1944

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(EIGHTEENTH ANNUAL REPORT OF THE)

Presented to both Houses of the General Assembly by Leave

CONTENTS

MINISTER'S STATEMENT

THE continuation of the war has necessitated the maintenance of the Department's interests on matters directly relating to its prosecution and to the war economy of the Dominion's industries. The soundness of the development undertaken in previous years has been amply demonstrated by the continued help which the Dominion Laboratory, the Dominion Physical Laboratory, the Radio Development Laboratory, the Laboratories established in association with Auckland University and Canterbury University Colleges, have rendered to all branches of the fighting Services and to the production of munitions. Though with the recession of the Pacific front away from New Zealand the urgency of these needs has lessened, nevertheless all these sections of the Department still continue to render very valuable service towards the successful prosecution of the war. Opportunity has been taken also to test out the efficacy of this co-ordinated organization in handling certain manufacturing problems which will be of importance in the peacetime development of New Zealand industries.

Increased attention has been paid to food problems in view of the very serious situation which is developing on a world-wide scale. The range of the Department's activities enable it to render useful services in this direction. Its Soil Survey Division has during the year devoted attention to soil-fertility problems, and has produced maps showing where this is being reduced through erosion. The Grasslands Division has evolved new strains of grasses and clovers, and investigated how these may be grazed or otherwise utilized to effect maximum production. The Agronomy Division has produced improved grain, pulse, and fodder crops. The Plant Diseases and Entomology Divisions have played important roles in reducing losses through the ravages of plant pests. The Wheat Research Institute and the Dairy Research Institute have devised means for the better processing and the improvement of the quality of grain and dairy products. The Dominion Laboratory and the Plant Chemistry Laboratory have given valuable scientific assistance to the vegetable and fruit dehydration plants towards providing a product possessed of high nutritive value for use by the Forces. As yet only the fringe of the food problem has been touched. The war and the post-war problems of food, the relation of food to health and nutrition, must be live interests of research in such an important food-producing country as is New Zealand.

Steady progress has been made in research work relating to all New Zealand's three main fibres—wool, linen flax, and phormium. The successful introduction of a dry chlorination non-shrinking process will henceforth enable our woollen-mills to improve markedly the quality of their woollen goods. Machinery has been designed and tested which will enable linen-flax tow to be better prepared for manufacture.

Much work has been accomplished and is being pushed forward now as rapidly as possible on surveys and tests of all readily accessible supplies of coal, both on the West Coast and in the Auckland province. Considerable progress has also been made in surveys and tests of clay deposits which are being utilized to a much greater extent in the growing brick, tile, and pottery industry.

In view of both its immediate and post-war importance, much attention is being devoted to building research problems, and three officers of the Department have been sent overseas in order that the best possible information of the latest overseas developments may be available for New Zealand. An important achievement during the year was the devising of a cheap and ready method for controlling the development of moulds which disfigured seriously the plaster lining material of many houses.

The Department has continued to develop its policy of fullest collaboration with all State Departments in projects which have required scientific assistance. By the appointment of scientific liaison officers in Australia and the United States of America during the year it has been possible to establish closer connections between these countries and the Dominion. The Scientific Liaison staff in London has continued to render excellent service which has enabled the Dominion to be kept fully abreast of scientific progress in both the civil and the defence spheres in Great Britain.

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

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

SECRETARY'S REPORT

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

I have the honour to submit herewith the annual report of the Department for the year 1943–44.

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

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

Permanent services—

	£
Head Office: Comprising general expenses of administration, publications (including the *New Zealand Journal of Science and Technology* and departmental bulletins), and grants to the Royal Society of New Zealand, the Imperial Institute, and the Carter Observatory ..	19,557
Dominion Laboratory (with branches)	34,796
Dominion Observatory	1,497
Geological Survey	10,407
Magnetic Observatory	3,684
Grants to Imperial Agricultural Bureaux	4,797
Dominion Physical Laboratory	73,729
Research investigations	138,510
	286,977
Recoveries	83,948
	£203,029

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

	£
Imperial Agricultural Bureaux Headquarters	1,798
Cambridge Low Temperature Research Station	625
Farnham House Laboratory	937
Wool Industries Research Association, Torridon	62
Imperial Mycological Institute	438
Imperial Institute of Entomology	562
Imperial Bureau of Dairy Science	141
Imperial Forestry Bureau	234
	£4,797

