Wheat Committee, with the organizations of farmers, millers, and bakers, and with many individuals and firms in the industry. A number of addresses was given to various organizations. The travelling baker continued to visit numerous bakers throughout the Dominion. Exhibits were arranged for agricultural shows at Christchurch, Timaru, and Methven.

CAWTHRON INSTITUTE

Director: Sir Theodore Rigg

Assisted by grants from the Department of Scientific and Industrial Research, the Cawthron Institute has carried out a wide scope of investigational work connected with soil survey, mineral deficiency problems, fruit and tomato research.

In addition, the Institute has co-operated in the work of the Entomology Division of the Plant Research Bureau, which is located at the Cawthron Institute and has collaborated with the Tobacco Research Station in the conduct of soil, plant, and disease investigations relating to the improvement and development of the tobacco industry. An account of the tobacco and fruit investigations handled by the Institute appears in the annual report of the Department under the headings of "Tobacco Research" (see p. 54), and "Fruit Research" (see p. 20), respectively, and the report of the Entomology Division is included in that of the Plant Research Bureau (see p. 38). Other research work carried out with the assistance of grants from the Department is reported below under the headings of "Soil Survey," "Mineral Deficiency Investigations," and "Tomato Investigations."

Soil Survey

During the past year detailed soil mapping has been continued on the alluvial soils of the Waimea and Wai-iti Rivers. The Brightwater - Spring Grove sector of the Wai-iti Valley was completed, and tobacco soil maps covering this locality have been prepared and made available to the Tobacco Research Station, the tobacco-manufacturers, and Tobacco Growers' Federation. The last section of the Wai-iti Valley, covering Wakefield-Belgrove, with the adjoining valleys of 88 and Pigeon, has been mapped, but the final classification of the soils cannot be completed until mechanical analyses of samples

representative of different areas are available. Dry weather has impeded field-work and has delayed greatly the collection of representative soil samples. The Wakefield-Belgrove sector, covering some 10,000 acres of alluvial soils, is more suitable for tobacco-culture than the northern part of the Wai-iti Valley. The soils, however, are patchy, and great variation in texture is frequently experienced, even within restricted areas of soil. Air-drying of Burley tobacco is more popular with farmers than the culture of kiln-cured varieties. The acreage of both air-dried and kiln-cured tobacco, however, tends to increase, particularly in Pigeon and other valleys, where the soils are derived mainly from Moutere Hills material.

A commencement has also been made with the mapping of tobacco soils in the Motupiko-Tapawera locality. In this area some soils are high in magnesia, which confers characteristic properties on the tobacco leaf. Soil classification must therefore take into account both chemical and textural qualities of the soils.

Land Utilization.—Maps showing the present use of the land in the Brightwater - Spring Grove and Wakefield-Belgrove sectors of the Wai-iti Valley have been prepared. Tobacco, hops, stone fruits, and small fruits are all important crops in this part of the Nelson district.

In view of the great importance of extending the forest cover on the hill country, forming the water-sheds of the Wairoa and Motueka Rivers, an attempt has been made to classify the hill land and establish a boundary between land suitable for agriculture and that which is required for river control.

Soil Erosion on the Moutere Hills.—At the request of the Nelson Catchment Board observations have been made concerning soil erosion in orchards established on the Moutere Hills. Owing to the planting of orchards on somewhat steep slopes, a great deal of erosion has taken place in many orchards. This is evidenced by the denudation of topsoil on the higher slopes of the orchards and the accumulation in the valleys of silt which has submerged trees to a depth of 12 in. to 15 in. The displacement of soil has been caused in part by cultivating implements, but heavy rains during the summer when the land is bare and the soil loose have been responsible for the deposition of much silt in the lower part of the orchards. In conjunction with the Orchard Instructor of the Department of Agriculture, an article on soil erosion and methods of control was prepared and reprinted by the Nelson Catchment Board for circulation to fruitgrowers in the Nelson district.

Chemical Work.—The mechanical and chemical analyses of soil samples collected in the Waimea and Wai-iti surveys have been continued. Silt loams and sandy loams are the most common textural types, but clay loams and stony loams are also found. Chemical analyses of some eighty-five samples taken throughout the Waimea and Wai-iti Valleys show that the phosphate status is moderately good, especially on the Appleby, Heslington, and Brightwater soils, many of which are used for tomatoes and other garden crops. The potash status, on the other hand, tends to be low, particularly in the case of soils derived mainly from the Moutere Hills. For the most part liming has received attention by farmers, for the average pH value of the soils is over 6·0.

Determinations of ammonia and nitrate nitrogen have been made of tomato and tobacco soils which have been subject to experimental treatment with steam and soil disinfectants. Increase in ammonia nitrogen was again found to be associated with steaming and with the use of formalin and chloropicrin as soil disinfectants.

The use of sawdust in the preparation of tomato soil greatly reduced the amount of soil nitrate nitrogen while the use of compost resulted in a very great increase in nitrate nitrogen. The effect of steaming soils at different steam pressures and for different lengths of time was investigated in regard to the ammonia and nitrate nitrogen status of the soils. Although prolonged steaming (fifteen minutes) was associated with the highest ammonia figures, the results were not sufficiently outstanding to rely on the nitrogen status as an index to efficiency of steam treatment.

General.—At the request of the Rehabilitation and State Advances Departments, reports have been prepared on several properties required for ex-servicemen desirous of taking up tobacco-growing. Many requests from Nelson farmers have been received concerning the use of lime and fertilizers on their soils.

Mineral Contents Investigations

The field trial commenced in the previous year has now been completed, and additional information has been obtained concerning the value of small applications of cobalt sulphate for the control of bush sickness at Sherry River.

Further examinations have been made of the experimental areas in magnesium-deficient apple orchards. Individual leaf analyses from mangesium-deficient and other twigs have been continued.

Pot experiments to investigate the effects of potash and magnesium on a Nelson soil have been continued.

Cobalt Investigation.—As was reported last year, the trial at Sherry River to test over two seasons the value of applications of cobalt sulphate at 4 oz. and 8 oz. per acre showed that in the first season there was little to choose between the live-weights of the groups of sheep under the various treatments. In the spring of the second season (1944–45), however, the sheep on the cobalt-treated areas began to increase rapidly in weight, those on the area receiving 8 oz. cobalt sulphate in 1943–44 giving the greater increase. On the other hand, the animals on the control (no cobalt) area began to fall rapidly in weight. During the summer of 1944–45 all the animals on the areas increased in weight, although two deaths from bush sickness occurred on the control area. Maximum average live-weights were as follows: control, 91·7 lb. (at end of April); 4 oz. cobalt sulphate per acre, 111·4 lb. (at beginning of June); 8 oz. cobalt sulphate per acre, 122·0 lb. (at beginning of June). Later in the season all animals lost weight, those on the control area losing more than those on the cobalt-treated areas. At the last recording of live-weights on 29th September the average live-weights were as follows: control, 68·0 lb.; 4 oz. cobalt sulphate per acre, 103·4 lb.; 8 oz. cobalt sulphate per acre, 112·2 lb. Owing to the seasonal conditions no further live-weights were recorded before the sheep were shorn in the middle of November. The average yields of raw wool were as follows: control, 7·0 lb.; 4 oz. cobalt sulphate per acre, 7·9 lb.; 8 oz. cobalt sulphate per acre, 8·7 lb. These figures show that appreciable increases in wool yield were obtained following the use of cobalt sulphate. At the end of the trial all sheep on the treated areas were in fat condition. The higher rate of application of the fertilizer has been beneficial in increasing live-weight and wool clip sufficient to give a monetary return much greater than the cost of the cobalt salt employed.

During the course of the trial periodical samples of pasture were obtained for chemical analysis. In the earlier part of the trial the cobalt content of the pasture was increased twice and four times over that of the control for the 4 oz. and 8 oz. applications respectively. Later, the cobalt contents of the treated pastures tended to come closer together, but, with one exception, the treated pastures always showed at least twice the cobalt content of the dry matter of the control pasture, for which the average figure was 0·04 p.p.m. cobalt on the dry-matter basis. The cobalt contents of the pastures therefore correlate well with the responses of the animals as shown by their live-weights.

This trial has demonstrated that under the conditions at Sherry River a single application of cobalt sulphate at either 4 oz. or 8 oz. per acre will give good results with sheep over two seasons. The higher rate gave the better result both in live-weight increase and in yield of wool.

Magnesium Investigations.—Analysis of individual leaves from twigs of apple-trees has been continued for observation of variation of magnesium and potash contents. An improved Titan yellow method for estimation of magnesium down to 0·0025 mg. of magnesium has been found satisfactory. A description of this method has been prepared for publication.

Tissue Testing Method.—The methods of Carolus have been applied to apple, tobacco, and tomato leaves. While the methods for some of the constituents in the fresh tissue appear satisfactory, it was found that improvements in the magnesium and potash methods were desirable. These have been made. It is considered that the results now obtained are more reliable than by the original methods.

Serpentine-superphosphate Investigations.—In order to examine inter-relations in the effects of potash and magnesium further pot experiments using Sherry River soil have been set up. The crop was Western Wolths. Three series were run: Series A, base dressing of 1 cwt. sulphate of ammonia per acre; Series B as A, with addition of 2 cwt. muriate of potash per acre. In these two series superphosphate, basic superphosphate (made with slaked lime), serpentine-superphosphate, and superphosphate plus magnesium oxide equivalent to the magnesium in the serpentine-superphosphate were used. The phosphate in all cases was equivalent to a rate of 3 cwt. superphosphate per acre. To the eye there were no great difference visible in the growth of the crops of the A series, and only slight differences in the B series. By weight of dry grass, the best crop was obtained in the A series from superphosphate plus magnesia. No significant differences were shown between superphosphate, basic superphosphate, and serpentine-superphosphate. In the B series use of the potash salt appreciably increased the yield with superphosphate and basic superphosphate, and slightly with superphosphate plus magnesia, but had no effect where serpentine-superphosphate was used.

In series C, 1 cwt. sulphate of ammonia and 1 ton of magnesium carbonate per acre were used as a base dressing. Superphosphate and serpentine-superphosphate, with and without 2 cwt. muriate of potash per acre, were used as variants. Where potash was omitted very poor germination and growth were obtained. Browning of the leaf tips was severe. This browning also appeared later on the other treatments, being least apparent with superphosphate. Taking the superphosphate pots as 100, the comparative yields in this series were as follows: superphosphate, 100; serpentine-superphosphate, 37; superphosphate and muriate of potash, 198; serpentine-superphosphate and muriate of potash, 113. It is of interest that the yield from the superphosphate pots in this series was only just over half that with superphosphate in series A. Magnesium carbonate at the above rate reduced the yields with superphosphate and serpentine-superphosphate to 80 per cent. and 60 per cent. respectively of the corresponding yields in series B. The yield from serpentine-superphosphate plus sulphate of ammonia was reduced by the magnesium carbonate to only 21 per cent. of the yield from the phosphate and nitrogen only.

It is evident, therefore, that there is a very strong reciprocal action between potassium and magnesium under the conditions of this experiment. There is a strong response to potassium, a fact not surprising in view of the occurrence of potassium deficiency symptoms in some crops on this soil-type.

Tomato Investigations

During the past season a great deal of work on different aspects of tomato-production has been carried out. The investigations have comprised (*a*) studies of steam and formalin treatments of glasshouse soils in relation to yield and quality of tomatoes; (*b*) the effect of fertilizers, compost, charcoal, sand, and differential rates of watering on yield and incidence of "cloud"; and (*c*) the effect of steam, soil disinfectants, fertilizers, and soil amendments on yield and incidence of "hard-core" in outside grown tomatoes.

(*a*) *Use of Steam and Formalin for the Treatment of Glasshouse Tomato Soil.*—Steam sterilization again showed to great advantage over formalin treatment for our tomato soil, the following results being obtained for representative plots under the different treatments:—

Treatment.	Yield per Plant. lb.	oz.
Steamed each season	7	10
Formalin (1 pint of 40 per cent. per square yard)	5	8
Unsterilized	4	10

Note.—*Standard fertilizer* used in all treatments.

The results show the marked improvement in yield effected by steaming the soil. Formalin treatment resulted in an increase of 14 oz. tomatoes per plant, but was decidedly inferior to steaming both in growth of plant and yield of tomatoes. The yields of all treatments are lower than last season due to somewhat drier conditions in the house.

(*b*) *Effect of Compost, Charcoal, &c., on Tomato Yield.*—In view of the high percentage of clay and silt in the Nelson soil used for tomato-production it was considered that such materials as compost, charcoal, sawdust, and sand might beneficially affect both growth of tomatoes and quality of fruit. With this in view certain plots in the glasshouse were treated after steaming with steamed compost (stack bottom) or sawdust from *Pinus insignis* at the rate of 30 tons per acre, with charcoal (derived from New Zealand beech) at the rate of 30 tons per acre, and with coarse river sand at the rate of 300 tons per acre. In each case the material, after spreading, was forked into the top 8 in. of soil. The usual fertilizer programme was given to all these plots, but the one treated with sawdust owing to the appearance of marked nitrogen-deficiency symptoms received an additional supplement of nitrogen equivalent to that contained in the base fertilizer.

The use of sand was associated with earlier growth of the plants, while sawdust very definitely retarded growth. The steamed compost gave the best all-round result, with charcoal in second place.

The following table shows the average yield of tomatoes from the different treatments :—

Treatment.	Yield of Tomatoes, per Plant. lb.	oz.
Steamed compost	8	14½
Charcoal	8	10½
Sand	7	4
Sawdust	6	5
Control (average of seven plots)	7	7

The yield data show the marked benefit which has been obtained on the Institute soil from the use of both steamed compost (stack bottom) and charcoal and the detrimental effect, in the first season at any rate, from the use of sawdust (*Pinus insignis*). Although the use of sand appeared promising in the early stages, yield of tomatoes was not improved on the glasshouse soil over that of the control plots. A similar experiment conducted on outside tomatoes, however, showed considerable increase in yield from the use of coarse sand at the same rate.

(*c*) *Effect of Different Rates of Watering on Yield of Tomatoes.*—This year the differences in yield of tomatoes from the steam sterilized plots watered at three different rates were not so pronounced as last year, but again the highest yield was associated with the heaviest rate of watering and the lowest yield with half-standard rate of watering. Averaged over a period of three years the heaviest rate of watering (two W.) gave 9 lb. per plant, the standard rate (W.) 8½ lb. per plant, while the lowest rate of watering (half W.) gave 8 lb. per plant.

(*d*) *Tomato "Cloud."*—The Dreadnought variety was again tested under different conditions in the Institute glasshouse. Individual records were kept of some 260 plants under different treatments, including steam sterilization, use of fertilizers, different rates of watering, and use of different soil amendments. Unfortunately, the percentage of "cloud" in the tomatoes was very low, the average for all plots being 3·8 per cent., compared with 14·1 per cent. in the previous season. It would appear that the dry weather experienced in December, January, and February and a drier condition of soil, particularly in the early part of the season, were mainly responsible for the reduction in "cloud" this year.

(*e*) *Tests of Steam and Soil Disinfectants on Outside Tomato Soil.*—Chloropicrin, formalin, and steam have again been tested for the treatment of outside tomato soil. Early in the season, steaming, the use of chloropicrin (36 ml. per square yard), and the use of 2 per cent. formalin solution showed to advantage in superior growth of the tomato plants. Formalin 1 per cent. solution came next, while the control plots lagged behind. This advantage in growth was maintained throughout the season, particularly

with steam and chloropicrin treatments. The yield of tomatoes (Kondine) are shown in the following table :—

Treatment.	Yield, Pounds per Plant.
Control	5·3
Steam	6·4
Chloropicrin	6·2
Formalin, 2 per cent.	6·3
Formalin, 1 per cent.	5·8

NOTE.—All plots received *standard fertilizer* treatment.

The results from steam, chloropicrin, and 2 per cent. formalin are approximately the same and are significant. The result from 1 per cent. formalin is intermediate and is not significant.

(*f*) *Effect of Soil Amendments on Outside Tomato Soil.*—In view of the high percentage of clay and rather low plant-food status of the soil used for tomatoes on the grounds of the Institute, several materials were tested to ascertain their effect on both yield and quality of tomatoes. The materials comprised coarse river sand at the rate of 300 tons per acre, charcoal, sawdust, sheep-manure, and cocoa-bean husks all at the rate of 30 tons per acre. These materials were spread on the topsoil and worked into the top 8 in. of soil. Cocoa-bean husks and sheep-manure had a marked effect on growth of the plants and also yield of tomatoes. Sawdust very detrimentally affected growth and yield, while charcoal failed to benefit yield, but the appearance of the plants was rather better than on the corresponding control plots. Coarse sand induced early growth of the plants and had a beneficial effect on yield of tomatoes.

The following table shows the yield of tomatoes from the different plots :—

Treatment.	Yield of Tomatoes, Pounds per Plant.
Control (no fertilizer)	6·1
Control (fertilizer)	6·0
Sawdust (fertilizer)	4·5
Charcoal (fertilizer)	5·6
Sheep-manure (no fertilizer)	6·8
Cocoa-bean husks (no fertilizer)	6·9
Coarse sand (fertilizer)	8·0
Cocoa-bean husks (fertilizer)	9·2

Although several of the materials used in the above experiment have exerted a marked effect on the growth of tomatoes and yield of fruit, it should be noted that the experiment must continue over a period of years before any final statement can be made concerning their relative value for the treatment of Nelson tomato soil.

(*g*) "*Hard Core.*"—A great deal of work has been carried out in connection with the elucidation of factors which operate in the production of "hard core." Although it is not possible in this brief report to review all the available data, it can be stated that steam treatment or the use of chloropicrin or 2 per cent. formalin effected a reduction in the amount of "hard core." Cocoa-bean husks, particularly where fertilizer had also been used in the treatment of the plots, likewise effected a very marked reduction in "hard core." Sheep-manure also gave a decrease in percentage of "hard core," but charcoal, sand, and sawdust had little effect. The greatest percentage of ailment occurred on the no-manure plots.

In the fertilizer experiments relating to "hard core" potassic manures, particularly where nitrogen was included in the fertilizer mixture, gave the lowest figures for "hard core." The no-manure plots or those without potash in the fertilizer gave the highest percentages of "hard core."