The activities of the Department have continued to be concentrated on problems relating to the war, especially those concerned with physical, chemical, and food matters. A number of branches of the Department have been engaged on munition work, and thereby have both helped directly in the war effort and assisted New Zealand manufacturers in developing quality and quantity of output. Much attention has also been given to the scientific aspects of vegetable, fruit, and meat dehydration and to the packing of dried and other concentrated foodstuffs in a form suitable for Service requirements in the tropics. A considerable amount of survey and testing work has been done in connection with the Dominion's resources of coal, phosphate rock, serpentine, and clays, all of which are of increasing importance both in the war effort and for civil purposes. Consideration has been given to problems which have an immediate and post-war significance, by the Department's economic surveys of the dairy industry, its soil-fertility and soil-erosion surveys, its initiation of building research, and its development of a scheme for the promotion of research associations in manufacturing industry. Through industrial psychology investigations it has also been possible to devote some attention to human problems vital both to the welfare of the workers and to the sound development of industry. The agricultural research Divisions of the Department have continued their valuable work towards maintaining a very high standard of crop and pasture seeds, preventing disease losses in many crops grown in somewhat exceptional circumstances, and in facilitating the production of high-quality dairy and grain products. Despite the difficulties of the war period it is pleasing to note that steady progress is also being made with problems relating to the Dominion's three main fibre industries—*e.g.*, wool, linen flax, and phormium.

STAFF

The staff of all sections of the Department, seriously depleted in numbers by the demands of war, has been obliged to deal with an increasing number of urgent problems. I wish to express appreciation of the zealous and loyal manner in which the staff has performed its duties during a difficult year.

E. MARSDEN, Secretary.

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

BUILDING RESEARCH COMMITTEE

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. J. Fletcher, 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).

The following appointments to the Committee were made during the year: Dr. J. C. Andrews, as representative of the Council of Scientific and Industrial Research, in place of Professor H. G. Denham, whose death occurred in February, 1943; Mr. A. R. Galbraith, Chairman of the New Zealand Standards Council; Mr. A. R. Entrican, Director of Forestry; and Mr. L. E. Brooker, Chief Architect and Property Supervisor of the State Advances Corporation.

A panel comprising Professor C. R. Knight (Chairman), Professor of Architecture, Professor T. D. J. Leech, Professor of Engineering, and Professor P. W. Burbidge, Professor of Physics, with power to co-opt, was set up to supervise research projects allocated to Auckland University College by the Building Research Committee.

A sub-committee consisting of the Chairman, Mr. G. F. Wilson, Professor C. R. Knight, and Mr. J. Mawson prepared a report setting out their views as to lines along which a comprehensive plan for the building industry should be developed as a prerequisite to a research plan, and recommending the nature and the scope of the surveys that would be necessary to obtain the basic information required. This report was adopted by the Building Research Committee and submitted to the Hon. Minister of Scientific and Industrial Research for transmission to the Right Hon. the Prime Minister, the Hon. Minister of Works, and other Ministers concerned.

It was not possible during the period under review to implement the Committee's recommendation for the appointment of an Acting Director of Building Research. Inquiry was made as to the possibility of obtaining the services of a senior officer of the Building Research Station, Watford, England, for a period, but owing to the stress of war and reconstructional work this was not possible. The Director of this station, however, generously offered to train personnel if they could be sent from New Zealand, and this offer has been accepted to the extent of sending Mr. J. L. Mandeno, M.Sc., a chemist on the staff of the Dominion Laboratory, for a period of some months' training in the chemical aspects of building research and testing of building-materials.

The Timber Protection Research Committee and a special Committee set up to deal with the problem of mould growth on the linings of houses were brought under the Building Research Committee in accordance with the policy of co-ordinating under one Committee all research activities relating to building.

The appointment of two representatives of the Standards Institute to the Building Research Committee has ensured that the work of that organization in connection with the development of a National Building Code and the related standard specifications for materials, equipment, and processes will proceed with full regard for the work of the Building Research Committee. In this way the results of the various research projects carried out from time to time will be embodied in the appropriate standard specifications and so made available to the building industry in a way that will ensure that the fullest practical benefit is derived from the research carried out.

The following is a summary of the research work carried out during the year:—

TIMBER PROTECTION RESEARCH

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

Dominion Laboratory

During the year the Laboratory has carried out chemical analyses and investigations required by the Committee.

Entomology Division, Plant Research Bureau

Termites.—Investigations have been continued into the biology of the two native termites, *Calotermes brouni* and *Stolotermes ruficeps*. Though the difficulties of rearing *C. brouni* under laboratory conditions have not been fully overcome, it has been possible to maintain colonies for twenty-eight months, but without any increase in the number of individuals. It has been found that decayed wood is essential for the alates of *C. brouni* to start new colonies and that these are established at ground-level. Attention is being given to the factors influencing the development of the different castes in a colony. Similar studies are being carried out with *S. ruficeps*, and in this case information has been secured on the activities of the termites at the time when the winged forms issued from the timber.

In regard to Australian termites, an attempt has been made to develop a reliable method, based on "workers" characters, by which the three species of *Coptotermes* can be identified. In co-operation with the termite-control operations, valuable data on the Australian termites in service timbers have been secured. Examination of imported Australian hardwoods (power-poles, sleepers, &c.) revealed that living drywood and subterranean termites are still being imported by this means.

Anobium.—In co-operation with the Plant Diseases Division, investigations into the biology of *Anobium punctatum* were undertaken. A study was made of the factors controlling oviposition and of the influence of seasoning of both kiln and air-dried sapwood upon *Anobium* attack, with a view to securing data on the best methods of treating various timbers as a protection against borer attack.

Plant Diseases Division, Plant Research Bureau

Decay in Timber in Tunnels.—Rapid decay was noted in timbering of the Albert Park tunnels, caused by various species of fungi. Cultures of these have been sent abroad for identification.

Timber Insects.—Further work has been carried out to ascertain the suitability of *Anobium punctatum* (common house borer) as an insect for testing timber therapeutants. Optimum conditions for breeding the insect in large numbers were ascertained. In the course of this work some eight thousand five hundred beetles were collected and confined in breeding-cages for study of details of life-cycle, &c. Tests of several synthetic types of wall-board were made to ascertain if they were immune to infestation by several common timber-infesting insects. All were found to be susceptible to attack under conditions of the tests employed.

State Advances Corporation

The State Advances Corporation has continued its work on field investigations of timber-infesting insects and fungi, the field application of termite control, and the field application of wood-preservatives.

Termite Control.—Under the Termites Act, 1940, the application of chemical measures to control foreign termites is the responsibility of the State Advances Corporation. As mentioned in the last annual report, the work, while being carried out by the Corporation, takes full advantage of the research which is being undertaken by the Entomology Division, and close co-operation is maintained both with the Entomology Division and Plant Diseases Division. The new methods of applying arsenic dust previously mentioned have proved largely successful. The most difficult infestations to control are those which are connected with transmission or other poles. The termites use the deep checks in the poles for their runways, and it is difficult at times to make a satisfactory application of arsenic dust. It also appears evident that poles are liable to become reinfested more readily than other timbers. It can be stated that the termite situation as a whole is being dealt with satisfactorily and is steadily coming under control. No further infestations have been reported from the Gisborne district, and there is every reason to expect that the infestation is localized.

Native Termites.—In co-operation with the Entomology Division, the work on biology and control of native termites is proceeding. The incidence of these insects is still high, and the modification of the control specification mentioned in the previous report will be adopted. Generally speaking, it has been found necessary where native termites are present in the foundation of houses to carry out a programme of reblocking—*i.e.*, replacing the infested wooden blocks by concrete.

Fungi.—The Corporation continued to collect information concerning the incidence of various fungi infecting house timbers. The question of moulds attacking lining-boards, which is a major house problem, is being dealt with by a special sub-committee of the Building Research Committee, and the results achieved are reported below.

Wood-preservation.—During the past year specimens of the more important native and exotic timbers were forwarded to the Forest Products Laboratory, Princes Risborough, England, for pressure impregnation tests with a water-soluble wood-preservative. The results of these tests are as follows:—

Name of Timber.	Heartwood.	Sapwood.
Rimu	Resistant	Permeable.
Matai	,,	,,
Totara	Very resistant	,,
Tawa	Not sent	,,
Red-beech (*Nothofagus fusca*)	Impermeable	Resistant.
Silver-beech (*Nothofagus menziesii*)	,,	Moderately resistant.
Pinus ponderosa	Permeable	Permeable.
Pinus radiata	Moderately permeable	,,
Douglas fir	Very resistant	Moderately resistant.

Further work with water-soluble wood-preservatives is proceeding.

MOULD IN HOUSES

Mould in Houses Research Committee.—Mr. L. E. Brooker (Chairman), Dr. G. H. Cunningham, Dr. E. R. Cooper, Mr. A. S. Mitchell, Mr. L. R. L. Dunn, Mr. A. F. Clark (Secretary).