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 Pasture Investigations

J. W. Calder

The seventh season has been reasonably good for the growth of subterranean clover pastures. An excellent establishment occurred in February, 1945 and heavy rainfall in August resulted in substantial growth in the early spring months. November was very dry and the herbage dried off considerably, but a recovery occurred in December. The latter half of January and early February were dry and the sheep have grazed most of the available herbage.

The method of measuring production was altered this season. For the past six years a self-maintaining flock of Corriedale ewes was carried on each of the four treatments. Production was measured in terms of live weight and wool-production of lambs, ewe hoggets, and ewes. This season dry sheep were used and production measured in terms of sheep-grazing days—tupping ewes for two months (April to May) and ewe hoggets for four months (October to February); no grazing June to September.

The plots are 3 acres in area and there are six replicates of each of the four treatments, making a total of 18 acres per treatment:—

Treatment A: 5 cwt. of lime alternating yearly with 1 cwt. of superphosphate.
Treatment B: 2 cwt. of superphosphate annually—no lime.
Treatment C: 2 cwt. superphosphate annually—1 ton lime in 1938.
Treatment D: 2 cwt. superphosphate and ½ cwt. potash annually—1 ton lime in 1938.

Carrying-capacity, in Ewes per Acre, over Seven Seasons

Treatment.	First Year, L*, 1939–40.	Second Year, S*, 1940–41.	Third Year, L*, 1941–42.	Fourth Year, S*, 1942–43.	Fifth Year, L*, 1943–44.	Sixth Year, S*, 1944–45.	Seventh Year L*, 1945–46.
A	1·0	1·3	1·6	2·15	1·60	3·15	2·2
B ..	1·3	1·2	1·2	1·44	1·73	2·31	2·1
C	1·6	1·7	1·8	2·05	1·70	2·92	2·2
D	1·6	2·1	2·3	2·35	1·78	3·20	2·58

L* = lime applied to treatment A. S* = superphosphate applied to treatment A.

Total Quantity of Lime and Fertilizer applied.—Over the establishment period and the grazing period, a total of nine years, the following quantities of lime, superphosphate, and potash have been applied to the respective treatments:—

Treatment A: 5 cwt. superphosphate (five applications) and 1 ton lime (four applications).

Treatment B: 19 cwt. superphosphate (ten applications).

Treatment C: 19 cwt. superphosphate (ten applications) and 1 ton lime (one application, 1938).

Treatment D: 19 cwt. superphosphate (ten applications), 4 cwt. potash (eight applications), and 1 ton lime (one application, 1938).

Results from trials extending over nine years indicate—

(1) That treatment A shows to greater advantage in the seasons when superphosphate is applied. This indicates the desirability of annual applications of superphosphate.

(2) That the initial benefit derived from a heavy initial application of lime in treatment C has declined by the fourth season, after which production is equal to or only slightly better than that of treatment B, which has had no lime.

(3) That the heavy application of 2 cwt. of superphosphate annually in treatments B and C is not as efficiently utilized as the 1 cwt. of superphosphate every other year in treatment A, because of the absence of lime (B) or the decline in the lime status (C)

(4) That the ½ cwt. of potash in treatment D has retained its superiority throughout but production from treatment A in the sixth year ("superphosphate" year) is only slightly below that of Treatment D.

Treatment A appears to provide almost adequate supplies of lime and superphosphate to maintain high production on this class of land. The application is equivalent to 2½ cwt. of lime and ½ cwt. of superphosphate per annum. However, the high production was not reached until 10 cwt. of lime and 4 cwt. of superphosphate had been applied (fourth season). One may conclude that on light plains land the fertilizer treatment for subterranean clover pastures should start off with 10 cwt. of lime and 2 cwt. of superphosphate and, once a satisfactory cover has been obtained, that the maintenance of the lime and superphosphate status of the soil can be secured by an annual application of 2½ cwt. of lime and ½ cwt. of superphosphate, or its equivalent. The other treatments used in the investigation, though capable of increasing production, are considerably more costly than treatment A. This treatment applied to subterranean clover pastures on light plains land is capable of raising the carrying-capacity to approximately two ewes per acre.

Entomological Investigations

L. Morrison

Wheat Variety Trials for Hessian Fly and Argentina Stem Weevil Studies

Hessian-fly infestation was more severe than normal, due probably to the later sowing date leading to the most susceptible stage of the plants coinciding with the emergence, during October and November, of the over-wintering fly. The degree of infestation was very much higher at Hororata than at Lincoln, but the varieties retained the same relative positions in both areas. The susceptible varieties were Hunters, Dreadnought, and Cross 7, and the resistant varieties were Tainui, 78, 01, Tuscan, and 140, 014.

Stem-weevil infestation was more severe at Lincoln than at Hororata, but on the whole the varieties retained the same relative positions in both areas. Tuscan was susceptible and Dreadnought was resistant in both areas, whether from the point of view of (*a*) stems killed, (*b*) tillers killed, or (*c*) stems bored but not killed. An indication of the susceptibility or resistance of the other varieties was shown, but the position was less clearly defined. The results tended to show that the presence of weevil strongly affected that of Hessian, particularly in areas where infestation was not excessively heavy. In varieties where stem-weevil infestation was greatest, Hessian-fly infestation was least, and *vice versa*.

An analysis of the results obtained for Cross 7, Tuscan, Hunters, and Dreadnought over a period of years and in widely separated districts—viz., Lincoln, Hororata, Highbank, and Ngapara—shows that the results have been consistent from year to year, irrespective of the district in which the varieties were grown.

Housefly Control

(*a*) *Trials with D.D.T. for the Control of Adult Flies.*—The D.D.T. powder was dissolved in acetone and kerosene was used as the carrier. A 5 per cent. solution proved to be highly satisfactory, and a single spraying of rooms was effective for a period of three months or more. The addition of pyrethrum gave a remarkably quick "knock-down" effect. Solutions of D.D.T. in kerosene at less than 5 per cent. were not very satisfactory, and a 1 per cent. solution was quite unsatisfactory.

(*b*) *Trials with 666 (Gammexane) for the Control of Adult Flies.*—The 666 powder was dissolved in acetone and kerosene was used as the carrier. A 2·5 per cent. solution was effective and rapid in action, but a single spraying remained effective for a day or two only. The offensive odour of the 666 spray, unless masked by the addition of some chemical, renders it unsatisfactory for use in the treatment of dwellinghouses.

(*c*) *Trials with 666 Spray and 666 Dust for the Control of Housefly Maggots in Horse-dung.*—(1) Eighteen cubic feet of horse-dung was treated with a 2·5 per cent. solution of 666 in kerosene. The outer 4 in. only was sprayed. The quantity of spray used was 350 ml. The heap became heavily infested with maggots, which were able to complete their feeding, pupate, and emerge as adults.

(2) A 4 per cent. 666 dust was used to treat two heaps of horse-dung, each approximately 18 cubic feet in volume. In one case the heap was turned and thoroughly dusted throughout, while in the other case the heap was dusted on the outer surface only. In both cases the heaps became heavily infested with maggots, which were able to complete their feeding, pupate, and emerge as adults.

The control of maggots in horse-dung by spraying with a 4 per cent. aqueous solution of borax proved quite effective. The spreading of horse-dung in a thin layer on the ground so that it dried out rapidly prevented it becoming infested with maggots, whereas the spraying or dusting with 666 proved quite unsatisfactory.

Sheep-dipping Trials

D.D.T.—D.D.T., extended on to talc particles and used in water suspensions, is being tested as a sheep-dipping material for control of keds, body lice, and blowfly strike on sheep. Small-scale trials with keds and lice have given excellent results. A large field trial for prevention of blowfly strike is still in progress. Similar trials are in progress using D.D.T. extended on to sulphur and talc by jet pulverization.

Lameness in Sheep following Derris Dipping.—The problem of lameness in ewes following derris dipping is receiving attention. Full particulars of conditions of dipping and source and quality of derris used are being recorded. Attempts are being made to induce the type of lameness which has resulted only from dippings where derris or the pure ground root of other rotenone-bearing plants have been used.

MICROBIOLOGY

I. D. BLAIR

Pre-emergence Decay: Peas

Blue Prussion and William Massey varieties treated with dusts at 2 oz. per bushel were grown in unsterilized soil maintained at the levels of 50, 70, and 90 per cent. of saturation capacity, one series within temperature range of 56–116° F., the other within 34–69° F. The statistical analysis showed that the seeds dusted with Agrosan, copper carbonate, Spergon, and cuprous oxide germinated significantly better than undusted seed. Cuprous oxide dust gave a result significantly better than any of the other dusts used. The interaction analysis revealed (1) the relative effect of dust treatments was the same at each moisture level; (2) the effects of the dusts and moisture levels were not altered significantly by the varieties; (3) the temperature levels did not lead to any significant differences as between the dust treatments. It was shown, also, that no dust treatment had any effect in protecting plants from natural soil infection after emergence.

Botrytis *Decay of Lupins*

Severe *Botrytis* stem decay of field crops of lupins has followed injury caused by snow or heavy rain. Under glasshouse conditions in sterile soil the lupin varieties Sweet Blue, Sweet Yellow, Sweet White, and Bitter Blue were wound inoculated with *Botrytis cinerea*. Disease ratings showed that each of these varieties except Sweet Yellow were very susceptible to *Botrytis* infection, whereas repeated inoculations failed in the latter variety, which remained free of *Botrytis* stem wilt.

Disease Survey

(*a*) *Potatoes.—Phytophthera infestans* caused severe losses throughout the South Island in the autumn of 1945, the epidemic following the abnormal summer rainfall of 1944–45. A survey of a limited area, including sixty separate potato crops, revealed —

(1) Among the main crop varieties, Dakota was distinctly less affected by tuber decay than other varieties. The Arran Banner variety showed heavy disease infection throughout, up to 80 per cent. tuber loss.

(2) When the varieties were examined in relation to seed stock, mother-seed lines were less severly affected, but the differences in infection between crops grown from mother seed, commercial, or uncertified lines were small.

(3) There were distinct differences in the amount of tuber loss occurring on different soil types. The heavier and damp loams were associated with more disease within the varieties than sandy loams. The evidence of the field inspections suggests that the extent to which a particular soil type retains moisture (following initial soil saturation) is a primary factor.

(4) Among the varieties Aucklander S.T., Arran Banner, and Dakota, no evidence was obtained from the field observations that planting date (between mid-October and mid-November) influenced the ultimate degree of infection. No conclusion was possible regarding the effect of amount of fertilizer.

(5) Among Aucklander S.T., Arran Banner, and Dakota varieties, infections were less severe when the crop had been planted after lupins for green manure, and most severe where potatoes were being grown for the second time in succession. It is thought that the favourable effect following a lupin green-manure crop is attributable to the open-soil texture and quick drainage associated with soils on which lupins had been ploughed in.

(*b*) *Perennial Rye-grass : Blind-seed Disease.*—During the past two seasons several hundreds of rye-grass samples submitted by farmers in Canterbury have been examined for pre-harvest infection with the fungus *Phialea temulenta*. The following figures represent the distribution of infection within the samples examined :—

Percentage of Disease.	Percentage of Samples tested.					
	Under 10.	10–20.	20–30.	30–50.	50–70.	Over 70.
1944–45	3	13	15	32	15	22
1945–46	35	20	15	10	10	10

Pre-harvest estimates of germination capacity closely followed final official germination percentages. The data from a questionnaire among growers who submitted samples for testing were analysed, but no positive correlations could be detected between amount of infection and management since sowing, degree of lodging, amount of clover undergrowth. Certified lines of seed continued to show severe infections, in comparison with which a number of uncertified lines from very old pastures have in these two seasons of severe infection been free of the disease. Abnormal rainfall at the time rye-grass seed is being set appears to be the most significant environmental factor contributing to blind seed.

Ear Blight of Wheat

(1) An investigation is in progress to provide some account of the condition in maturing wheat referred to as "scab." Certain fungi have been isolated from ears collected in the field. Spore suspension inoculations have been made in both glasshouse and field plots of six varieties. There appears to be at least six distinct types of *Fusarium* capable of causing ear blight under both glasshouse and field conditions, to the extent of complete sterility. How natural infection proceeds in the field is unknown. Artificial inoculations produce symptoms in the wheat ear comparable with those collected in the field.

(2) Comparisons are being made between the symptoms of ear blight collected from the field and those attributed to frost injury. Single plants in pots were transferred to a Frigidaire at anther extrusion and subjected to "frost" temperatures.

Plants held at 32° C. for seven hours revealed at maturity no abnormality. Those held at 30° C. for two hours showed 60 per cent. normal spikelets, the remainder having sterile or shrivelled grain. At 26° C. for two hours 80 per cent. of spikelets were affected with some form of "frost" injury, chiefly complete sterility. Symptoms identical with those found in frosted fields in Ashburton in December were noted in the artificially frosted ears. Frosts of five degree have been recorded in December, and if there is anything in the above observations such a frost at the time wheat is flowering might be expected to cause distinct "ear blight" of a physiological type. There seems to be little difficulty in distinguishing between ear blight due to frost and that supposedly due to fungus infection.

(3) The "whitehead" condition, very common this year, should be included as a phase of "ear blight." The "straggle" phase of *Cercosporella* injury leading to "whiteheads" was observed in severity at Lincoln, moderately at Horrelville, slightly at Leeston. The organism was isolated from plants at Lincoln and Horrelville.

"Whitehead" associated with late attacks of *Ophiobolus graminis* affected several crops very severely and traces of this form of disease were widespread. Its prevalence in crops sown after grass is in accord with Garrett's work at Rothamsted.

In the field it seems possible to distinguish between the symptom pictures of *Cercosporella* "straggle," *Ophiobolus* "whitehead," *Ophiobolus* "take-all," Hessian fly, and stem weevil straw break, all of which result in white empty ears.

Root Rots of Seedling Wheat

Work is in hand attempting to clarify the phases and causes of fungus root injury in wheat seedlings. Material has been collected from a wide area through North Canterbury. Washed roots have been examined and several hundreds of isolates grouped. Inoculations of pure culture types into sterile soil sown in wheat are now being carried out, but it is suggested that from the field evidence the following might be a better picture of seedling root rot:—

Type 1: Lesions on sub-crown inter-node—*Rhizoctonia solani* and *Fusarium* spp.
Type 2: Root tip decay—*Ophiobolus graminis*.
Type 3: Seedling blight—*Fusarium* spp. (secondary infections).

This year *Ophiobolus* and *Rhizoctonia* were isolated more frequently than any *Fusarium* species from the dwarfed seedlings selected in the field as being affected with some form of root rot.

Wool Metrology Laboratory

P. R. McMahon

Wool Survey.—Thirty thousand fleeces were weighed and graded during the last shearing season from thirty-two different locations. Five of these locations were in the Whangarei district, where wool-survey work is being correlated with soil, pasture, and management surveys. Analysis of this data is proceeding.

A special survey has been made of a number of properties carrying out the practice of shearing before lambing. In all, ten properties running twenty-four thousand sheep

on environments varying from tussock to irrigated pasture were visited. The results suggest that shearing before lambing has certain advantages. Arrangements are being made to carry out trials in Canterbury during the coming season.

Intensive Investigations.—The intensive nutritional experiment with Romney and Corriedale sheep which has been running for the past two years has concluded. Much material has yet to be examined, but in general the results are in accord with breeders' observations that the fine-wool breed produces the better wool where plane of nutrition is low.

Some indication of the importance of nutrition in wool-production is given by the following table, showing fleece weights at different periods from the same sheep :—

Breed and Tag No.	Period June, 1943, to June, 1944.		Period March, 1945, to March, 1946.	
	Treatment.	Fleece Weight.	Treatment.	Fleece Weight.
		lb.		lb.
Romney 206	High plane ..	20·2	Low plane ..	7·8
Romney 218	Low plane ..	5·6	High plane ..	13·6
Corriedale 208	High plane ..	22·0	Low plane ..	7·9
Corriedale 215	Low plane ..	5·6	High plane ..	14·0

Approximately three hundred wool samples from the Kirwee experimental area have been graded and scoured. Statistical analysis of live-weight data in connection with feeding and other trials has been carried out and a statistical study on the growth rate of successive lambs of individual ewes is in progress. Fleece data will later be correlated with the growth data.

Wool Metrology.—Sets of tops calibrated for fineness have been prepared and are available on request. Attempts to prepare corresponding sets of calibrated raw greasy-wool samples have been abandoned owing to gross anomalies between appearance and measured fineness.

Wool-manufacture.—Non-medullated and slightly medullated wool of 56's–60's quality is now being processed in co-operation with the New Zealand Woollen Mills' Research Association and the Kaiapoi Woollen Manufacturing Co.

A preliminary investigation of the relations of unlevel dyeing to conditions of wool-production is being carried out.

This laboratory has co-operated with the New Zealand Woollen Mills' Research Association in the design of a trial to study the possibility of felting occurring in scoured wool during ocean transport from New Zealand.

A detailed analysis of greasy-wool production for the 1943–44 clip has been completed and circulated to interested parties. The information on which this analysis is based was made available by courtesy of the New Zealand Wool Buyers' Association and the Export Division of the Marketing Department.

MASSEY AGRICULTURAL COLLEGE

N-type Sheep Research

F. W. Dry

Breeding experiments have been carried out on the Massey Agricultural College farm and at the Ruakura Animal Research Station with the valued assistance of the Animal Research Division of the Department of Agriculture. The breeding-work, in addition to maintaining stocks, has been chiefly concerned with the following problems : —

(1) The genetic relationship between Dominant-N and Recessive-N, these two genes, together with Non-N, seeming likely to form a series of multiple allelomorphs.

(2) The significance of horns, the presence or absence of which enables us, perhaps nine times out of ten, to distinguish homozygous from heterozygous Dominant-N ewes.

(3) The occasional coming to poor expression of the Dominant-N factor, one result of which is that a homozygous ram might be taken to be heterozygous.
(4) The inheritance of the abundance of secondary, or later, kemp—*i.e.*, that grown in the follicles from which birthcoat kemps have shed.

The N-type work has been conducted as fundamental research in genetics and on the architecture of the fleece. Recently it has become apparent that the N-type coat may in one way or another possess commercial possibilities. Enough is known about the genetics to multiply N-type sheep quickly, and an understanding of the more complicated aspects of its inheritance is being acquired. In addition, from the records and stored specimens of the last twelve years, much has been learnt about what may be called refinements of characterization that would be of significance if there should be a call for the products of N-type sheep.