This Committee was set up to direct and co-ordinate research to discover a means of combating the damage done by mould growths on the interior walls of houses. This had become a serious problem to Government Departments owning or controlling houses and also in privately-owned houses. It was decided to undertake research along the following lines:—

(1) To discover a method of preventing mould growth by the application of chemical therapeutants. (Plant Diseases Division of the Plant Research Bureau):

(2) To study (*a*) The physical properties of various lining-materials and structural units under accurately-controlled conditions of humidity and temperature; (*b*) the temperature and humidity conditions which favour mould growth under living-conditions in houses. The purpose of this work is to discover what structural modifications would be necessary to prevent excessive condensation of moisture on or within the wall surface (Dominion Physical Laboratory).

The following report of the Plant Diseases Division shows that the problem of controlling mould growth has been solved by the application of 2 per cent. of sodium pentachlor-phenate to the materials used in finishing the wall surfaces.

Plant Diseases Division

Work has mainly been directed towards investigations into, and control of, moulds in State houses. Preliminary work showed that discoloration of ceilings and walls was caused by various species of fungi, mainly *Cladosporium herbarum*, and to a lesser extent several species of *Penicillium* and *Aspergillus*. It was found by experiment that these organisms developed upon the glue used for sizing gypsum plaster-board employed as lining for walls and ceilings, casein used as a binding medium for water distemper, and flour paste employed to attach wallpaper, since they did not grow upon gypsum plaster-board alone. Investigations were then directed towards finding means of proofing such substances against mould attack. It was found ultimately that a 2 per cent. concentration of sodium penta-chlor-phenate completely inhibited mould growth when added to glue size, casein distempers, and flour paste.

Dominion Physical Laboratory

It was discovered in preliminary investigations at the Dominion Physical Laboratory that mould had a much greater tendency to develop in a humid atmosphere on surfaces that had been papered by the ordinary trade method than on unpapered surfaces. (Further work along this line was taken up by the Plant Diseases Division.) However, the problem of reducing the tendency for moisture to condense on the inner-wall surface still remains to be investigated, and work on this is still proceeding.

Auckland Panel

The main research project undertaken under the direction of the Auckland Building Research Panel during the year was an investigation of the behaviour under stress of a floor consisting of pre-cast reinforced-concrete joists and slabs. This was undertaken at the request of the Housing Construction Department. The objects of the investigation were—

(1) To determine whether joints and slabs could be cast by a manufacturer which would support the design and assembly loads in accordance with accepted principles of reinforced-concrete design and whether they could be submitted to the handling of carriers and workmen in the course of erection without structural damage:
(2) To determine whether a floor could be built up of pre-cast units consisting of slabs and joists which would develop T beam action in accordance with accepted mathematical theory of reinforced-concrete design, and whether the extent of T beam action developed would provide a suitable factor of safety:
(3) To find any faults in construction or assembly of the system as a whole:
(4) To determine the factor of safety and load factor for such a system when subjected to the New Zealand Code domestic load of 40 lb. per square foot of floor area.

The conclusions from the first series of tests were as follows:—

(1) The units adopted will stand all reasonable handling by workmen, carriers, &c., and also withstand the assembly stresses:
(2) T beam action is definitely developed, but whether complete up to point of failure of steel it was not possible to say:
(3) There are no apparent faults in system, although some minor improvements are possible:
(4) The assembled floor showed a factor of safety of 3·9 for the New Zealand Code domestic loading, but the steel was only stressed by computation to 53,000 lb. per square inch and by extensometer to 43,650 lb. per square inch, so that if a mild steel of 29 tons per square inch were used the factor of safety would be 4·8 for 4,000 lb. concrete and 3·6 for 3,000 lb. concrete. The floor withstood six times the Code load, and if the steel were stressed to 29 tons per square inch the load factor would be 7·3. A novel hydraulic loading suggested by Professor T. D. J. Leech was used in the experiments and found to be very simple, efficient, and flexible.

The experiments made it apparent that pre-cast units of the type used will carry the design load in a satisfactory manner. It will be necessary, however, for further tests to be carried out before definite recommendations can be made by the Committee. There is also the possibility of construction of this type in a light-weight concrete.

The Auckland panel also made a preliminary report on a plan of work for investigations on light-weight concrete.

DAIRY RESEARCH INSTITUTE (N.Z.)

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

The Committee met at two-monthly intervals throughout the year to review work in progress and consider new projects. Mr. A. Morton retired from the Committee after acting as member since 1927 and Chairman since 1934. Mr. R. A. Candy was appointed by Massey Agricultural College, *vice* Mr. Morton, and Mr. A. Linton, a member of the New Zealand Dairy Board, was elected Chairman.

Research work was again limited to the conduct of projects concerned with New Zealand's war effort.

Dry-butterfat Production.—The staff has continued, as circumstances required, to give advice on and assistance with the commercial production of dry butterfat by the method developed at the Institute. The dry-butterfat plant at Auckland, being run by the Internal Marketing Division, ceased regular operation in June, 1943. With the decision to export whey butter as butter, there has been no call for the plant to operate except for occasional runs to supply small quantities of butterfat for special purposes. Meanwhile, at the request of the United Kingdom Government, a further plant is being established at Frankton as a standby. The Institute has co-operated with the Internal Marketing Division in the designing and installation of the equipment.

Reconstitution of Butterfat to Butter.—Some trials have been made in the reconversion of dry butterfat to butter. It has been found that the use of a centrifugal homogenizer to emulsify the butterfat with skim-milk before churning in a butter-churn gave butter that rapidly turned fatty. By use of suitable baffles in the uptake pipe of the vacreator it has been possible to produce an adequate emulsification in the vacreator itself. The resultant creams when churned gave a butter with a cooked-fat flavour, but of excellent keeping-quality even under high temperature conditions. Arrangements are in hand for the trial of reconstitution by the margarine process.

Butter and Cheese Spreads.—Work has been continued on the problem of finding a suitable butter substitute for use in tropical countries. The use of beef stearine as a hardening agent has been discontinued because of the accompanying animal flavour. Beeswax (4 per cent.) has been found to give a spread with satisfactory properties, but the supply of beeswax is limited. The only available alternative appears to be hydrogenated peanut-oil. In Australia the use of hydrogenated butterfat has been abandoned in favour of hydrogenated peanut-oil. Trials are at present being made of two batches of beeswax spread forwarded to the tropical areas.

A cheese spread made by admixture of dry butterfat with good-quality cheese has excellent promise, and arrangements are now well under way for a trial of production on the pilot-plant scale.

Land-cress Taint in Cream and Butter.—Work on this problem during the past year has given a clear indication that the benzyl isothiocyanate present in land-cress (*Coronopus didymus*) is not the cause of the peculiar "land-cress" taint in the butter from cows consuming land-cress. Garden-cress contains the same glucoside, and the benzyl isothiocyanate can be isolated from it in exactly the same way as for land-cress. When garden-cress was fed to cows in quantities of up to 7 lb. per feed, there was no sign of typical land-cress taint in the milk even after four successive days of the trial.

Land-cress, on the other hand, gave the taint in one day. It has been confirmed that land-cress taint does not always appear in the cream and butter from cows consuming land-cress. A herd of forty cows was grazed on a land-cress-infested paddock for six weeks during the 1943 spring without the appearance of any land-cress taint in the butter. It is clear, therefore, that the causal agent of the taint has yet to be isolated, and that the passage of the taint into the milk is related to the general condition of the cow or to some other unknown factor.

Iodine Value and Melting-point of Butterfat.—An attempt is being made to establish whether the previously reported fall in iodine value of butterfat in the late spring and rise in the autumn is due to feed changes, variations in plane of nutrition of the milking cows, or to lactation changes. Cows at different stages of lactation and on different planes of nutrition in the same herd are being used for the trial.

Starters for Cheese-manufacture.—The principles laid down in previous years for protection of starter culture from infection with bacteriophage have proved to be sound. During the past year many isolated starter-rooms have been built at commercial cheese-factories, and continued experience has shown that single-strain starter cultures can be maintained free from infection over long periods where isolation together with aseptic handling is practised. Simpler systems of protecting starter cultures against phage infection, which may obviate the need of much of the expense involved in building starter-rooms, are under trial. The most promising of these is one devised by Mr. C. S. Martin, an Instructor in the Dairy Division of the Department of Agriculture. Success in the maintenance of starter cultures themselves has, however, disclosed other avenues of infection of cheese-vats with phage. Failure in acidity-production in cheese-vats can be caused by (i) phage infection of the starter itself (prevented in a large degree by isolated starter-preparation rooms); (ii) phage infection of the equipment in the factory; (iii) phage infection of the milk-cans arising from carriage in them of cheese-whey back to the farms.