Research on the Roundworms of Sheep

J. H. Tetley

During the past twelve months experiments have been continued on the problem of the nature of the resistance of sheep to the large roundworm, *Haemonchus*.

The investigation is designed to contribute towards an understanding of the factors which determine the epidemic appearance of this parasite in sheep, and so, ultimately, to provide information of value in its control.

The present experiments are some of several that have been carried out to explain this seasonal infection. In these investigations sheep which have been reared from birth indoors and so are free from infection have been used, together with normal flock animals.

Previous observations have shown that *Haemonchus* is abundant in sheep in the autumn, but that at other times of the year smaller numbers are found. Earlier experiments revealed that sheep raised free of infection, when placed in the field in winter after normally acquired infection in other animals had disappeared, remained uninfected. The problem then resolved itself into the questions: (1) Were infective larvæ absent from pasture during the winter or did sheep become resistant because of growth to maturity? (2) Did the presence of parasites stimulate an acquired resistance which eventually brought about their elimination?

The experiments of the past twelve months had been planned to demonstrate the relative roles of age resistance and acquired immunity. So far it has been shown that the problem is a complicated one and that factors such as nutritional state play a part.

Animal Nutrition

C. R. Barnicoat

Milk-supply of the Ewe.—The effect of plane of nutrition on milk yield was studied. For this purpose sixty Romney ewes were fed entirely on hay and concentrates during six weeks before lambing, thirty being on a high plane, the remainder at about maintenance level.

At parturition, half the high-plane sheep were changed to low plane, and *vice versa*, thereby giving four experimental groups. The milk-production was measured at weekly intervals for a period of twelve weeks after lambing and showed considerable differences between the groups. These differences were in favour of those receiving the more food. Analyses of the milks also showed consistent variations between the high- and low-plane groups.

The growth rate of the lambs showed a close correlation with the milk-production.

Wear in Sheep's Teeth.—It is clear that both feeding and breeding influence the wearing-qualities of ewes' teeth. It is usually found that the better farms carry the poorer mouths, though within any one flock there are wide differences in teeth between animals kept under identical conditions.

Information on these and other practical points will probably be obtained from the systematic examination now under way of over seven hundred ewes' mouths on twenty-three types of property.

Plant Propagation Research

J. S. Yeates

CO_2 as an Aid in the Rooting of Cuttings.—Positive results have been obtained with cuttings of *Coleus blumei* and of carnation, Otaki Pink, by artificial increase of CO_2 in the atmosphere surrounding the leaves of the cuttings.

Cuttings were grown in sand in an enclosed section of a glazed propagating-frame inside a glasshouse. Both the glass of the propagating-frame and of the south-facing glasshouse were kept as nearly as possible clear of shading. In spite of this, the light intensity on the cuttings was approximately one-quarter of full daylight. The CO_2 was brought twice daily to a concentration of 2·5 per cent. (at 9.00–9.30 a.m. and at 2.30–3.00 p.m.). The frame was left open during the night. From sunrise until 9.00–9.30 a.m. the cuttings had only the normal atmospheric CO_2.

The effects of the CO_2 were shown by a definitely greater amount of root, and in the case of *Coleus* by considerable elongation of the internodes and much earlier commencement of flowering. These results are strikingly similar to those obtained by American workers investigating the effects of long versus short day periods.

Rooting of Azalea mollis.—Some two thousand five hundred cuttings were inserted and the results have been examined to see exactly what factors influence the rooting of cuttings. These factors appear to be :—

(1) The genetical type of the parent bush. These plants should correctly be called *Azalea mollis* hybrids. According to the proportions of other species in the parent plant, rooting appears to be easier or more difficult. A preponderance of *Azalea flavum* (pontica) seems in general to aid easy rooting.

(2) *The Stage of Ripening of the Wood.*—The results show that in general the rooting percentage is much higher with "soft" cuttings than with ripe ones. Their description as soft is a somewhat vague one, and therefore the following criteria have been used to distinguish "ripeness" or "softness": (*a*) the stage of development of the terminal bud (in ripe cuttings this is well developed); (*b*) in less ripe cuttings, the number of leaves at the apex which are still not expanded (the larger number of unexpanded leaves indicates a softer cutting); (*c*) the term "very soft" is used where there is an indefinite number of leaves not expanded.

(3) *Date of taking Cuttings in relation to Flowering Date of Bush.*—Considerable attention was given to this aspect, on account of the importance attached to it by some very successful overseas workers. At the period six to eight weeks after flowering, which is considered best overseas, we find shoots in widely different stages of ripeness, and their ability to root varies accordingly. While the suggested period after flowering may thus include the time when the maximum number of shoots are in the best stage of ripeness, yet it is still necessary to select them on the basis of ripeness or softness.

(4) *Hormone Effects.*—Although the past season's work was concerned mainly with finding the best stage at which to take cuttings, some experience was gained also of the use of hormones as an aid to *Azalea mollis*. In this case, too, the lack of uniformity from bush to bush weakens the value of averages. Both indolebutyric acid and napthaleneacetamide in solutions of 1 in 20,000 or stronger used for twenty hours caused basal damage to the cuttings. Concentrations of 1 in 30,000 and 1 in 40,000 gave sufficient promise to merit more thorough trials. A proprietary talc-dust hormone preparation which became available at the end of the season was also tried.

Minor Investigations on Cuttings of Commercial Importance.—Daphne: Since this is one of the most profitable cutting crops in New Zealand—largely for export in normal times—it was considered worth-while to test the effects of various factors on its successful rooting. The trials were made in a propagating frame kept at approximately

75° F., and the effects of the following treatments were investigated: (*a*) hormone versus no hormone; (*b*) coconut fibre versus washed sharp river sand as a rooting medium; (*c*) splitting of basal ⅛ in. to ½ in. of the cutting. No hormone treatment used gave results equal to untreated. Coconut fibre gave superior results to sand, more particularly in cases where the bottom heat was applied by heated water below the rooting medium. There was definitely no gain through splitting the bases of the cuttings. These results were based on some six hundred cuttings.

Drainage Research Work

A. W. Hudson

Maintenance Work and Recording.—Continuous records of outflows from the drainage experiments were obtained up to the beginning of December, when the meters were removed for overhaul as no further outflows were expected.

Routine testing of about three hundred mole junctions of three different types were carried out.

Analysis of Records.—Records collected during the war years are being examined and it is hoped that some of the investigations which have been the subject of these records will be finalized. Records from the following experiments have been collected:—

(1) A comparison of fast pulling with slow pulling of the mole plough. Records examined indicate that efficiency of drains was not affected by pulling at speeds of from one to three miles per hour.
(2) Uphill versus downhill pulling of moles. Records from this experiment indicate that there is no justification for the practice sometimes adopted of pulling one way only.
(3) A comparison of the effect of a thick blade with a thin blade on the life of a mole channel. A thick blade definitely facilitates the entry of water into the mole channel but may also hasten deterioration.
(4) A comparison of three different depths of pulling moles. The shallow moles gave greater outflows initially, but records so far examined indicate that they may also deteriorate more rapidly.
(5) A comparison of two different types of plug.
(6) A comparison of five different types of backfill material over tile drains.

Concrete Field Tiles.—Owing to the difficulty of procuring earthenware field tiles and the increasing cost of them, investigation of possible alternatives is being made, and to this end information concerning machines for manufacturing concrete field tiles is being collected.

Nutrition Experiment

E. A. Clarke

Results of the first four years of the trials have been worked up and their presentation in a form suitable for publication has been completed.

Manurial Trials.—This trial is now in its second year of a further four-year period, having been restocked in February, 1944, with two-tooth ewes. Results to date confirm the previous findings that in so far as thrift and productivity of ewes and lambs are concerned there are no measurable differences which can be attributed to manuring treatments. Differences in carrying-capacity are of much the same order as in previous years, although owing to the favourable winter conditions more stock has been carried on all plots. Lime effects are becoming more obvious, and in the case of some plots of the control area (1 cwt. super per acre) moss, weeds, and volunteer grasses are becoming more evident. Records are being kept in the same detail as in the past.

This long-range experiment is producing much valuable basic data on the sheep and on pastures under stabilized management and will provide increasingly valuable material for the study of soil reactions to manuring treatments.

Trials of the Carrying-capacity of Pedigree V's H1 Rye-grass.—This trial was stocked with in-lamb ewes at the rate of three ewes per acre at the end of May. Pasture establishment on all plots has been good and pasture-production high. A notable feature of the Short-rotation rye-grass pastures has been the considerably higher production in the winter and early spring in comparison with pedigree rye pastures. These latter, however, have since September surpassed the Short-rotation pastures. Differences between rotationally grazed plots and set stocked plots are, however, not very well defined.

Mutton and Wool Improvement

R. Waters

The collection of data and compilation of the progeny test of 24 sires based on 453 ewe hoggets of 1943 was completed. Eleven sires and a considerable number of their progeny were culled on this test, and 3 sires gave sufficiently promising results to warrant special mating. Matings for these 3 sires have been arranged. In addition, 22 new rams have been selected for progeny testing, including 15 sons of 203 and 213. Several of these have produced very promising lambs and give good expectation of being worth closer study.

The usual field-work for collecting data for the progeny tests for rams used in 1944 and in connection with the 1945 lambing season is being carried out.

Investigations on the distribution and variation of hairiness in New Zealand Romney Marsh sheep from four months to five years old have been completed.

The first two papers on this subject have been published in the *New Zealand Journal of Science and Technology*. These are as follows: "Distribution of Hairiness in the Fleeces of New Zealand Romney Marsh Ewe Hoggets"; "Yearly Changes in Hairiness in New Zealand Romney Marsh Sheep."

The last two are in the hands of the editor. These are as follows: "Growth of Hairiness in New Zealand Romney Marsh Lambs"; "Relation between Fleece Hairiness and Fleece Weight in New Zealand Romney Marsh Sheep."

"Quantitative Inheritance of Hairiness" is now in the course of preparation. Preliminary results indicate that hairiness is much more strongly inherited than previous results (McMahon) would suggest, hence the possibility of discontinuing hairiness in the progeny test must receive consideration.

Much useful data has been accumulated by the Department in the course of its progeny-testing experiments, a statistical investigation has been commenced in stud flock composition, production, reproduction, and vital statistics of which there is at present a lack of adequate knowledge. These investigations will be carried out with special reference to progeny testing.

Pig Research

Wm. Riddet

Research work on the inheritance of carcass length in Tamworth and Crossbred pigs commenced in 1937 and has been continued during the year, the complete carcass measurements of College-bred baconer pigs now totalling approximately six hundred. The original intention was to select two distinct strains, one short, the other long, from within the Tamworth stocks in possession. Progress was made during the initial phases, but from 1940 an increasing tendency towards smaller litters was noted among the inbred short strain. An attempt was made to correct this by an outcross, but a high mortality rate during the war years has resulted in the short strain being almost eliminated. There are in possession, however, a gilt and a young boar of this inbred strain with which the family will be perpetuated.

In the long strain considerably more success has been encountered. Though incidence of losses has been high, sufficient records have been accumulated to indicate that successive generations are improving in respect of length. Fourth-generation sows from the original stocks are leaving progeny appreciably longer than their forbears. Though the numbers available in the last year are inadequate to permit of statistical analysis, the trends observable indicate some degree of progressive improvement in length.

Certain of these inbred animals were crossed with Large Whites and the resulting progeny closely bred. Little difficulty was experienced in fixing the desirable red colour from the Tamworth, but the inbred first crosses had to be back-crossed to the Large White to get greater length and better hams. Again numbers of carcass measurements available are small, but the main feature to date has been their variability. The longest carcasses are to be found among this group, and with careful selection based on progeny testing a stock breeding consistently for the desired length should be obtained.

With the degree of inbreeding which has been practised in the past, the sow population can now be classified into short and long strains with a considerable degree of certainty. This will permit of a more accurate interpretation of the progeny testing of boars and make the selection of future breeding-stock more certain. At the outset of the work, of necessity, sows were classified largely on appearance, but with the stocks now relatively pure for either shortness or length, present generations are more fixed in type and are better experimental material for studying modes of inheritance.

Due to the relatively small herd that can be maintained on the feed available and the necessary time lag in proving both sows and boars, progress must be slow. This becomes accentuated as the necessary selection from close breeding proceeds.

DOMINION LABORATORY

Director: Mr. R. L. Andrew

The Dominion Laboratory is primarily a service laboratory for Government Departments. Besides the analysis of a great number and variety of materials, this work has always involved a considerable amount of investigation of a fundamental nature, as well as work on specific problems.

The Director and other senior members of the staff have been consulted continually by Government Departments for advice on scientific and industrial matters. From the fund of knowledge possessed by the specialists of the staff it has often been possible to answer specific inquiries at very short notice. This service is always available to Government Departments and, in fact, to any person requiring scientific information, and is fully utilized. It is not, however, possible to undertake analytical work indiscriminately for industrial firms or private individuals, especially when that service can be obtained from consulting and analytical chemists in private practice. In recent years it has been the policy of the Department to assist local industries by the investigation of problems of manufacture which are of a generalized nature and which are beyond the resources of the industry concerned. For this purpose a staff has been assembled which consists of chemists, chemical engineers, and physicists. The Laboratory and its branches in Auckland, Christchurch, and Dunedin are prepared to undertake such industrial investigations as are possible with the present restricted staff and accommodation.

In respect of staff the Laboratory has been unfortunate in losing experienced chemists, and has found difficulty in obtaining replacements. The accommodation position, which was commented on in last year's report, has not yet been improved, and has actually deteriorated owing to the necessity of finding additional space for ceramic work.

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

Contributor or Department.	Dominion Laboratory, Wellington.	Auckland Branch.	Christchurch Branch.	Dunedin Branch.
Agriculture	16	3	283	7
Air	543	..	8	..
Army	1,274	172	290	..
Broadcasting	..	..	3	..
Coal Survey	218	..	..	..
Customs	275	13	2	29
Education	..	..	1	..
Forestry	48	..	..	..
Health	2,725	6,772	6,373	2,207
Housing	146	23	6	6
Industries and Commerce	7	4	6	6
Internal Affairs	..	1	..	4
Internal Marketing	12	3	27	1
Island Territories	..	6	..	..
Lands and Survey	..	6	..	3
Local bodies	77	..	70	7
Main Highways Board	42	..	..	..
Marine	7	2	..	..
Mines	83	6	4	..
Munitions	601	..	..	..
Native	69	..	..	..
Navy	5	8	3	..
Plunket Society	273	61	68	..
Police	68	216	109	24
Post and Telegraph	53	4	1	1
Printer	8	..	..	..
Prisons	193	..	..	..
Public Works	384	28	67	18
Railways	10	3	6	41
Scientific and Industrial Research—				
Dominion Laboratory and Branches	35	..	..	..
Dominion Physical Laboratory	34	..	..	..
Geological Survey	108	..	..	..
Manufacturers' Research Committee	..	3	..	19
Plant Research Bureau	95	..	..	..
Radio Development Laboratory	5	..	..	..
Soil Bureau	1	..	..	..
Unclassified	16	354	35	6
Standards Institute	16	..	..	..
State Advances	126	41	27	..
Supply	116	26	31	..
U.S.J.P.B.	76	..	..	..
Miscellaneous	242	..	49	30
Totals	8,007	7,755	7,469	2,409

The total number of samples for the year was 25,640, as compared with 30,176 in 1944. The decrease is due to the smaller amount of work done for the Armed Forces. On the other hand, industrial work, which does not involve a number of samples commensurate with the work done, is increasing steadily.

While it is not possible or desirable to divide the laboratory into completely separate divisions, a great deal of the work of the Wellington laboratory falls naturally into sections which deal with a comparatively restricted range of work. These sections, although specialized, are none the less complex and are frequently required to collaborate with each other on a particular problem. The tendency is for each of these sections to be under the direct charge of a senior man who is responsible to the Director for the work of his section. Free interchange of junior staff between the sections is desirable so that they may have a wide general knowledge of the work of the Laboratory

as a whole before becoming more highly specialized in the work for which they may be more particularly adapted or trained. The branches of the Laboratory in Auckland, Christchurch, and Dunedin may be considered as such sections which have a rather wider range of functions than the sections of the Wellington Laboratory. The work carried out during the year ended 31st December, 1945, will be reported under headings which correspond only approximately with the above-mentioned sections owing to the overlapping which takes place.

Only in occasional instances will the work of the branches be mentioned separately.

Physical Chemistry

The most important development in this section was the arrival of complete equipment for x-ray crystallographic analysis. At the end of the year the apparatus was being installed. It is anticipated that the equipment will find useful and increasing application in the examination of clays (both for Ceramics Research and for the Soil Bureau), of pigments, boiler scales, &c.

In continuation of work started last year, pH meters constructed by the Radio Development Laboratory were calibrated by this section.

The new policy of the Department in respect to assistance to industry through the Manufacturers' Research Committee brought a considerable increase of work in the preparation of reports on processes and in carrying out special investigations. Besides spectrographic analyses and work on electroplating, general work included reports on silvering of mirrors, on improved methods of making connections to carbon resistors, and an investigation of a method of estimating the antimony content of lead for batteries by determination of the freezing-point of the molten metal.

As in previous years, the Physical Chemistry Section had to carry out a considerable amount of work on electroplating problems. Analyses of solutions have been required, but the Hull cell has also been found useful in checking the performance of plating solutions. The thickness of electroplating on samples of hardware plated in New Zealand was determined for the Standards Institute in connection with the preparation of an Emergency Specification for Electroplated Hardware, and assistance was given in specifying methods for determining the thickness of coatings. The recommendation to use the B.N.F. jet test was confirmed by finding it in the B.S.I. Specification arriving shortly afterwards.

Assistance was given to industrial firms through the Manufacturers' Research Committee. Reports were prepared on speculum metal-plating, metallizing of plastics, lead coatings on brass, bronze finish on zinc-base die castings. A review of the plating industry in New Zealand won for its author, Mr. M. Fieldes, Physical Chemist, the Industrial Chemistry Essay Prize given by the New Zealand Institute of Chemistry.

Spectrographic analysis remains the main work of the Physical Chemistry Section, although even in this field, as well as in the other fields of physical chemistry, the work that can be done is seriously limited by the small staff available.

The end of the Japanese war brought an immediate fall in the considerable number of analyses of metals required for munitions. In particular, the daily testing of zinc-base die-cast alloy for mortar-bomb parts from several factories has now stopped. This had been carried out in a routine way since March, 1941, and at one time samples from four factories were being received. As far as is known, this is the only laboratory where a small glass instrument, the wave-length spectrometer with camera attachment, has been used for this purpose. Lead, tin, cadmium, iron, and chromium have all been occasionally found, as well as insufficient magnesium, and, apart from routine work, interesting points have been followed up. At the very last a long investigation was made of the cracking on firing of a certain lot of bomb tails. The trouble could not be correlated with the lead content, and a careful examination did not disclose any significant amount of other impurity. Mechanical tests by the Dominion Physical Laboratory confirmed that the metal was weaker than satisfactory samples. Further work by chemical methods indicated only that the weakness could be rather indefinitely associated with higher oxide content.

The method evolved using the instrument for the qualitative examination of steels was frequently found useful as a preliminary to exact analysis by the Metallurgical Section.

Almost the only work on organic material was the spectrographic examination of beer and worts. The results were not definite, and only speculative suggestions as to adding trace elements to promote yeast growth could be made. Damaged wood from an aileron was examined, and the presence of elements not found in sound wood pointed to contamination with drips of dirty water which induced fungal growth.

The speed of spectrographic methods is illustrated by the one used for testing for toxic elements in plastic utensils. Filings from the samples were made into 50 mg. pellets and arced on graphite electrodes. No elements considered particularly toxic were found, although in a few samples zinc, barium, chromium, and cobalt compounds were present as fillers or pigments.

The method evolved for testing for the presence of sea-water residues in cases of corrosion was applied to a sample of badly corroded galvanized wire. In this case there was much sodium present. From spectrographic and chemical work it appeared likely that corrosion was due to sodium hydroxide dissolved from the cargo by sea-water, but in the presence of so much sodium the evidence for sea-water as the primary cause was not conclusive.

The relief from war work meant that some time could be given to some work of geological interest. The boron content of some thirteen samples of manganese was determined for the Geological Survey. The method used by B. Wasserstein on South African ores could not be improved on. In contrast to this worker's discovery in regard to braunite, the content of boron in the New Zealand ores—manganites with one psilomelane—was low, the highest being 0·04 per cent. A method was worked out for the determination of lithium, rubidium, and caesium in mineral waters. The small glass instrument is used with plates sensitive to the infra red. The contents of lithium in waters from hot springs is significant and its determination should not be neglected in complete analyses.

The work of the photographic technician has been supervised by this section. Most was copying work for Head Office and Dominion Laboratory. Work for other Departments was spool developing and printing. There was some photography of specimens, such as fruit, and corrosion products. Assistance in photomicrographic work was given to the Paint and Metallurgical Sections.

The volcanic outbreak at Mount Ruapehu offered an opportunity for chemical work on volcanic products, but owing to the acute shortage of staff no advantage could be taken of this. An official visit was made to the volcano by a member of the staff in the company of Mr. J. Healy, Volcanologist at Rotorua, towards the end of the most active period. Sulphur dioxide could be detected in the steam cloud coming over the rim of the crater. From information from various workers on effects of the ash from the volcano, it appears that corrosion effects, poisoning of fish, and tainting of butter might have been due to sulphur compounds in the ash. It would be desirable in any further outbreak to make a survey of the distribution of sulphur compounds, but on this occasion there was no staff to spare, and it was even too late to obtain and examine a fresh sample of ash.

Minerals

The number of scheelite samples analysed (forty-five) was less than in 1944, because of the withdrawal of Government subsidy on production. Assays for gold and silver also declined somewhat. On the other hand, there was a great increase in the number of high-accuracy complete analyses of minerals (separated in the pure state by New Zealand Geological Survey). Minerals tested for the possible presence of uranium were thorite, chromite, garnet, monazite, ilmenite, sphene, and allanite. Wanganui ironsands from both beech and dune deposits were analysed for iron content of their magnetic and non-magnetic fractions, for inclusion in a report by New Zealand Geological Survey.

Some seventy-five limestones from Hokianga, East Cape, and Poverty Bay districts were analysed for the Native Department for lime content. Limestone samples from Te Kuiti and from Mapua were analysed for suitability for caustic soda regeneration in paper-manufacture. Serpentine from the newly opened quarry near Te Kuiti was tested for use in serpentine-superphosphate. Concrete blocks, of blast-furnace origin, brought here by ships in ballast were tested for sea-retaining walls for Eastbourne Borough Council. In connection with the eruption of Ruapehu, the lava was analysed and the dust was examined for acidity and corrosion effects. Over thirty samples of cement, mainly from Karapiro Hydro, were examined for the Public Works Department for possible high-alkali content, and some samples were more fully analysed for conformity with British Standard Specifications. For the Mines Department the examination of dusts for minerals injurious to health in the stone-dusting of mines was continued.

Ceramics

The main investigations during the year consisted of the systematic examination of clay deposits from several areas, in co-operation with the Geological Survey. These included survey of brick-clay deposits in the Wellington and suburban districts; examination of pottery and aluminous clays from North Auckland; report on white-burning clays from Mount Somers; tests on brick clays from Te Aroha, Nightcaps, and Levin; analyses and burning tests on clays from Otorohanga, Ruapekapeka, Tauranga, Nelson, and Kakahu.

Special investigations included development of testing methods for fine earthenware (cups and saucers) of local manufacture, and comparison with the imported article; examination of imported refractories for gas-fires as a guide for local manufacture of gas radiants and insulating refractories; comparison of refractory electrical radiator bars of New Zealand manufacture with imported article; silica gel—testing of efficiency of the locally made product and advice to manufacturers *re* improvement; glass-sand (Ross)—quality investigated.

Other subjects dealt with in special reports were production of aluminium sulphate from local clay, brickmaking by a new tunnel-kiln process, availability of pottery clays, suitability of local clays as paper fillers, jointing cement for suspension-type electrical insulators, and failure of hard-plaster hospital-wall finishes.

An apparatus for the examination of clay by a new method, differential thermal analysis, was constructed during the year.

Paint

A large number of paint and related samples have been examined on behalf of the State Advances, Housing, Army, Navy, Air, and other Government Departments for compliance with purchasing specifications. In many cases the samples failed to comply with specifications.

Special problems still under investigation include the priming of totara and development of a satisfactory specification for totara primers, the effect of wood-preservatives on paint durability, the painting of asbestos-cement, and development work on casein paints.

An accelerated weathering unit for comparing the durability of paint was installed towards the end of 1944 and has been in almost continuous operation during the present year in testing metal protective paints. Sufficient experience has now been obtained with these paints to develop a satisfactory method of testing this class of material. This has been made possible through information made available by the Public Works, Railways, and Post and Telegraph Departments from records of actual exposure tests made by those Departments.

An extensive long-term programme of paint research has been planned and will be put in operation during the coming year. This work is under the sponsorship of the Inter-departmental Committee for Paint Investigation, a Committee of representatives of Government Departments interested in the use of paint, and arose from the recommendation of a member of the staff who was sent overseas to study building-research activities in England and America.

Among the more important aims of this programme are the establishment of the most suitable types of paint for exterior wood surfaces in the different climatic areas, a comparison of the recently developed two-coat painting system with the traditional practice of 3-coat painting, the development of accelerated durability tests for paints for exterior wood surfaces, the effect of wood species on paint durability, the effect of preservative treatment of timber on paint durability, and the amassing of information on which paint specifications can be drawn up and kept up to date with developments in paint technology. It is expected that the general public will benefit from this work through information disseminated by the New Zealand Standards Institute by means of paint specifications.

Small-scale paint mixing and grinding equipment has been installed and will be used for manufacture of the experimental formulations. These experimental formulations will be exposed in various parts of the Dominion and systematic inspections and records will be kept of the behaviour of the paints. It is expected that the information obtained from the long-term paint research programme will lead to very substantial savings per annum in the cost of painting State-owned buildings.

A certain amount of work has been carried out on industrial problems through the sponsorship of the Manufacturers' Research Committee.

Members of the staff have acted on the Paints and Sectional Coatings Committee of the New Zealand Standards Institute and on Inter-departmental Committees for Paint Investigation. These Committees have sponsored many of the above investigations.

As in the past, members of the staff have been required to give advice and information on painting problems to Government Departments and industry.

Building Research

The work carried out during the year has comprised the examination of a number of materials such as roofing-tiles, asbestos-cement products, enamelled sinks, plastics, cements, wallboards, &c. A considerable part of the time of the officers in this section has been taken up in advisory and consultative work on such subjects as manufacture of various types of building-materials, particularly concrete products, and utilization of local raw materials in the building industry. A certain amount of work has been done in investigating the causes of failure of building-materials.

The greatest part of the Laboratory's work on building-materials continues to be on paint, which is dealt with in another section of this report.

Chemical Engineering

Work on the dehydration of vegetables was discontinued. A complete new layout for the apple-dehydration factory of the Internal Marketing Division at Motueka was designed, and the factory has been put in running order for the 1946 season. An improved method of tunnel-dehydrator operation was worked out and an original design of apple-sulphiting equipment which is now giving satisfactory service was installed. The chief advantages of this piece of equipment are that it is compact, its design allows of easy control of the sulphiting process, it is easy to operate, it is easily cleaned, and the design obviates discoloration of the fruit.

The investigation of tobacco-kiln design has been continued in collaboration with the Tobacco Research Station. As a result of a survey of conditions in tobacco-kilns, a modified type of kiln was designed and will be tested during the 1946 season.

A unit for the drying of fescue seed to the design developed by the Chemical Engineering Section has been in operation in Invercargill and has proved of great value to the industry. The design of the commercial unit has been revised with a view to simplification of construction. The installation of several new units is projected.

A general-purpose drying plant for the Agronomy Division, Lincoln, with 1,000 square feet of tray surface was designed and put into operation in December.

A heated-sphere anemometer to a design developed at the University of Illinois was constructed and calibrated for the measurement of low air-velocities in connection

with the tobacco-kiln work. The design proved promising and a number of further units were constructed at the Dominion Physical Laboratory. These were calibrated and have been found very satisfactory for measurement of air velocity between 15 ft. and 200 ft. per minute.

A Fuel Technologist was appointed to the staff in November to initiate the projected work on industrial fuel efficiency. Until such time as the necessary staff can be obtained, the work will be largely confined to the testing of steam-raising equipment, furnaces, &c. Equipment has been obtained for the measurement of CO_2, temperature, steam flow, &c.

An officer of the section collaborated with the Radio Development Laboratory in developing methods for measuring humidity at various heights in the atmosphere.

Lack of staff has prevented progress on an investigation of processes for the commercial preparation of New Zealand bentonite. A commencement has, however, been made on the design of pilot plant for carrying out this work.

The section has been asked to design an experimental plant for the research on antibiotics to be carried out at the Plant Chemistry Laboratory, and the necessary work has been commenced.

As in previous years, the section has been called upon to do a certain amount of design and advisory work for the other sections of the Laboratory and has also been consulted on industrial problems.

Metals and Corrosion

While the stoppage of munitions-production following the cessation of hostilities considerably altered the character of the work undertaken in this section, more attention being given to problems affecting industry, the volume of work has been maintained.

Chemical analyses were made of a variety of metals and alloys either to establish their nature, to test their compliance with specification, or to assist in ascertaining the cause of metallurgical failures. The samples examined included ninety steels, twenty zinc alloys, seventeen brasses, twelve bronzes, sixteen lead alloys, solders, and type metals, besides a number of aluminium alloys, ferro-alloys, magnet alloys, fluxes, and other metallurgical products. A great deal of analytical work was also required in the investigation of corrosion problems referred to below. A number of commercial zinc and cadmium plating solutions were analysed for metal content, and chemical methods were used for estimating the thickness of electroplated coatings. In the analytical work considerable assistance was received from the Physical Chemistry Section, particularly in the determination of minor constituents and in the rapid qualitative determination of compositions.

Advice was given in a number of cases on the suitability of metals for use under specific conditions. Mechanical failures in machinery were found to be due to the use of steel and wrought iron of low fatigue strength in locations subject to severe vibration. Damage to an aluminium-alloy cylinder head was shown to be due to overheating. Soldering difficulties were traced to solder of unsuitable composition. Advice was given on problems connected with the tinning of cast iron and of copper.

The steady increase in the number of corrosion problems submitted to the Laboratory in recent years emphasizes the serious economic loss that is continually being caused by the corrosive wastage of metals and the necessity for more attention being given to this matter.

A number of lead sheaths from telephone cables were examined for the Post and Telegraph Department. In most cases the evidence indicated that the corrosion was due to stray electrical currents. Corrosion of bearings was found to be due to sulphur-containing additives in lubricating-oil. The pitting of tinned copper sheet was believed to have resulted from electrochemical action between the copper and the heavy copper-tin-alloy layer that had been formed as a result of overheating the sheet. Corrosion of silver contacts in automatic railway signalling gear was traced to sulphur derived from plastic insulating-material.

As a result of complaints that recent supplies of copper used for laundry boilers corroded much more rapidly than the copper formerly used, work was commenced on the examination of the metal used for this purpose. A number of samples of scales from boilers and calorifiers were examined to determine if they had resulted from corrosion of metal parts. In one case metallic copper dissolved from a boiler feed-pipe was being deposited on steel boiler-tubes. A deposit in the fuel-feed housing of an aero engine was found to have resulted from the corrosion of a magnesium-alloy casting. Sludge in the insulating-oil of a transformer contained a large proportion of lead derived from the corrosion of the lead sheathing of a cable, by the action of organic acids produced by the oxidation of the oil.

The Laboratory was consulted with regard to the possibility of corrosion of water-mains and plumbing fittings by domestic water-supplies. During the year analyses were made of water samples from the Rangitikei River, proposed sources of supplies near Gisborne, Hawera, and Wellington, and from existing supplies at Trentham, Silverstream, Orongoorongo, and Wainuiomata. Advice on the suitability of pipe material and methods of water treatment for correction of corrosiveness was given. In the case of two small supplies, suggestions were made for overcoming trouble due to staining of sanitary ware by metal salts in corrosive waters.

Oil, Bitumen, and Tar

Although it was expected, following the cessation of hostilities during the year, that a very considerable reduction in the demand from this section would occur, such has not been the case. Despite inadequate staffing, the output, though subject to delays which have caused concern, has actually increased markedly. The number of aircraft fuels examined has remained approximately the same as for the year 1944, but the number of other samples, including those not connected with the Armed Forces, has increased. The amount of investigational work associated with lubrication failures, theft of aviation fuel, police investigation, &c., has also increased. A feature of the year's activities has been the number of critical examinations made for lead in aviation fuel. This is no doubt due to the long storage of fuel in the more remote islands. Some of these samples gave phenomenally high figures for tetra-ethyl lead content.

The total number of samples examined during the year was 464, compared with 425 in the previous year. Of this total, aviation fuels accounted for 333, routine examinations of other products numbered 63, and the remaining 68 samples either required partial examination or were associated with special investigations.

The materials examined included aero lubricating-oils, anti-corrosion oils, aviation fuels, Diesel fuels, Diesel lubricating-oils, engine coolants, hydraulic fluids, kerosenes, lubrication sludges, motor fuels, motor lubricating-oils, petroleum jellies, spray oils, steam-cylinder oil, turbine lubricating-oils, transformer oil, and used oils of various types.

The section has also been of service in an advisory capacity, and this service has been appreciated by the interests concerned.

Examples of investigational work performed during the year are as follows :—

(1) Lubrication failures due to excessive sludge formation. In certain cases this was associated with contamination by engine coolant.

(2) Further examination of accepted methods for rating the protective capacity of anti-corrosion oils.

(3) Study and application of methods for detecting adulteration of various products—chiefly in connection with suspected theft of aviation fuel.

(4) Investigation, by semi-micro methods, of an arson case for the Police Department.

During the war years the activities in road materials were much reduced owing to the restricted roading programme then in operation. It is expected, however, that there will be an increase in roadbuilding and maintenance in the next year, and this work is likely to increase correspondingly.

Although the number of samples received gives only a rough indication of the amount of work that is being done, the following figures may be of interest: in the 1942-43 period, 59 samples in all were received, which, with exception of one sample, were purely routine work. During the 1944–45 period the number of samples had increased to 110, of which 17 required investigational work.

Special work over the period varied considerably in its nature. Owing to the shortage of imported bituminous materials, the demand for gasworks tar for road purposes became greater and many of the smaller gasworks throughout New Zealand submitted samples to this Laboratory for analysis and advice.

Work was also done on the design of bituminous mastic material for the expansion joints in the Karapiro Dam project.

As already mentioned, the restriction on overseas bituminous materials, especially various types of American cutbacks, caused the road engineers to consider the best methods of using the bituminous stocks at present in the country. This Laboratory was able to give considerable help in the preparation of large numbers of experimental cut-backs and the selection of those which best fit the local conditions. The work is still proceeding, but is considerably handicapped by lack of space and staff.

Unless further facilities are provided, it appears probable that only a bare minimum of urgent routine work can be handled.

Coal Survey

The Coal Survey Committee comprises representatives from the Mines Department, the Geological Survey, and the Dominion Laboratory.

The Mines Department is represented by the Under-Secretary, the Superintendent of State Mines, and the Chief Inspector of Coal-mines, the Geological Survey by the Director and the geologist in charge of field work; and the Dominion Laboratory by the Director (Chairman of the Committee), the Assistant Director (Secretary), and the chemist in charge of laboratory investigations.

The Committee met on six occasions during the year and issued sixteen coal-survey reports and five information circulars.

As a result of information supplied to the Organization for National Development, Cabinet approved a number of recommendations for extending the work of the Survey and for undertaking work on fuel technology.

The field staff appointed by the Geological Survey, working in conjunction with Mines Department officers, prospected coal-bearing areas in various parts of the Dominion, notably in the bituminous coalfields of the west coast of the South Island.

A valuable new field at Garvey Creek, in the Reefton district, was shown to contain a considerable reserve of coal. Geologists were active in various fields recommending sites for boreholes and analysing the results of boring. Samples from bores, outcrops, and mines were forwarded to the Laboratory in Wellington for analysis, and in all 218 samples were analysed during the year, the greater proportion coming from the West Coast, Ohai, and Mataura.