Several instances of the two latter types of infection have been encountered. Infection of the factory equipment is easily remedied either by heat treatment or chemical disinfection. Infection of the milk with whey by way of the milk-cans is not so easy to avoid if the farmer insists on continuing to carry whey in the cans. The trouble caused is spasmodic in occurrence, and it obviously depends on the farmers' thoroughness in cleaning the milk-cans from day to day. Assuming that the carriage of whey in milk-cans will continue, three methods of avoiding trouble from this source have been investigated:—

(*a*) Pasteurization of the whey as it runs from the cheese-vat. The whey was heated to 190° F. and subsequently cooled to 90° F. in a regenerative plate pasteurizer. A temperature of 190° F. in a flash pasteurizer is needed for the certain destruction of bacteriophage. It was found that protein from the whey was rapidly deposited on the heating-plates on the pasteurizer, so that the heating efficiency was rapidly lost and the plates were subsequently very difficult to clean. The idea of using such a pasteurizing treatment was abandoned at least for the present:

(*b*) Treatment of the whey after its passage through the separator with hypochlorite solution. If sufficient amounts of hypochlorite are used it is possible to prevent the further development of bacteriophage in the whey and thus reduce enormously the concentration of phage in the whey carried home by the farmer. Trials of this system of whey treatment are still proceeding, including pig-feeding experiments, to determine whether chlorinated whey has any adverse effect on pigs existing on a whey and meat-meal diet:

(*c*) The use day by day in rotation of four or five different single-strain starter cultures, the strains selected being susceptible to distinct specific phages. This means that on any given day in the cheese-factory the starter culture in use in the cheese-vats is immune from attack by the phage or phages which may be present in a significant concentration in the milk as a result of failure to sterilize the factory equipment or the suppliers' milk-cans.

The first two methods, even if successful in overcoming the trouble, would involve extra expenditure. The last method costs nothing, but involves greater skill on the part of the factory-manager both in handling the starter cultures and in adjusting the treatment of the vats each day, since no two starter cultures behave exactly in the same fashion. Granted that the extra skill is forthcoming, the third method gives excellent results. It has been operating in several large factories for the greater part of a dairying season. Continued experience in commercial practice will ultimately indicate the soundest methods to adopt. The fundamental point is that it is now possible in any given case of failure of acid development in cheese-vats to define the immediate source of the trouble and to advise on remedial measures.

Bacteriophage and Mastitis.—A tentative start has been made on an investigation into the possible use of phage as a cure for mastitis in dairy cows. Several phages active against staphylococci from cases of bovine mastitis have been isolated, and it was found possible to irrigate an udder with relatively large quantities of phage preparation without adverse effect on the cow or even on milk-production. Attempts are being made to procure phages active against mastitis streptococci, but all this work cannot be pursued in any sustained fashion until it is possible to procure adequate skilled assistance.

Openness in Cheese.—Towards the end of last season it was suggested that "mechanical" openness in cheese (as distinct from "slit" openness) might be due to a pressure of carbon dioxide originating from the milk itself. It was shown that the addition of sodium bicarbonate to cheese curd resulted in mechanical openness in the cheese. The appearances were indistinguishable from those associated with naturally-occurring mechanical openness. It has not been possible, owing to shortage of staff, to develop the above hypothesis further, but during the present season there has been progress in the field towards a cure for mechanical openness. On the recommendation of Mr. L. H. Jones, Instructor in the Dairy Division of the Department of Agriculture, several factories in the Wairarapa district fitted hydraulic cheese-presses which enable the cheese to be kept under a constant pressure of about 160 lb. per square inch overnight. The grading points scored by the cheeses made in these factories early this season suggested very strongly that they did not show as much openness as in the past. In order to get more evidence of the point, it was arranged, with the co-operation of the Dairy Division, to conduct a trial at Rexdale Dairy Factory. Over a period of a fortnight the curd from two vats was hand-pressed while the curd from another two vats was hydraulically pressed. Examination of the cheeses at the grading port after a fortnight indicated that the cheese from the hydraulic presses were significantly freer from mechanical openness than those from the hand presses. It still remains to be seen whether the difference in openness persists as the cheese ages. Experiments carried out by the Institute about fourteen years ago did not indicate that hydraulic presses (at a pressure of about 100 lb. only) improved the texture of cheese. Possibly the very greatly changed conditions of manufacture nowadays, the improved milk quality, and the use of more active starters, together with a higher pressure in the hydraulic presses, account for the difference in result.

Dairy Cow Nutrition Projects.—During the 1943–44 production season, groups of cows were again maintained on pastures of three classes—*i.e.*, perennial rye-grass and white clover, cocksfoot and white clover, and a mixed sward containing a wide variety of pasture species. No outstanding differences in the health of the cattle or in the yield and composition of milk have yet been observed which could be attributed to the sward differences.

Throughout the year an attempt has been made to contrast the production and composition of milk from cows kept on an adequate plane of nutrition by the addition of meal to their normal farm ration with that from cows receiving pasture and the usual farm supplements of hay, silage, and roots. During the extremely dry summer and autumn experienced in the season of 1943–44, the production of the meal-fed cows was maintained at a higher level than that of the contrasted group, but the meal-feeding did not prevent a fall in the solids-not-fat content of the milk at this time. This result seems to indicate that some environmental factor distinct from the availability of nutrients was responsible for differences observed in milk composition.

Hormone Studies.—(*a*) Milk Secretion in Dairy Cattle: A number of cows from which a season's production would have been lost through temporary or permanent sterility have been treated with diethylstilbestrol, and substantial productions of milk and fat have been obtained from some of these animals. The composition of the milk and the trend of the lactation curves were normal, but the level of production was in all cases below previous natural production records. The addition of further hormones is being tried in an attempt to increase the productivity of these artificially-induced lactations. Encouraging results have been obtained with preparations having thyroid potency.

A study is in progress of the preparation of potent thyro-protein. This material will provide a cheap source of a valuable tool for research, and facilitate further trials of the effect of thyroid-active material on milk secretion, particularly of its value to increase production and its effect on the health of dairy stock so treated.

(*b*) Parturition in Pigs: It has been suggested that one cause of still-birth in pigs is slow delivery at parturition. In experiments extending over two farrowing periods, a New-Zealand-prepared pituitrin solution was injected into sows at farrowing to determine whether the rate of birth of young pigs could be thus increased. The sows appeared quite refractory to this preparation, which gave no speeding up of parturition even with particularly heavy doses.

Dairy Cattle Growth.—Comprehensive data covering the size of New Zealand dairy animals are at present unavailable. By systematic weighing of all dairy stock at the Institute throughout their lifetime a study is being made of the growth rate of young stock and the variation in weight of mature animals of different size and at different times throughout the productive cycle.

The growth rates of two groups of calves, one receiving a diet pasture and skim-milk and the other being fed similarly but for the substitution of ½ lb. meal for an equivalent amount of skim-milk, have been contrasted over the growth period from six weeks until twenty-four weeks of age. In two separate seasons' trials no significant difference was recorded between the respective groups.

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

Dissemination of Results of Work.—A large number of dairy-factory managers and first assistants from all parts of the Dominion attended the annual "week" held at the Institute on 5th and 6th May, 1943, when research work carried out during the previous season was described and discussed. This annual gathering is very much appreciated by managers and first assistants in the butter and cheese industries.

FOOD PRESERVATION AND TRANSPORT ADVISORY COMMITTEE

Personnel.—Sir Theodore Rigg (Chairman), Dr. J. C. Andrews, Mr. G. A. Duncan, Mr. E. J. Fawcett, Mr. R. P. Fraser, Dr. E. Marsden, Mr. G. M. Pottinger, Professor W. Riddet, and Mr. F. J. A. Brogan (Secretary).

Sir Theodore Rigg was elected to the Chair, left vacant by the greatly-regretted death of Professor H. G. Denham in February, 1943. During the year the Committee lost another member by the death of Mr. F. W. Grainger, of the Export Division, Marketing Department. Mr. Grainger's knowledge and experience of food transportation and storage problems was extensive, and his loss was keenly felt.

Mr. A. H. Cockayne retired from the Committee following his retirement from the Department of Agriculture, and his place was taken by his successor in office, Mr. E. J. Fawcett.

Mr. R. P. Fraser, Acting Director of the Internal Marketing Division, accepted an invitation to join the Committee in order to represent the Division's important activities in food dehydration.

Messrs. G. A. Duncan and E. J. Fawcett attended the United Nations Food Conference at Hot Springs, United States of America, as members of the New Zealand Government delegation.

Dr. J. C. Andrews visited the United States of America to attend a conference on dehydrated-meat production at Washington. He also visited a number of meat-dehydration and vegetable-dehydration plants in the United States of America and Canada and obtained much valuable information on dehydration plant and processes.

The Committee held one meeting during the year to review progress with research and developmental work proceeding under its general direction.

Dry Butterfat and Butterfat Spreads.—Since the commercial production of dry butterfat was taken over by the Internal Marketing Division when the Auckland plant was opened in August, 1942, the Dairy Research Institute has concentrated on the utilization of dry butterfat in spreads for use by the Armed Forces under hot climatic conditions. Various hardening agents have been tried, with due regard to their effect on the palatability of the spreads and their availability in sufficient quantity in New Zealand, and bulk samples of the most promising products have been supplied to the New Zealand and United States of America Army authorities for trial under active-service conditions. Dr. F. H. McDowall visited Australia in March to investigate work in progress on butterfat dehydration and the utilization of dry butterfat for Army spreads.