An examination was also made of the opencast areas of Huntly and Waitewhena and of a series of outcrops at Mangatangi. Recommendations were made for the storage and examination of bore-cores in the main coal areas, and it is hoped that the scheme will be applicable to bores put down for other purposes. Not only did the Laboratory analyse field samples in connection with the survey, but members of the staff also carried out briquetting experiments on New Zealand coals and commenced an investigation into the efficiency of various fuels on the domestic open fire. Assistance was also given to the Chemical Engineering Section of the Dominion Laboratory in some preliminary boiler-efficiency trials.

Interest was also shown in the total gasification of low-grade coals, and special inquiries were made regarding the Broadhead process in Australia. It was decided to survey the Mataura field in greater detail and to send a shipment of opencast lignite to Australia to investigate its suitability for briquetting.

It was also decided that the senior Fuel Chemist should proceed to Australia to witness the briquetting trials and to investigate methods of complete gasification of low-grade coals.

Food and Drugs

Milk.—The numbers of samples examined were: Wellington, 2,508; Auckland, 6,013; Christchurch, 5,769; Dunedin, 1,875.

In the Wellington district the milk-supply is of good quality. The number of samples taken was considerably lower than in previous years, and an insufficient number were taken for the reductase test. As conditions become more normal this should be rectified, especially in the outlying districts and centres outside Wellington.

In Auckland the main feature requiring comment was the unsatisfactory nature of the pasteurized milk, due to overloading of the inadequate pasteurizing plants. The reductase test at 63° c. was applied to all samples of pasteurized milk and has given useful information as to the state of the pasteurizing plant. Reduction times varied from one hour to ten hours.

In Christchurch the fat content and bacterial condition of the milk were very satisfactory, but during recent years there has been a steady deterioration in the content of solids other than fat during the winter months. The principal reasons for the deficiency are the low plane of nutrition of the cows and the increased use of low-testing breeds of cows in order to obtain a greater volume of milk. As far as the consumer is concerned, milk deficient in solids other than fat is no better than watered milk. This tendency to produce low-testing milk is encouraged by the failure to enforce the minimum legal standard for solids other than fat.

In the Dunedin City area approximately 5 per cent. of the milk samples were deficient in fat, nearly 4 per cent. were below the standard for other solids, while 9 per cent. were shown by the reductase test to be stale. Nine samples were definitely dirty. Of samples of pasteurized milk taken in the city and in country towns, 10 per cent. to 12 per cent. were found to be insufficiently heat-treated. Milk-supplies in Otago and Southland are far from satisfactory and should receive increased attention from the authorities. An innovation was the application of the reductase test to milk samples from Oamaru, Balclutha, and Alexandra.

Waters.—Regular examinations were made of water-supplies throughout the Dominion. A few swimming-bath waters were examined. Sewage effluents were examined, particularly from plants constructed by the Public Works Department at Trentham, Silverstream, Burnham, and Taieri. Industrial effluents were tested to determine whether they would pollute streams or injure fish.

Food and Drug Samples other than Milk.—These amounted to 2,723 and included an extremely wide range of foods and a very small number of drugs.

Some of those worthy of comment include:—

Almond pastes, some of which contained little or no almond, but were flavoured with almond essence.

Several brands of arrowroot consisted of either canna or manihot (tapioca) starch. As it was considered that these root starches had a claim to the name "Arrowroot," a definition for the regulations was framed accordingly.

A large proportion of the bacon samples contained boric acid.

Butter samples in general contained less than the maximum permitted amount of water.

Cherry brandy and similar liqueurs were considered to be labelled in a misleading manner, and regulations to control them have been drafted by the Department of Health.

Most of the brands of cochineal were found to consist of synthetic colouring substances.

A deodorant which was alleged to have caused dermatitis contained hexamine.

The fish-liver oils (cod and halibut) on the local market were examined for compliance with the British Pharmacopœia requirements. Most of the brands were up to standard and contained the amounts of vitamin A claimed.

A sample of gin contained methylated spirits.

A ginger wine contained 3·4 per cent. of alcohol and can hardly be regarded either as a wine or as a " compound cordial." In such cases more accurate labelling should be insisted on. The same sample contained an excessive amount of salicylic acid as well as sulphur dioxide.

A few samples of ice-cream were deficient in milk-fat, and a few contained more milk-fat than is permitted by the emergency regulations.

Iodized salt in general contained the correct amount of iodide.

Some samples of minced meat contained excessive amounts of sulphur dioxide.

A " pineapple " marmalade was found to contain no pineapple.

A port wine contained only 10 per cent. of alcohol, and the seller was convicted of false and misleading labelling.

Samples of rose-hip syrup contained from 13 mg. to 210 mg. of ascorbic acid per 100 ml. It is now proposed to fix a minimum standard of 200 mg.

A considerable number of sausage samples contained less than 75 per cent. of meat, and some contained excessive amounts of sulphur dioxide.

Syrups (or cordials) were sometimes unsatisfactory in that they contained synthetic colouring substances without declaration or contained excessive amounts of preservatives. These are matters which will receive attention.

Twelve brands of tea, tested as the result of suggestions of adulteration, were found to comply with the Standard.

A large number of wine samples were examined. Twenty-four New Zealand wines contained synthetic colouring substances, and thirty-seven were condemned on account of excessive acidity.

Organic

Much of the work of the Organic Section is reported under the headings " Toxicology " and " General Investigations " and some under the heading " Food and Drugs."

In connection with the Botany Division's programme on the production of medicinal plants in New Zealand, belladonna, henbane, and stramonium were examined for alkaloid content. A quantity of mixed alkaloids was extracted from pukatea bark to be used as a source of pukateine for clinical experiments overseas.

A considerable number of natural and synthetic rubber hoses and gaskets were examined to specifications for resistance to oil, petrol, and glycol. Sediments from hydraulic systems and petrol-filters were examined and were found to have originated from anti-knock compounds or decomposition products from rubber fittings. Rubber adhesives were examined for suitability for use in making mortar-bomb tail covers. Other matters dealt with included arecoline hydrobromide, a cable wrapping supposed to have caused dermatitis and which was found to contain coal-tar pitch, solutions of D.D.T., rubber seatings for spillway gates, oils from India, Australian and New Zealand starches, " manila " rope and canvas which consisted of cotton fibre, plastics, and adhesives. A commencement has been made with analyses of New Zealand woods with a view to the utilization of waste material.

Toxicology

Poisons detected in police exhibits included aconite, arsenic, barbitone, belladonna, bismuth, Black Leaf 40, carbon monoxide, chloroform, hydrochloric acid, and sodium nitrite.

Alcohol was determined in blood and in urine in cases of fatal accidents.

Several cases of death or severe illness resulted from the accidental taking of sodium nitrite, which is commonly and legitimately used in meat-pickling. A regulation has now been made to control the use and labelling of this dangerous substance.

Two deaths caused by the accidental use of poison transferred to bottles bearing other labels indicate the danger of this practice. One death was due to " Black Leaf 40 " and the other to arsenical weed-killer. In the latter case a residue of cough mixture in the bottle used made the contents appear very similar to cough mixture.

Two cases of the use of dirty bottles for the bottling of beer were investigated. In the first a tarry arsenical preparation had been kept in the bottle and gave a dangerous amount of arsenic to the beer. In the second case the creosote residue had a strong taste, but was not dangerous.

General Investigations

These include work done by some of the sections mentioned above and by the branches.

For the police a great deal of work was done in addition to that mentioned under "Toxicology." This included the following investigations: in arson cases, oil was detected in the remains from fires; sand was recovered from the sump oil of a Diesel engine suspected to have been wilfully damaged; many samples of intoxicating liquor were examined for the purposes of the Licensing Act and the Distillation Act; in connection with a safe robbery, ground-up crystals and traces of sawdust were found on the shoes of a suspect, and similar crystals (ammonia alum) and sawdust were present in the lining of the damaged safe; prepared opium was identified in material seized in raids; assistance was given in investigating the theft of Air Force petrol; a considerable number of drugs, tablets, and appliances were examined in connection with alleged criminal abortion.

Other investigations included the following: enamelled ware was examined for compliance with the standards; fluorine determinations were made on a large number of water-supplies, and the results will be published; work on the treatment of boiler-feed waters was continued; sand was tested with the object of finding a new Empire standard sand for cement-testing; foundry dusts and mine dusts were examined for silicosis-producing material; the number on a stolen lead storage battery was restored by etching with acetic acid; the Auckland Branch co-operated with the Plant Diseases Division in the investigation of timber-treating solutions, treated wood, and treated canvas samples; a series of severe but not fatal cases of poisoning by honey at a camp cookhouse led to a lengthy investigation on poisonous honey in conjunction with the Department of Agriculture (a new poisonous substance was extracted from the honey, and it was shown that it was possibly derived from honey-dew obtained by the bees from tutu leaves); over thirty samples of mine air, sewer gas, industrial air, flue gas, and coal-gas were analysed; a method was developed for the detection of minute traces of carbon monoxide in air; the usual wide variety of samples was examined for the Customs Department to enable them to be classified for Tariff purposes.

Fats Research

During the year, work dealing with the characterization of the fats present in New Zealand butter was commenced in a Fats Research Section of the Laboratory. The importance of butterfat in New Zealand's economy need not be stressed, and it has been deemed necessary to acquire as complete a knowledge as possible of the composition of the fats comprising butter as influenced by feed, seasonal, climatic, and other influences. This work has been placed in charge of Dr. F. B. Shorland, who has specialized in fats research.

The work has been undertaken under the guidance of a Committee comprising Dr. F. H. McDowall, Chief Chemist, Dairy Research Institute, Mr. R. L. Andrew, and Dr. Shorland. Close attention has been given to the development of the techniques necessary for the characterization of the unsaturated fatty acids occurring in butter, and when these are adequately developed it is intended to proceed with comprehensive surveys of New Zealand butterfats.

Molecular distillation of fish-liver oils has been under close investigation during the year, and as a result of the progress which has been made in the technique of such distillation it has been found possible to produce vitamin A concentrates equivalent to 1,000,000 I.U. per gram from New Zealand fish-liver oils.

Bacteriology

It has been found necessary for the adequate control of milk and water supplies to undertake a certain amount of bacteriological work. A start has been made with this in Auckland and Christchurch, and this work will be extended as staff and equipment become available.

Gas-testing

The gas-supplies of the four main centres and of most of the other main towns of the Dominion were regularly examined for calorific value, pressure, and freedom from sulphuretted hydrogen. All gas-meters put into service were tested and stamped before being passed for use. This involved the accurate testing of many thousands of meters.

Library

To ensure that the Library will be kept up to date by additions of the latest text-books, a Library Committee consisting of three senior members and the Librarian has been set up.

A considerable number of books has been received during the year and a few new subscriptions to journals have been taken out. Two of the French journals which ceased to come during the war years are again arriving regularly.

The monthly accessions list is now circulated to all members of the staff and to several departmental libraries.

A wide variety of inquiries on matters of applied chemistry have been dealt with, whilst a good number of library interloan requests have been received, as well as approximately fifty requests through this means being made by members of the Laboratory staff.

Papers published in Scientific Journals by Members of the Staff

Although most of the work of the Laboratory is unsuitable for publication or is not available owing to its confidential nature, the following papers by members of the staff were published during the year :—

"A Rapid Determination of the Alkalies in Portland Cement." J. J. S. Cornes. *N.Z. J. Sci. & Tech.*, *26* (1945), 239.

"A Simplified Analysis of Serpentine for Acid-soluble Magnesia." J. J. S. Cornes. *N.Z. J. Sci. & Tech.*, *26* (1945), 188.

"The Microscopic Structure of Oxford Chalk." J. J. S. Cornes. *N.Z. J. Sci. & Tech.*, *26* (1945), 185.

"Water-insoluble Alkali in Ash." J. J. S. Cornes. *N.Z. J. Sci. & Tech. 26* (1945), 190.

"Clay Deposits near Levin." L. R. L. Dunn and I. C. McDowall, with E. O. Macpherson of the N.Z. Geological Survey. *N.Z. J. Sci. & Tech.*, *26* (1945), 307.

"Clays of the Mount Somers District." H. W. Wellman, of the N.Z. Geological Survey, with L. R. L. Dunn and I. C. McDowall. *N.Z. J. Sci. & Tech.*, *26* (1945), 311.

"The Utilization of New Zealand Ironsands as a Source of Iron, Titanium, and Vanadium." B. Mason. *N.Z. J. Sci. & Tech.*, *26* (1945), 227.

"Heat-evolution Characteristics of New Zealand Portland Cements." L. R. L. Dunn and F. T. Seelye. *N.Z. J. Sci. & Tech.*, *27* (1945), 157.

"Contributions to the Mineralogy of New Zealand." C. O. Hutton, of the N.Z. Geological Survey, and F. T. Seelye. *Trans. Royal Soc. of N.Z.*, *75*. (1945), 160.

"A Review of the Electro-plating Industry in New Zealand." (New Zealand Institute of Chemistry Industrial Chemical Prize Essay). M. Fieldes. N.Z. Institute of Chemistry, 1945.

"Boron and Strontium in New Zealand Coal Ashes." F. T. Seelye and T. A. Rafter. *Nature*, 1945.

"Losses of Iodide from Iodized Salt." R. L. Andrew and G. W. Stace. *Analyst*, *70* (1945), 88.

DOMINION OBSERVATORY

Acting-Director: Mr. R. C. Hayes

Time Service

Control of Clocks.—The method of controlling the standard clocks has been the same as in previous years.

Time Signals sent out.—The usual time-service arrangements have continued without interruption. The error of the ZLW radio time signals did not exceed 0·28 second at any time during the year, and on most occasions it was less than 0·25 second. There were partial failures of the ZLW signals on 11th and 26th August, and on 7th December. The cause of these was outside the Observatory, except the one on 7th December, which could not be traced.

By arrangement with the National Broadcasting Service, extra time signals were sent out through 2YA on 14th January for observers of the solar eclipse on that day.

The number of telephone calls for correct time maintained a high level throughout the year, but did not exceed the number for the previous year.

Public Clocks.—The Government Buildings clock was checked daily at 9 a.m. and regulated when necessary. The maximum errors observed during the year 1945 were 41 seconds fast, and 35 seconds slow.

The longest uninterrupted run of the synchronous electric clock was from 12th February to 31st May (108 days). The maximum errors observed during that period were 7 seconds fast and 55 seconds slow.

Free Pendulum.—The free pendulum suffered considerable disturbance during the year. In October it was dismantled for extensive improvements to the mechanism.

Clocks.—Towards the end of the year nearly all the clocks were overhauled by the Dominion Physical Laboratory and remounted on the clock-room walls. This is more satisfactory for the clocks and also considerably increases the available floor space in the clock-room.

Chronometer Rating.—During the year two Navy chronometers were received for rating and safe custody. One chronometer was put through daily rating over a period of ten days for the Public Works Department.

Seismology

Summary of Seismic Activity in New Zealand in 1945.—The principal seismic feature of the year 1945 was the outbreak of activity in the Hanmer region on 30th August. Three shocks reached or slightly exceeded M-M VI, and a considerable number of smaller ones also occurred. Although some damage was done, none of the shocks could be classed as "destructive." They were of abnormally shallow origin and affected a comparatively small area. The activity was of short duration.

Rather strong shocks occurred in Hawke's Bay on 2nd January, and in the Wairarapa on 7th June. On 20th–21st July an outbreak of slight activity occurred in the Rotorua region. An isolated slight shock originated forty to fifty miles west of Auckland on 31st July. It was felt slightly in parts of Auckland City area. A group of slight or moderate shocks occurred near Tokaanu about the middle of October.

During 1945, 127 shocks were reported felt in some part of New Zealand; 73 of these were felt in the North Island and 58 in the South Island. Four were felt in both Islands. These figures are based on reports from Post Office and lighthouse officials and from several private observers.

New Seismograph Station.—The Observatory assisted with the establishment of a new seismic station at the Chateau Tongariro.

GENERAL

Astronomy.—Daily sunspot records were made with the 5 in. refractor of the Royal Society up to October, when this work was again officially taken over by the Carter Observatory.

Partial Solar Eclipse, 14th January, 1945.—A programme of observations of this eclipse with the Royal Society's 5 in. telescope was planned. Owing to cloudy weather, only one observation was obtained. The results of this were sent to the Royal Observatory, Greenwich.

Experimental Work.—Towards the end of the year some equipment was obtained for experiments on the application of electronic methods to various seismograph and time-service apparatus.

DOMINION PHYSICAL LABORATORY

Director: Dr. E. R. COOPER

Advisory Committee.—Professor T. D. J. Leech (Chairman); Mr. G. W. Wyles (representing New Zealand Standards Institute); Dr. E. Marsden; Mr. W. M. G. Colquhoun (Munitions Controller); Messrs. J. G. Lancaster and R. M. Campbell (representing New Zealand Institute of Engineers); Dr. D. B. McLeod (Acting), *vice* Professor F. C. Chalklin (representing New Zealand University Colleges—Physics Departments); Mr. J. A. D. Nash (Secretary).

The present annual report covers the seventh year of establishment of the Dominion Physical Laboratory.

The Radio Development Laboratory, which operated under War Expenses as a separate section of the Department of Scientific and Industrial Research during the war, has been incorporated into the Dominion Physical Laboratory as from 31st March, 1946. The 1946–47 estimates are therefore designed to cover the needs of the Radio Development Laboratory as well as the Dominion Physical Laboratory.

The Research Amendment Act, 1945, was passed during the year, and the responsibility for maintaining the legal standards of physical measurement in New Zealand now devolves on the Dominion Physical Laboratory. Provision is being made to send officers to the National Physical Laboratory, Great Britain, so that the initial planning of the Standards Laboratory shall be along correct lines. The Metrology Laboratory at the Dominion Physical Laboratory, which functioned during the war with a staff of seventeen members, has been reduced to a staff of four members, who will form the nucleus of the future Standards Laboratory.

The tool-room staff has been reduced from forty-five to twenty-five members, who are engaged on the construction of scientific equipment and special tools for industry, Government Departments, and public institutions.

A complete staff plan covering the following peace-time activities has been prepared, indicating the Laboratory's future activities under the following titles: Electrical, Electronics and Acoustics Laboratory; Radar Laboratory; Radio Laboratory; General Physics, Heat and Light, Materials-testing Laboratories; Instruments Testing and Development Section; Standards Laboratory; Engineering Laboratory; Design and Draughting Section; Library and Technical Files; Workshops Planning Unit; Precision Metal Workshop; Fine Instruments Workshop; Patternmaking Workshop; Glassworking Section; Electrical Instrument Workshop; and Clerical and Stores Section.

The Air Department (Civil) has loaned a large portion of the mechanical testing equipment and instruments-testing equipment, previously installed at the Air Inspection Department Test House, Miramar, to the Dominion Physical Laboratory. An arrangement has been concluded whereby the Laboratory shall undertake such mechanical tests as are required by the Civil Aviation Branch of Air Department.

Physical Laboratory

Major projects which have been worked on during the past year in the various sections are as follows:—

General Physics and Materials testing

(1) *Heat Insulation of Houses.*—The thermal transmittance values of walls, ceilings, and floors of several State houses have been measured by a modified "guarded hot-box" method, and comparisons have been made between different types of constructions—*e.g.*, brick versus asbestos, cement sheet versus timber weatherboard, and ventilated versus non-ventilated wall cavities and floor spaces. A report has been published giving some interesting data. Further work is at present being undertaken on a recently completed house with walls built of no-fines concrete.

(2) *Mould in State Houses.*—This project is nearing completion. Following a series of measurements of atmospheric conditions—temperatures and relative humidities—inside and outside of the houses and in the wall cavities, work has been completed on the calibration of the thermocouples and recorders used. A report is being drawn up on the measurements made.

Relating to this project, a technique has been developed for measuring the rate of ventilation of rooms, and a series of measurements is being made in several of the houses used in the above investigation.

(3) *Timber Impregnation.*—Vacuum-pressure impregnation of *pinus radiata* with plastic resins in a water-soluble state and then cured by heat treatment to an insoluble form has been carried out on lines suggested by the Forest Products Research Laboratories, United States of America. Two types of resin—a urea-formaldehyde (dimethylolurea) and a phenol formaldehyde—were used separately and marked improvements were made in certain properties. With phenol formaldehyde the swelling and contraction of treated wood due to moisture absorption or loss have been reduced to about one-third of that occurring in untreated wood. The work is proceeding, using different concentrations of solution to reduce the cost of treatment.

(4) *Hot-plate Investigation.*—A comparison of locally made electric oven hot-plates with imported ones according to an established British Standard Specification revealed some interesting and valuable information with respect to the design of hot-plates and the type of refractory material used. A detailed report was submitted to the Department of Industries and Commerce.

(5) *Fuel-conservation Survey.*—Preliminary work on the efficiency of open hearth fires was conducted in collaboration with the Dominion Laboratory, by measurement of the radiant heat output of an open hearth fire, using weighed amounts of coal, &c., of known calorific value. Approximate measurements of flue draughts were made. Calibration of the radiometer elements is required to complete this first investigation.

(6) *Rubber Air-hose.*—A comprehensive examination was made for the Army Inspection Department of rubber air-hose for use in pump connections for motor-vehicles. As a result of much preliminary testing, a uniform and high-quality tube was produced.

(7) *Maraetai Rock Investigation.*—The survey commenced about September, 1944, on the physical properties of the foundation rock of the new dam to be built at Maraetai by the Hydro Branch, Public Works Department, was completed and a comprehensive report supplied.

(8) *Electronic Magnetizer.*—An electronic apparatus for magnetizing awkwardly shaped magnets—*e.g.*, speaker magnets assembled with loud-speakers—was developed and a prototype constructed. This was so successful that two such electronic magnetizers have been ordered by private firms and a third is being made for the Laboratory's use.

(9) *Strain-gauge Recorder.*—The Railways Department has requested the development and construction of strain-gauge equipment to record dynamic strains set up in railway-lines due to the passage of trains. This section of the Laboratory is investigating an A.C. resistance bridge circuit with oscillographic measurement of the change of resistance.

(10) *Conductivity of Railway Ballast.*—Difficulties encountered by the Railways Department with respect to conductivity of ballast near railway crossings with automatic warning signals have resulted in a request for electrical conductivity measurements of different types of ballast.

Tests and Calibrations

Some 600 separate instruments have been calibrated during the year covering electrical meters (87), thermometers (111), pressure-gauges (201), barometers (6), telescopes (10), binoculars (39), rangefinders (1), theodolites (19), sextants (9), laboratory balances (8), traffic loadometers (inspecting) (31), foot candle meters (4), tachometers (14), surveyors' levels (2), lenses (14), mirrors (40), and Aldis lamps (6).

Tests were made on the following materials and equipment: cow-covers, concrete blocks (16), leather belting (3), rot-proofing fabric (10), oilcloth, canvas (6), cotton duck (2), salvus valve, worsted cloth, paper, mould in State houses, hot-plate investigation, asbestos-cement sidings (6), fishing-lines, calico, thermal conductivity of wall sections (4), open hearth fires, resistance thermometers, rubber gloves (5), piston-rings, timber (4), elasticity of stone, pinex slabs, airfield lights, pressure tests on pipes, Pinex wallboard, Maraetai rock, welded cables, catgut, copper disks, electric lamps, casein glue (3), batteries, drum panel, linen thread (2), weld metal (2), copper tubing, bull-chains, insul wool, loud-speaker magnets, and margarine.

STANDARDS LABORATORY (including Metrology)

During the year the staff engaged on the measurement of limit gauges has been reduced to four. The work of packing away the many thousands of gauges has now commenced. Steps are now being taken to arrange for the taking-over of measuring-equipment in the Laboratory which is the property of the Munitions Controller. The following metrology equipment has been put into use during the year: optical dividing head—received from the National Physical Laboratory in November, 1945: inspection grade slip gauges; optical projection apparatus for one hundred times full size; a surface-finish recorder of the National Physical Laboratory type is now ready for calibration; and levelling-apparatus for major surfaces.

The following work has been completed during the year: investigation of gramophone needle and cutting stylus profiles for National Broadcasting Service: inspection of components for Karapiro hydro scheme; and inspection of a 35 ft. machine bed for Messrs. Andersons, Ltd.

The Laboratory has undertaken a considerable amount of gauge and measuring-instrument design, the gauges being mainly for threaded work. Some four thousand five hundred limit gauges of all types have been measured.

A start has been made to accommodate the electrical standards in the Metrology Laboratory. The galvanometer and potentiometer set-up is now in operation in the new situation. Further shifting is now awaiting the wiring of the Electrical Standards Laboratory by the Works Department. The wiring is also required for the photometric bench.

A special small room has been constructed to house an Oërtling precision balance which is to be used for standards work.

Negotiations are proceeding with the various Government Departments concerned with standards of measurement and with the National Physical Laboratory in Great Britain regarding the setting-up in New Zealand of primary standards.

Engineering Laboratory

The following matters have been investigated during the year :—

(1) *Karapiro Dam : Examination of Setting Concrete.*—Equipment was designed and manufactured for the analysis of the expansion, contraction, and heat generated in a large body of concrete during setting. It comprised resistance thermometers and strain gauges which could be placed in position during the pouring of the concrete and become incorporated in the structure.

(2) *Vibrations of Turbine.*—Vibrations in a hydro-electric turbine generator were recorded and an analysis made to determine the position, magnitude, and cause of the vibration.

(3) *Hydraulic Tests on a Model of a Proposed Spillway for Maraetai Dam.*—A model of a proposed diversion tunnel and spillway intake for the Maraetai Dam was made and tests undertaken in order to determine the flow of water as well as the character of the flow under various conditions.

(4) *Particle Sizing.*—Equipment was built to investigate rapid sizing of pumice particles by centrifugal action.

(5) *Dynamic Stress Equipment.*—Resistance strain gauges were built, together with an A–C bridge to measure dynamic stresses in structural numbers.

(6) *Routine Work covered.*—Pyrometers (33) ; thermocouples (15) ; special tests (67), including conductivity of refractories at high temperatures, x-ray examination of Pelton buckets, 119 fuses, railway coupler castings, mechanical tests on bolts, webbing, crane hooks, spring steel, piston-rings, ·303 cartridge cases, paravane shackles ; metallurgical inquiries (52), including the determination of S curves for tool steels, electrolytic polishing, plating of chrome nickel cadmium, finishing of metal parts.

Design and Draughting Section

The end of the war has brought a large increase in the number of requests for special instruments and equipment from local industry. This has further overloaded the already understaffed Design Section. The following are the major design projects handled during the year :—

(1) Pyrometry : (*a*) Design of indicator type B having increased sensitivity, reduced time to assume deflection, and decreased coil resistance, This instrument is suitable for measurement between the ranges 0–300° c. and 0–1,000° c.

(*b*) Controlling pyrometer type 104. This can be made at a lower cost than type 103 and is arrived at by simple attachments to the indicator type B. It is suitable for controlling temperatures within the same ranges as above. Photo-cells are replaced by an inductive circuit.

(*c*) Indicating-controlling-recording pyrometer (thermocouple type). This instrument, the design of which is nearing completion, can be modified to be either simple indicating, or indicating-recording, or indicating-controlling, or indicating-recording-controlling. It is of the self-balancing potentiometer principle, incorporating the latest electronic devices, and operates off thermocouple potentials.

(*d*) An indicating-controlling-recording pyrometer (resistance type) is being worked on.

(*e*) Two special pyrometric installations of some complexity have been installed in a New Zealand paint-manufacturing factory which will materially reduce the fire hazard attached to the mixing of resins.

(2) An electron microscope is being designed in collaboration with the Physics Department of Auckland University.

(3) A sound-film modulator has been designed for the National Film Studios incorporating a permanent magnet light valve operating on the variable area system.

(4) A multiple-temperature incubator consisting of ten separate chambers, grading in temperature from 0° c. to 50° c. automatically controlled, has been designed.

(5) Draught Gauge: A sensitive meter for measuring the difference in pressure between the lower end of a rotary cement-kiln and atmospheric pressure, and graduated from +0·05 in. to —0·15 in. water, was designed and made for a cement-manufacturer.

(6) Electronic Alarm for Gas Calorimeter: A special device was designed for attachment to the recording calorimeter at the Christchurch Gas and Coal Co. to give a sound alarm whenever the calorific value of the gas varied beyond a certain deviation from an optimum value.

(7) A recording instrument has been asked for by a firm making artificial fertilizers to record the weight of rock, weight of acid, temperature of acid, density of acid, and the time of mix on one chart. The design of this recorder is almost complete and many of the components have already been constructed.

(8) Molecular Distillation Still: A prototype still has been completed for the separation of vitamin A from New Zealand fish-oil. A commercial model is at present nearing completion. The prototype has functioned satisfactorily and has provided sufficient data for the building of a commercial model for use in a New Zealand factory.

(9) Miscellaneous: In addition, complete drawings have been produced for the following: pivot polishing and inspection equipment; conductivity cell; barrel-viewing periscope, AID 5772; compressormeter for 6 in. cylinders; pitot tubes and manometers; resistance elements (platinum); micro hypodermic syringe; multiple slide wire (drum type); loadometer-testing machine; multiple switch; backing-pumps; Lamb's roller extensometer; metal vacuum taps; thermostat capsules; air-recirculation furnace; pick-up arms and heads; galvanometers (high sensitivity); resistance bridge and box; head for vacuum packing-machine; and specific-gravity balance.

Radar Laboratory

As mentioned before the Radio Development Laboratory has now been incorporated in the Dominion Physical Laboratory. The peacetime functions of the radar group have been approved by Cabinet as follows:—

(1) Technical service and advice to Government Departments and commercial interests on radar.

(2) Develop radar equipment for navigational purposes to suit New Zealand circumstances and conditions and to collaborate with the radio industry in its manufacture.

(3) Service and maintain radar navigational aids used for civil shipping and aircraft.

(4) Engage in radar research on problems of local application and significance.

(5) Study radar developments of defence significance, thereby having within New Zealand specialists with up-to-date knowledge of radar in the event of another national emergency.

(6) Provide means whereby Service personnel can gain technical training in and knowledge of current radar developments.

The following projects are in hand:—

(1) *Design and Construction of Micro-wave Meteorological Radars.*—Four sets of equipment are being constructed for the Meteorological Service (Air Department) for installation at stations in New Zealand and in the Pacific. This apparatus will provide information on winds up to a height of 50,000 ft. for the use on the Trans-Pacific air route and for New Zealand aviation and weather forecasting. Personnel to maintain and operate the sets will be trained at the Dominion Physical Laboratory.

(2) *Canterbury Project.*—During the next twelve to fourteen months a joint team from New Zealand and the United Kingdom will conduct a long-term research experiment in radio meteorology in the South Island. Its aim is to—

(*a*) Correlate the extent and properties of radio ducts formed with an off-shore wind, and when complicated by a sea breeze, with general meteorological data that is normally available and with low level soundings taken inland, in order that a forecasting technique for the formation and properties of radio ducts may be formulated.

(b) Check current theories of ultra-high-frequency propagation in the troposphere under conditions of duct formation leading to the phenomenon of super-refraction.

The results of the project are of fundamental importance in radio meteorology and will have world-wide application.

The work is being carried out in the Mid-Canterbury Plains, where the prevailing warm dry north-west wind blowing out over the Canterbury Bight provides an ideal situation for the formation of radio ducts under stable meteorological conditions.

The British authorities are sending out six senior scientific and technical personnel to participate in the project, and are providing all the S and X band equipment for the radio measurements. The United States of America has supplied on loan a large portion of the low-level meteorological sounding gear. New Zealand is supplying the majority of the personnel, three metre radar and associated equipment for radio measurements, and all the remaining technical and general equipment. Wired sonde measurements of temperature, humidity, and wind velocity will be made from several points on land and from a ship at sea before, within, and above the radio duct. These will be supplemented by aircraft observations and will give in detail the gradients of these quantities throughout the lowest few thousand feet of the atmosphere. The ship and aircraft will be fitted with transponders on three metres, S and X bands which will be triggered by radars on these frequencies situated on the coast. The signal strength received at the radars from the transponders will be measured, and by discreet manipulation of the aircraft and ship it is hoped to be able to obtain a complete picture of the distribution of field strength, both within and above the radio duct.

(3) *Prototype Loran Air Navigational Aid.*—This equipment is being designed for the Navigational Aids Committee, Air Department. Its original purpose was to provide navigational fixes for the transport runs to the forward areas. Since the end of the war the project is being continued with the dual purpose of aiding the communications with the J Force and for assisting commercial air services.

(4) *Servicing of Radar on New Zealand Shipping.*—(*a*) A maintenance service is being provided for British shipping in New Zealand ports.

(*b*) Radar sets are being installed on the t.e.v. "Rangitira" and on other ships operating in New Zealand waters.

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

At the conclusion of the war the larger type of instrument-construction work was transferred to the Tool-room. The Instruments Workshop now confines its attention to the finer type of construction and repair, involving, for example, pivots and jewels, hairsprings, fine suspensions, lenses, &c. This class of work requires specialists with considerable training.

The following is an analysis of the instruments work over the past twelve months, excluding those items mentioned in the Physical Laboratory list, which also received repair prior to calibration or testing: clocks, chronometers, stop-watches (61); miscellaneous measuring instruments (55); surgical instruments (22); navigational instruments (7); meteorological instruments (37); special drawing instruments (7); engraving measuring scales (13); seismographs repair (2); repairs to glass laboratory equipment (80); and electrical instruments (46).

TOOL-ROOM, INCLUDING GRINDING AND HEAT TREATMENT

The following is an analysis of the work completed in the Tool-room during the twelve months ending 31st March, 1946: gauges (772), heat treatment (1,388), grinding (272), cutters (milling, &c.) (73), miscellaneous tools (771), taps (509), dies (52), chasers (74), hobs (17), end mills (64), reamers (35), mandrels (15), and collets (36).

The following items deserve special mention:—

(1) Jig borer centrescope. This instrument was designed at the Laboratory and may be fitted to a jig borer, enabling the optical location of boring centres to be made.

(2) Button-type ring gauges for $\frac{5}{8}$ in. Cordeaux thread insulator pins have been made in New Zealand. The diameter of the rollers was made to compensate for the large helixangle of the insulator pin by increasing the diameter twice the size of the pin and giving it a left-hand thread with two starts. Chasers for the manufacture of the pins were also made.

(3) Shrink fitting by the use of carbon dioxide snow has been adopted extensively with excellent results.

(4) Special thread grinding of form relieved gear cutters and taps (Enfield, Edison, gas, &c., forms) has been undertaken successfully. Boiler stay taps and bent nut taps have been thread ground from the solid in tool steel.

(5) Four hundred sets of three-thread rolls for the production of cycle spokes in New Zealand were made and a further request for two hundred additional sets has been received.

(6) Reed valves for vacuum pumps being made in New Zealand for installation of refrigerators. These valves contain a metal leaf which must be ground precisely to a thickness of the order 0·01 in.

(7) Miscellaneous components have been made for the Powers Samas statistics analysis machines used in the Treasury Department.

(8) Sliding microtomes for use in the microscopy of thin sections of animal and vegetable tissue.

(9) The repair of a seed-packeting machine for a New Zealand seed-merchant's firm was successfully completed.

(10) Thermostat flexible metal capsules were made for a New Zealand indentor of egg-incubators who was unable to obtain replacement supplies overseas.

(11) Extrusion tools for the manufacture of toothpaste-tubes in New Zealand.

(12) Precise worm shafts for meteorological balloon theodolites were thread ground.

(13) A microhypodermic syringe capable of delivering an exact but minute quantity of liquid of the order 0·1 millilitre was constructed for the use of the Cawthron Institute.

(14) Electrically recording anemometers for attachment to meteorological balloons were designed and constructed.

(15) Morse trainer heads for automatically transmitting signals to aircraft were built for Air Department.

(16) The reclamation of worn reamers by hard chrome-plating, and subsequent regrinding, has been successfully carried out for a New Zealand firm assembling motor-cars.

(17) Several types of diffusion pumps for producing vacua have been made and a considerable understanding of the operation of these pumps is being obtained. Successful diffusion pumps for operation with the molecular still (see Design Section) have been made. Measurements are proceeding to determine the performance of these pumps.

(18) Racks and pinions for incorporation in weighing-machines being produced in New Zealand.

(19) Crossheads for meat-saws being made in New Zealand.

(20) Miscellaneous thread-ground components for incorporation in plastic dies have been made. Clean and accurate threads resulted in the finished plastic product.

AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: J. BROOKE

Advisory Committee.—Mr. D. T. Clifton-Lewis (Chairman), Professor T. D. J. Leech (Vice-Chairman), Dr. J. C. Andrews; Mr. G. B. Bell, Dr. G. H. Cunningham, Mr. A. Dennison, Mr. K. M. Griffin, Mr. L. W. Tattersfield, Mr. I. Taylor, and Mr. F. C. McCullough (Secretary).

INAUGURATION

These Laboratories were, with Cabinet approval, formally established on 1st October, 1945, in Auckland as an experiment in the provision of immediate scientific and technical facilities to industry, thought desirable partly by virtue of the large number of manufacturing industries located there, and partly by the necessity for personal contact in dealing with certain scientific aspects of production. The nucleus of the staff and equipment was previously engaged on war work as the Auckland Technical Development Branch.

This proposal had the support of the Manufacturers' Research Committee, and the inauguration work done by the Auckland members of that Committee has been a major factor in the progress shown in this report.

Such a decentralized establishment is capable of giving speedy service where required and serves as a liaison office to correlate the activities of branches of the Department of Scientific and Industrial Research in Auckland in their dealings with industry.

As a central location was desirable for such work, which entails close contact with manufacturers, with the Government Analyst, and with the University, the Laboratories have been located at Smiths' Buildings, in Albert Street, and, at the same time, the opportunity taken of correlating the clerical side of the Department in Auckland in the form of a district office, which is conveniently located adjacent to the technical side.

Although the final set-up has been considerably delayed by difficulties in obtaining the precision machinery and equipment necessary for its efficient functioning, considerable progress has now been made in this direction.

ESTABLISHMENT

As originally planned, the branch consists of an engineering and metallurgical laboratory to which is attached an instrument development workshop containing light precision machines capable of handling accurate developmental work on instruments, mechanisms, and prototype equipment. These machines have been carefully chosen to be complementary to existing facilities in Auckland and to be capable of handling instrument work to comparable standards and limits to those obtaining overseas. An electrical and electronics laboratory and workshop similarly can handle developmental and servicing work in the electronic field, and will also have sub-standard testing facilities which are an integral part of the Dominion standards at Dominion Physical Laboratory in Wellington.

A Physical Section will deal with optical and physical problems, and attached to this is a small optical workshop capable of making precision components, such as lenses, prisms, and sensitive level bubbles. Chemical and biological problems are carried out in co-operation with the Government Analyst and the Plant Diseases Division, and similarly with projects involving other sections of the Department.

To allow of design work being handled efficiently either by local industry or by the tool-rooms of the Dominion Physical Laboratory, a Design and Draughting Section has been provided, with which is located a Technical Library and Information Section.

Personnel

The present technical personnel to carry out this programme are—

(*a*) Director, who also supervises the activities of the district office.

(*b*) Four section heads—mechanical design, electronics design, physical and optical work, metallurgy.

(*c*) One assistant engineer, one assistant electrical engineer, one assistant physicist, one workshop foreman.

(*d*) Two draughtsmen, one tracer (who acts as librarian), one optical worker.

(*e*) Two instrument-makers, two precision machinists.

Work completed during the Period covered by this Report

Although the branch has been in active operation for a little over six months and a considerable amount of effective time has been occupied in establishment, the results so far achieved augur well for its future. The following work has been completed during this period and is enumerated in order to give a picture of what requests have been made for assistance :—

(*a*) Investigation of performance of mattress-tufting machine, and readjustments of knotting mechanism—a mechanical engineering problem.

(*b*) The design and prototype production of an automatic 150-ton press for tabletting of dehydrated vegetables. This press preheats and forms six rectangular "briquettes" of dehydrated carrot or cabbage per stroke, thereby saving up to 85 per cent. in shipping-space. It has a fully automatic cycle and is capable of producing 2,880 briquettes per normal working-day. Trial runs have been completed with satisfactory results.

(*c*) Design of a tablet-counting machine and a fish-liver disintegrator used in the production of fish-liver oil vitamin products, the manufacture of this equipment being carried out by local engineering firms.

(*d*) Assistance in obtaining a satisfactory bronzing process for high-quality builders' hardware.

(*e*) Assistance in developing a high-efficiency heating-element for use in domestic appliances.

(*f*) Reports on the acoustic properties of a clothing-factory and the lighting of a office (in conjunction with the Industrial Psychology Division).

(*g*) The design and production of soil-testing equipment for the Soil Laboratory recently installed by the Auckland City Council at the site of the new earth dam at lower Nihotupu.

(*h*) The design and production of condenser lenses for local theatres.

(*i*) Upwards of one hundred precision tools, gauges, or components requiring thread grinding, form relieving, or profile grinding. Here it is our particular service to make the special machines held at the Dominion Physical Laboratory available to the Auckland manufacturers, as it is recognized by most manufacturers to be not economic in New Zealand for even large firms to possess this equipment and the scientific apparatus necessary for its control.

(*j*) Upwards of one hundred and sixty high-speed steel tools for heat treatment by the salt-bath method.

(*k*) Optical components for Navy. Some eighty components, including binocular prisms, doublet lenses, aluminized mirrors, and special graticules have been produced for Navy. We have usually been supplied with the broken pieces of a lens and have had to recalculate to obtain identical performance with the particular optical glass available.

(*l*) Repair and recalibration of precision electrical equipment. About twenty instruments have been handled in this section, including four pH meters of various types. This section cannot be regarded as being on a satisfactory basis until our substandards and auxiliary equipment come to hand.

(*m*) Several jobs entailing the use of a portable magnetic crack-detector, the most important of these being a report on the magnitude and extent of cracks in a cylindrical Navy boiler.

(*n*) The construction of a lamp for the determination of the sulphur content of fuels used for earthenware and crockery kilns.

(*o*) The engraving of graticule lines on drift-recorders for Tasman Empire Airways flying-boats.

(*p*) The design and manufacture of a 500-cycle amplifier for geophysical survey work, Thames goldfields.

(*q*) The design, construction, and installation of safety clutches for the catching rollers of ring spinning frames. This piece of subsidiary equipment, which was requested as the result of an accident, allows the operators to clear the rollers of wool without danger to their fingers.

(*r*) Design of limit and check screw gauges for various repetition production processes, their manufacture being arranged with the Dominion Physical Laboratory.

(*s*) The calibration of substandard test equipment for Tasman Empire Airways.

(*t*) Examination and report on locally manufactured plastic contact lenses.

(*u*) The repair and remaking of surgical instruments, mainly with respect to their optical components.

(*v*) Experimental work on refractory tiles and low-temperature silver solders for use in furnace brazing of jewellery.

(*w*) The production of a prototype train-control unit in which the operation is voice controlled, allowing duplex working on a single telephone line using microphone and loud-speaker, without interaction between the two channels.

(x) Some twenty small servicing jobs entailing physical or engineering assistance.

Work at Present in Hand

The following excerpts from the work at present in hand will also serve to illustrate the wide field in which assistance has been requested :—

(*a*) The design and installation of a heating system for the newly formed volcanological laboratory at Rotorua, using a steam bore.

(*b*) The design of heated platens for an experimental press in the Dominion Laboratory.

(*c*) The design and construction of a phase difference indicator for automatic signalling systems (New Zealand Railways) embodying a cathode-ray oscilloscope.

(*d*) Assistance in the design of a cooling stage in a plant producing zinc oxide.

(*e*) The construction of an electronic titrometer for the Government Analyst for use in volumetric analysis work.

(*f*) An investigation into the machine performance, fibre stresses, uniformity, and quality of the final product in a variable speed ring spinning frame for woollen fibre. This is a most important project, connecting, as it does, increased production with the quality of the final yarn. Special continuous recording equipment has been developed and manufactured so that the complete cycle of operations in the spinning of a "cop" can be interpreted graphically.

(*g*) The design and construction of a prototype unit for the cooling and humidification of glasshouses during the summer months, and their heating during the winter.

(*h*) The design of a hydraulically operated machine for the stretching of wire mattresses.

(*i*) The production of a prototype mechanism to allow for "unit" parking of cars in conjested areas.

(*j*) The design and production of a supersonic transmitter, intended to prevent pollution of reservoirs by seagulls, and interference with high-tension electrical equipment by nesting birds.

A total of 200 jobs have been undertaken during the year. Of these, 126 have been completed.

Research Sections

Administrative control of the Building Research and Radio Research Sections, located at Auckland University College, is vested in the Director of the Laboratories, and their activities are reported elsewhere.

General

Close liaison is maintained with the Dominion Physical Laboratory and every care is being taken to avoid unnecessary overlapping of activities. The Committee members are confident that this experiment will prove of great value to manufacturing industry, especially in the Auckland Province.

GEOLOGICAL SURVEY

Director: Mr. M. Ongley

Dr. J. Henderson, Director of the Geological Survey since 1928, retired in July, 1945. The period of his directorship was one of considerable expansion in the activities of the Survey. Dr. Henderson, during the whole of his service in the Geological Survey, maintained a high standard in all the work which was attempted, and enhanced the reputation of the Survey for the soundness of its achievements. Mr. M. Ongley, Senior Geologist, succeeded Dr. Henderson as Director.

During the year there has been abundant evidence of the still expanding needs for further geological service from various Government Departments, municipal bodies, and mining companies. The pressure for service in the field of economic geology is such that, with the staff available, it has not been found possible to undertake much regional survey.

A Volcanology Branch with headquarters at Rotorua was established during the year, and from this centre it is intended to develop all investigation surveys covering the Ruapehu-White Island volcanic region of the Dominion. At the inauguration of this station a conference was held in Rotorua, attended by representatives of various sections of the Department and the University, for the purpose of planning the development of investigations in this region.

In order to make the best use of the personnel and facilities available a staff conference was held and, arising from this, recommendations were made that the work of the Survey should be organized under four district geologists with six field parties, seven coal-survey parties, and six geologists working on water-supply. At the Geological Survey Office, Wellington, complementary research and publications of specialized work would be undertaken.

Coal.—During the year the coal resources and geology of the Huntly, Otorohanga, and Mangatangi districts have been surveyed and reported on. The field-work involved in the geological survey of the Greymouth coalfield has been completed and is now being assembled for publication in the form of a bulletin. In this field advice has been given to the Mines Department in connection with that Department's programme of coal prospecting by drilling and other methods. The survey of the Ohai Coalfield, in Southland, has been completed and reported on, and surveys of the Kaitangata, Mataura, and Hokonui fields are in progress. The Kamo Coalfield, in North Auckland, has also been mapped and reported on.

Water-supply.—Water-supplies in the Cheviot and Picton districts have been surveyed and reports submitted to the local authorities concerned. The water-table contours of parts of the Canterbury Plains in the Ashburton County have been mapped.

Palaeontology.—Large numbers of specimens have been collected during the year, particularly from the west coast and Southland, and from these valuable information has been obtained not only on local stratigraphic problems, but also concerning the

general geological structure of New Zealand. A revision has been undertaken of the stage divisions of the New Zealand Cretaceous and Tertiary rocks, and it is anticipated that this will be written up during the current year. Work has been continued on the systematic study and description of New Zealand Tertiary mollusca.

Micropalaeontology.—The number of samples submitted for identification has been considerable. Of special interest are some twenty-five sections collected in Westland in order to establish the stratigraphy of that area in relation to its coal problems. Studies of the foraminifera have enabled classification and correlation to be carried out, in many cases for the first time. This work has given additional support to the desirability for a reclassification of the New Zealand Tertiary beds as a whole. Similar examinations of microfauna from the Dunedin and Pahau areas have also been made. Intensive microfaunal work has shown that the Awamoan stage is apparently missing in the North Island and that the Hutchinsonian is extremely rare, these being the periods during which the Mokau coal was considered to be in course of formation. A report on the microfauna of the Oxford chalk and the important Orbitoids and similar foraminifera from the Eyre River bed has been prepared for publication.

Petrology.—Numerous demands have been made for petrological reports on various samples submitted by Government Departments. Many rock and mineral identifications and grading analyses have been undertaken. During the latter part of the year a large number of specimens alleged to contain uranium- or thorium-bearing minerals have been examined.

Petrological work also covered the asbestos-bearing serpentinites of the Takaka Valley, the dune sands of the Wanganui-Wangaehu shoreline, the rock types of the Murchison district, the heavy minerals occurring in river gravels and beach sands of south-west Nelson and Westland, and a survey of the rock types of the coastline of the Southland fiords. In a search for radio-active minerals the structures of the schists, gneisses, and igneous rocks have been carefully mapped.

Geophysics.—Areas in the vicinity of the proposed dam-sites on the Waikato River have been investigated on behalf of the Public Works Department. Similar work has been in progress in the Whakamaru, Maraetai, and Karapiro districts, where hydro-electric generating-stations are in course of erection or in contemplation.

Volcanology.—On the 8th March, 1945, Mount Ruapehu became active and continued the eruption of rocks, dust, water, and steam over a large area. Its activity continued till January, 1946. During the whole of the period of active eruption the mountain was kept under observation and geophysical installations were made in order to get a more precise picture of the nature of the activity attending this eruption, which was of greater intensity on this occasion than at any earlier period during historic times.

Miscellaneous.—The year was characterized by the very large number of geological investigations of a miscellaneous type which officers were called upon to deal with. These included investigation of the Takaka asbestos deposit, the geology of the zone traversed by the new thirty-six-mile water-pipe line leading from the Hutt Valley to Wellington City, the water-supply of the coastal area between Foxton and Levin, and the water-supply of the lower Plimmerton Valley.

An orogenic history of the Cretaceous and Tertiary beds, together with their structure and stratigraphy, was completed, such information being a useful compilation of the information collected during the explorations for petroleum resources which have been made in New Zealand between 1937 and 1944.

Much attention has been given to clay deposits of the Dominion, and the mapping and sampling of those located in the Wellington region has been brought almost to completion. During a reconnaissance trip to the southern sounds an examination of that region was made for the occurrence there of radio-active materials and for mica deposits. A further section of the ironsand deposits at Waitara has been mapped.

The programme of drafting-work during the year was a very heavy one and staff limitations have rendered it difficult to keep abreast of the work. In addition to the preparation of maps for the Greymouth coalfield bulletin, over two hundred maps and diagrams have been prepared for publication in the Department's *Journal*.

SOIL BUREAU

Director: DR. L. I. GRANGE

During the year the Soil Survey Branch was reorganized and renamed the Soil Bureau. The Soil Survey was formed sixteen years ago with the special function of mapping the soils of New Zealand. This work is being continued but to meet constant demands the functions of the Branch have considerably expanded until the title of "Survey" is no longer applicable.

EROSION SURVEYS

East Coast of North Island and Rangitikei Districts.—A general survey of soil erosion has been made of all of the country east of the main divide and of the Rangitikei district. Within the area covered are the catchment basins of the Poverty Bay, Hawke's Bay, Wairarapa, and Rangitikei Catchment Boards. When the Manawatu Catchment Basin is completed in the near future all the areas controlled by the existing North Island Catchment Boards will have been surveyed. The object of the survey is to map the various classes of erosion with a view to assisting Catchment Boards and the Soil Conservation and Rivers Control Council to formulate plans for soil conservation.

Several classes of soil loss have been recognized and subdivisions of these made according to the intensity of erosion. This gives a working map of the area, but for simplification of the problem a map has been constructed showing only three classes:—(1) soils showing little or no erosion under present farming practice; (2) soils that are eroding, but where the position is not serious and remedial measures can gradually be taken; (3) soils that are eroding badly and where action needs to be taken immediately.

The outstanding point of the simplified map is the relative area of the three classes. The class on which little or no erosion occurs covers about 45 per cent. of the total area, and that on which remedial measures can gradually be taken covers about the same area. Soils on which immediate action is needed cover 10 per cent. of the total area. Soils on which no erosion occurs include most of the flat land and a small portion of the hilly and steep country formed from soft papa and from limestone. On the class on which remedial measures should be gradually taken, slipping is a major problem. In any one valley slips occupy a small area, but recovery of the bare faces is slow, and the pastures that eventually establish are not as good as the original.

Soils on which immediate action is needed are, as stated, small in total extent. On the east coast the type which is causing most trouble is the slipping on shale. Slipping in a valley-bottom commences and gradually extends until it embraces the whole valley. Great bare gulches a quarter of a mile or more across develop. These are difficult to stop once they assume large proportions. Another type which occurs on the ranges west of Napier and at the head of the Rangitikei River and in the back country of Waiouru is the removal of volcanic soils by wind. In these parts the wind leaves a bare hard surface that is difficult to cover with vegetation. Drifting sand on parts of the coastal area of Rangitikei is urgently in need of stabilization by planting.

South Canterbury Downlands.—A detailed survey of the erosion on the downlands of Geraldine County has been completed. This survey shows that only 41 per cent. of the rolling country is uneroded, 38·9 per cent. is lightly eroded, 18·7 per cent. moderately eroded, and 1·4 per cent. severely eroded. Erosion is related directly to cultivation, uncultivated land being largely uneroded. These figures represent the state of erosion as it was during the survey of 1945, and in order to translate them into terms of soil conservation require supplementing by farm-management and farm-practice surveys so that the practices which promote or arrest soil erosion may be accurately defined. Further studies to determine the relationship between soil tilth, soil fertility, and erosion are also needed.

Wither Hills.—An account of erosion on the Wither Hills, Marlborough, by H. S. Gibbs was published in the *Journal of Science and Technology*.

Soil Surveys

General Survey, North Island.—Sheets 2, 4, and 5 of the soil map of the North Island have been published. Sheet 3 is in the press, and the preparation of the remaining four sheets is well advanced. The pedological part of the extended legend which will be published to accompany the map is ready for the printer. An arrangement has been made with the Department of Agriculture to supplement the notes dealing with the farming of the soil types.

General Survey, South Island.—The general survey of the South Island has been extended to cover the greater part of Southland and the whole of Westland. Areas not yet examined are the Dunedin and Nelson districts. The mapping of the Nelson district will be carried out in co-operation with the Cawthron Institute, which has already completed surveys of large areas. It is aimed to complete the field-work of this survey during the coming year.

North Auckland.—Eight of the set of ten maps covering the North Auckland Peninsula are now ready for the lithographic draughtsmen. The drafting of the soil and land-utilization maps of Whangarei County has been delayed owing to shortage of staff. As soon as the printing of the North Island map is completed the drafting of the Whangarei maps will be speeded up.

Mid-Hawke's Bay.—The soil maps of mid-Hawke's Bay have been published, and the manuscript of the bulletin is almost complete.

Hutt and Makara Counties.—A survey is being made of the soils of Hutt and Makara Counties. Two-thirds of the area have already been examined.

Canterbury Plains.—The survey of the Canterbury Plains has been continued systematically. In North Canterbury eighty-six square miles have been mapped. In Waimate County two-thirds of the plains between the Pareora and Waitaki Rivers have been covered, including the highly fertile soils of the Willowbridge region, where soils appear to owe their fertility to an admixture of glauconitic sand.

Geraldine County.—The detailed survey of the soils of Geraldine County has been completed. In the eastern part of the county the soils are derived from alluvium, and the soil pattern is complex. Between the Rangitata and Orari Rivers the soils are stony and infertile. South of the Orari River, and extending as far as the Opihi River, the soils are younger and much less leached and include some of the most fertile soils in South Canterbury. These fertile areas are, however, broken by strips of stony soils and, near the coast, by strips of meadow soils which require draining before they can be brought into full production.

Inchclutha.—A detailed survey of the soils of Inchclutha and adjacent valley-floors has been completed for the Clutha River Trust. The soils fall into three main groups—fertile recent soils derived from mica schist alluvium, moderately fertile soils requiring drainage for full utilization, and the peat and peaty loam soils which lie between the Koau Branch of the Clutha River and the hills to the south.

Glen Ledi District.—A survey covering 176,000 acres was made at the request of the State Forest Service to guide them in the selection of land for afforestation. The survey disclosed that the block, which stretches from Saddle Hill to Kaitangata, contains approximately 10,000 acres of ploughable land and 75,000 acres of unploughable land, both classes of land being of low natural fertility. In collaboration with local representatives of the Department of Agriculture an area of approximately 35,000 acres was delineated as being more suited to forestry than to agriculture. A map showing this area, together with a soil map and report of the whole block, was submitted to the State Forest Service.

South Molyneaux District.—A soil map and report was prepared for the South Molyneaux Development Committee, which represents a community of farmers anxious to raise the level of production in their district. The area surveyed covered 18,000 acres. The chief factor underlying the low production of the district is the general low fertility of the soil, particularly that on the unploughable land. The infertile hill land does not occur in one coherent block, and is therefore not suitable for afforestation by the State. Local afforestation projects, increased use of lime and fertilizers, and possibly adjustment of farm boundaries would go far towards raising the level of production.

Soil Chemistry

Soil Clay Minerals.—Work has been commenced on the differentiation of clay minerals present in New Zealand soils. This work is basic to soil classification and should do much to increase our understanding of soil reactions, particularly the reaction between the soil and added fertilizer. The technique at present in use consists of taking x-ray diffraction pictures of the powdered clay.

Soil Phosphates.—A start has been made in fractionating the types of phosphate occurring in soil. Both natural phosphates occurring in virgin soils and that occuring in soils which have been top-dressed are being examined. Phosphate fixation is one of the major problems of New Zealand agriculture, and an understanding of the mechanism of soil phosphate supply and fixation will help towards a more efficient use of fertilizers, whether it is brought about by altering the soil by such means as liming, or by changing the forms in which phosphate is applied to the soil.

Soil Corrosion.—Consequent on several requests being made for advice on the corrosiveness of soils an extensive investigation is being made on the factors involved in soil corrosion. While overseas data is useful as a first approach it is obvious that we must learn to solve our own particular problems. No estimation of single factors such as soil acidity, resistivity, water-holding capacity, differential aeration, and the presence or otherwise of certain bacteria is sufficient to assess the likely corrosiveness of a soil. The answer can be found only in the sum of these factors.

Advance data and a soil map have been provided for part of the proposed route of the pipe-line for the Wellington water-supply. Corrosion problems at Gisborne, Hastings, and Christchurch have also been investigated.

Kerikeri Orchard Soils.—Throughout the summer regular samples have been taken at Kerikeri by the Orchard Instructor and forwarded to Wellington for moisture analyses. Wilting-point determinations on these soils show that the orchards must have been close to wilting for a considerable period during the past abnormally dry season. In collaboration with the Horticulture Division, an attempt is being made to correlate the moisture holding power of the soil with different orchard practices.

Soil Fluorine.—A paper dealing with the fluorine content of New Zealand soils has been prepared for publication.

Lime Requirement of Soils.—Following the completion of the map showing the lime requirement of North Island soils a scheme for a Lime Advisory Service was drawn up detailing a method by which farmers could be advised of the lime requirement of their particular soils. The scheme received favourable comment, but it was decided that the operation of such a scheme was not the function of the Soil Bureau.

Soil Physics

Owing to numerous requests from civil engineers for soil-testing services, many of them of an urgent nature, the soil mechanics' work has almost exclusively dominated the work of this Division. It is intended, however, that with the increased staff recently appointed the work on soil tilth mentioned in last year's report will be considerably extended. Further samples have been obtained from deteriorated farms in Canterbury North Auckland soil types will also be investigated for structure, porosity, and soil moisture data.

Wilting-point.—Methods of estimating the permanent wilting-point of soils by means of the freezing-point depression and dilatometer method have been tried on orchard soils from Kerikeri and soils from irrigation areas in Canterbury.

Earth Dams.—Control limits have been fully investigated for the proposed material at Lower Nihotupu. Particular attention was paid to the relation between moisture content and required shear strength of the placed material, and the effect of air voids on the ultimate shear strength of the bank. The Auckland City Council's officer in charge of the soil-testing work at the dam spent some weeks in the Soil Bureau laboratory studying methods of soil testing. The Auckland City Council has set up a well-equipped soil laboratory on the site of the dam. A member of the Soil Bureau staff is on loan to the City Council and is assisting with the soil-testing work as construction proceeds

Tests have been made to determine the suitability of material for an earth dam intended for hydro-electric storage. Tests to date indicate a high degree of suitability for the purpose.

Foundation Surveys.—Exploring and testing soils for building foundations has formed the major part of the year's work. In view of the importance of this work it is intended that the Soil Bureau obtain modern equipment for carrying out the field-work quickly and efficiently. Soil exploration has been carried out to a depth of 85 ft., and large undisturbed soil samples have been obtained from a maximum depth of 50 ft. Well-boring equipment has been largely used for these purposes. Exploration has been carried out on a hospital and a factory site in Christchurch, on heavy building-sites at Lincoln, Otahuhu, and Longburn, and on a post-office site in Wellington South.

Permeability Experiments.—Tests were made in the laboratory to determine the rate of seepage through a block of country forming part of a reservoir storage system. Fairly good agreement was obtained with large-scale tests made by engineers in the field.

Soil Stabilization.—At the request of a county engineer, some soils from the Auckland district have been investigated for cement stabilization. One type containing a proportion of gravel and having a good grading curve gave satisfactory stabilization with 12 per cent. by weight of cement.

Soil Biotics

Soil Plant Relationships.—A study of the influence exerted by various native plant species on soil formation was commenced in the southern districts of the South Island, where the native vegetation has played an important part in determining the development of the soil types. Preliminary studies were made on—

(1) The soils of the forest, tussock grassland, and the ecotone lying between, in South Otago and Southland ;

(2) The soils of the beech (*Nothofagus menzesii*) forest and rain forest dominated by kamahi (*Weinmannia racemosa*) and rimu (*Dacrydium cupressinum*) in the Catlins District of South Otago ;

(3) The strongly leached soils associated with the dominance of kaiwaka (*Libocedrus bidwillii*) in the Akatore district. A map showing the extent of the former forest vegetation in these parts, as determined from an examination of the soils, has been prepared for publication ;

(4) The special soil and vegetation relationships of the Fiordland district as part of the scientific programme of the New Golden Hind Expedition. Forest is the main vegetation type, rainfall is high and temperatures are cool, chemical weathering of the rock is slow and little mineral soil is formed *in situ*, forest litter accumulates, and the forest soils have commonly a layer of surface peat 1 ft. to 4 ft. in depth overlying 2 in. to 8 in. of very strongly leached mineral soil. Skeletal soils predominate in this district, and landslides are of common occurrence. There appears to be an interesting relationship between soil development on steep rock faces and subsequent invasion of plants, reaching a climax in *Nothofagus-Meterosideros* forest. Later the trees, soil, and fissured rock mantle break away, exposing a fresh rock surface, on which the cycle commences anew.

Glasshouse Soils.—Investigation was continued on the problem of severe chlorosis in tomatoes (Potentate variety) growing under glass on the Hutt Valley alluvial soils. Soil analysis suggested that the trouble is associated with mineral unbalance caused by the application of potash, phosphate, and lime to successive crops in excess of the plant requirements. A study of the records of basal dressing and top-dressing over the past seasons confirms this picture, and suggests, in addition, that nitrogen has not always been adequate for the plant requirements. Analysis of the plant tissues showed that the chlorotic leaves were markedly low in magnesium and that the ratio potash/magnesium in chlorotic leaf tissue was more than seven times as great as in non-chlorotic tissues. Experiments on a wider scale than previously are being undertaken to determine whether the mineral unbalance in the plant can be redressed by supplying extra nitrogen and magnesium to the soil, or by the use of magnesium sprays on the growing crop.

Plant Indicators.—The search for a plant indicator for phosphorus, comparable to virginia stock in respect of calcium, was continued. A search for a plant indicator for potash in soils has been recommenced.

Ironstone Soil (Okaihau Clay Loam).—An experiment with rye-grass and white clover, sown out last year on ironstone soil raised to various levels of phosphorus and calcium, was under observation throughout the current season. This soil would appear to require heavy liming before a rye-clover pasture will respond to phosphate. A marked falling-off in the quality of the pasture was noticed six months after the inception of the experiment. One set of pots was treated with further dressings of superphosphate, and this gave an immediate and very marked improvement in growth of both rye and clover, suggesting that the initially added phosphate had been strongly fixed by the soil.

A new series of pots was laid down with ironstone soil, treated with phosphate in various forms and amounts (including superphosphate pellets and ammonium phosphate), and sown with white clover. At the end of a month, best growth has been made at the highest levels of phosphorus.

A third ironstone experiment has been laid down with white clover and suckling clover on soil treated with various minor elements. The purpose of this experiment is to see if any of the agricultural problems on this soil are related to mineral deficiencies.

Sand Podzol (Te Kopuru Sand).—To the farmer the strongly leached sand podzol is a " problem soil " second only to the ironstone. An experiment has therefore been laid down using this soil with various minor element additions. Molybdenum (with boron) is showing a good response on this soil.

Lime and Seedling Emergency.—Information has accumulated on the accelerating effect of lime on the rate of seedling emergence and the rate of cotyledon greening in different plants growing in various soils. Accelerated emergence of cotyledons is most marked in the podzol soils and least marked in the red-brown loams. Virginia stock and linen flax are plants that can be used to demonstrate this effect. Further investigation is required to discover the causes of this phenomenon.

MAGNETIC OBSERVATORY, CHRISTCHURCH

Director: Mr. H. F. Baird

Customary observational and recording programmes have been maintained. Magnetic resurvey operations were extended to remote parts of the South Island, but staff shortage and rearrangement temporarily halted this work. However, geomagnetic and geological reconnaissance was started near Oxford as a preliminary to mapping the basement rocks of the Canterbury Plains. A geophysical survey of these rocks is expected to solve fundamental geological problems which will be of wide economic application throughout the Dominion.

Terrestrial Magnetism.—At Amberley the three types of magnetographs gave continuous record throughout the year. Absolute observations were made every week, and, when possible, twice weekly to instruct junior members discharged from the Armed Forces. Scale-values were determined on most days, and measurement of hourly values is well forward. Local data of international magnetic character figures have been supplied quarterly to the Secretariat de l'Organization Meteorologique, Lausanne. These, and " K," the important three-hour range index of geomagnetic activity, were sent monthly to Carnegie Institution, Washington, D.C., United States of America. " K "-indices were supplied daily to the Defence Development Section, Christchurch. Steps to install the ionosphere training set in the Observatory grounds are well under way, and the necessary close link between workers in geomagnetic and ionospheric disturbance fields is being welded.

Magnetic Resurvey.—Field observations were extended into remote parts of Westland and Nelson, where desired consistent results were obtained. Staff shortage in the closing months of the war hindered progress in this work, and resumption, as expected, was delayed when Mr. Beagley and later Miss Bullen were transferred to Apia as Director and Assistant respectively. In October, 1945, Mr. Beagley flew to Apia and back to make intercomparison of magnetic standards.

Canterbury Basement Rocks.—Magnetic reconnaissance with a vertical balance was started during the long University vacation over a considerable area near Oxford Township. A third-year geology student co-operated in making the necessary geological investigations. This scheme, which it is hoped will ultimately cover all the Canterbury Plains, is being done in co-operation with Professor R. S. Allan and Dr. B. H. Mason, of the Geology Department, Canterbury College. Early results indicate that most of the basement rocks do not produce appreciable magnetic anomalies, but in some small areas volcanic rocks have done so. It is clear that geophysical investigations to map the basement rocks of Canterbury will require gravimetric and seismic apparatus suited to the purpose. It is widely recognized that such pieces of apparatus greatly increase the range of fundamental knowledge, which is essential for promoting many economic enterprises, which in their turn depend for success on a sound knowledge of the geological formations encountered.

Recordings.—The full programme of earthquake-recording was maintained under critical conditions. Most interest was attached to some relatively moderate shocks in August which did minor damage about Hanmer Springs. In the last few days of March a brilliant aurora was accompanied by a radio fade-out and a brief but very vigorous magnetic storm. It is doubtful if a more violent magnetic storm has ever been recorded at the Observatory. The cosmic-ray meter was operated as much as supplies permitted, and it is hoped that continuous operation will now be possible again. The demand for climatological data still shows an increase, especially from manufacturing concerns, and the programme of climatological observations is fully maintained to add still more to its value.

METEOROLOGICAL BRANCH

The Meteorological Branch of the Department which was transferred to Air Department, together with the Apia Observatory, at the outbreak of war, has remained under this control during the year. The report of the Meteorological Branch for the year ending 31st March, 1946, will be found in the annual report of the Air Department.

IMPERIAL AGRICULTURAL BUREAUX

The Imperial Agricultural Bureaux have continued to provide a valuable link between scientific workers in various fields of agricultural science, particularly within the various countries of the British Commonwealth. The abstracting *Journals* of the various Bureaux and the *Technical Communciations* published periodically provide excellent service. It is expected that an Empire Scientific Conference in London in the near future will make recommendations as to the future of the Bureaux.

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 Bureaux and the appropriate fields of research are maintained by official correspondents, who deal with specific inquiries. The Scientific Liaison Officer, London, also has useful contacts with all the Bureaux and is a member of the Council.

OVERSEAS LIAISON

The Scientific Liaison Officers in London, Washington, and Australia have rendered valuable service during the year, maintaining close contact with the research work in their spheres. The volume of technical information coming forward to the Department is continuing to increase and is being handled by the Technical Information Section. With the cessation of hostilities there has been a further decline in information on war projects, with a corresponding increase in requirements for civil and departmental purposes. A very wide range of inquiries has been dealt with, and the information received has greatly assisted the Department in keeping abreast with research development in Great Britain, the United States of America, and Australia.

INFORMATION SECTION

Technical Information

A large number of inquiries under this heading have been received during the year. These have either been answered by the officers of the section or referred to the divisions for a more detailed reply. A selection of these inquiries is as follows: *Phormium tenax;* production of lactic acid by fermentation of whey; chemical control of weeds; commercial possibilities of seaweed; hormones for rooting of cuttings; toasting of tobacco; control of insect pests; water divining; harvesting of grain crops by suction apparatus; preservation of tools from abrasive action of plastics. The lack of suitable trained staff has limited the amount of work done, but it is anticipated that this service will be called upon to an increasing extent in the future. Full use was made of liaison officers overseas in the gathering of information, and close collaboration has been maintained with the Manufacturers' Research Committee in the handling of inquiries from industry.

Publications

Journal of Science and Technology.—The *Journal* continues to be published monthly. The size has remained fairly constant at about eighty pages to meet the steady flow of material for publication. The circulation of the *Journal*, especially overseas, has increased considerably this year owing to the reopening of postal services to many countries, including Norway, Sweden, Finland, Spain, France, China, Netherlands, Eire, and the South American republics.

Bulletins.—The following bulletins have recently been published, are in hand, or about to leave the press:—

No. 92: "Soil Erosion in the High Country of the South Island," by J. D. Raeside, H. Gibbs, *et al.* 5s.

No. 93: "Prospecting and Mining the Claredon Phosphate Deposits," by R. W. Willett (in press).

No. —: "Soil Survey of the Hawke's Bay" (maps in hand).

Maps.—The following maps are being printed:—

Soil map of the North Island (4 ml. to the inch), (in seventeen colours; eight sheets).

Soil erosion maps to accompany Bulletin No. 92 (in six colours; three sheets).

Hawke's Bay soil maps.

Te Kuiti Subdivision maps to accompany the Geological Survey Bulletin.

Industrial Bulletin.—During the year arrangements have been made with the Department of Industries and Commerce for the joint publication of an *Industrial Bulletin*. This is an abstract bulletin and is published primarily for the use of manufacturers.

Publicity

Work has continued on the preparation and issue of articles for the press, farmers' journals, and popular periodicals dealing with special aspects of the Department's work. This work is considered to be of great value in bringing the name of the Department and its achievements to the notice of the general public and thus obtain support for its future activities.

Library

The work of the library has continued along the lines mentioned in previous reports. An endeavour is being made to prepare a catalogue of all books and periodicals held in the various branch libraries of the Department. The number of periodicals received has been increased owing to the reopening of postal facilities to the continent of Europe. With the object of making the information more readily available, a start has been made on the classifying of all pamphlets and periodicals by the Universal Decimal Classification. The library is a member of the New Zealand Library Association and full use has been made of the Association's "inter-loan" scheme.

Approximate Cost of Paper.—Preparation, not given; printing (1,086 copies), £220

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Price 2s.]