Some work has also been carried out on the drying of natural cheese, and on the incorporation of mature cheese with dry butterfat, which gives a spread of excellent palatability.

With regard to improvements in dry butterfat processing and plant, the problems of devising a melter to deal with frozen butter and of further prolonging the storage life of dry butterfat by a more rigid exclusion of air at the time of filling are being investigated.

Dehydrated Meat.—The commercial dehydrated-meat plant at Feilding, which is under the control of the Department of Agriculture, began production towards the end of March, 1942. The main developmental work during the period under review was concerned with (i) increasing the fat content up to 40 per cent. by the addition of edible rendered tallow; (ii) the installation of plant for the readditions of the concentrated cooking juices which improve flavour and palatability; (iii) the installation of plant for packaging the dried meat under compression in accordance with specifications of the United Kingdom Ministry of Food.

Various substitute containers have been tried, but none has proved capable of being substituted for tinplate.

Dehydrated Vegetables.—Commercial production of dehydrated vegetables began at the end of March, 1943, in a tunnel dehydrator of the Eidt type designed by the Chemical Engineering Section of the Dominion Laboratory and installed by arrangement with the Government at the Wattie Canneries, Hastings. The performance of this plant and the quality of its products have been fully up to the expectations based on prior research and developmental work. A dehydrator of similar design installed at the Wattie Canneries for the dehydration of apples on behalf of the Internal Marketing Division has now commenced production.

Additional commercial dehydration plants are being installed by the Internal Marketing Division at Pukekohe and Christchurch for vegetables, and at Motueka for apples.

Dr. J. C. Andrews, whose services have been made specially available, and officers of the Fruit Research, Dominion Laboratory, and Plant Chemistry Sections are acting in a technical advisory capacity in the installation and operation of these plants. Dr. H. Annett has been appointed technical liaison officer.

Research and developmental work on vegetable and apple dehydration has been proceeding along the following lines:—

(1) Suitability of different varieties for dehydration, from the following aspects: Culture, processing, yield of dry matter, vitamin content, and appearance of finished product:
(2) Storage tests on experimental and commercial products:
(3) Methods of peeling (particularly lye and flame peeling), blanching, and compression.

Dr. B. W. Doak, Acting Director of the Plant Chemistry Laboratory, visited Australia during March, 1944, for discussions with officers of the Australian Council of Scientific and Industrial Research and others engaged in vegetable-dehydration work, and for visits to commercial plants.

FRUIT COLD STORAGE RESEARCH

In view of the fact that investigations on the refrigerated transport of fruit overseas are no longer called for, it was decided that there was no further necessity to retain a special Cold Storage Advisory Committee, and that control could be assumed directly by the Fruit Research Advisory Committee on which key personnel of the Cold Storage Committee was fully represented.

Refrigerated Gas Storage of Apples

Jonathan.—Fruit for semi-commercial-scale trials by the Dominion Laboratory was drawn from Hawke's Bay and Nelson, but owing to failure of transport the Nelson fruit on arrival had to be rejected on account of over-maturity. The Hawke's Bay fruit was put into store on the 12th March, and examinations were made at monthly intervals, commencing from the second month. The total storage period was 154 days. The atmosphere in the store was maintained at 8 per cent. carbon dioxide and 13 per cent. oxygen. Brown-heart again appeared in the fruit this season, but on a reduced scale. It was apparent at the end of two months, and had undoubtedly occurred earlier, but it did not increase appreciably in extent at any later date. Size of fruit very much affected susceptibility, for with a range of size counts from 100 to 198 it was found at the final examination that there was 22 per cent. brown-heart in the largest fruit, but only 5 per cent. in the smallest. Breakdown and fungus were just beginning to appear at the final examination, though not in amounts of commercial significance. There was no Jonathan-spot. The recurrence of brown-heart strengthens the idea that the range of picking dates for this variety for gas storage is very limited. A slight lowering of the percentage of carbon dioxide from 8 to, say, 7 might help to provide a greater margin of safety.

Sturmer.—In view of the troubles encountered when this variety was gas stored under semi-commercial conditions, further studies have been made of its behaviour under various modifications of the storage atmosphere composition and under various temperatures. At each of the temperatures 35° F., 38° F., and 41° F., atmospheres containing the following percentages of carbon dioxide and oxygen were employed, for comparison with storage in air:—

Carbon Dioxide.	Oxygen.	Carbon Dioxide.	Oxygen.
5	16	5	10
7·5	13·5	5	7·5
10	11	5	2·5

The fruit remained in store for a maximum period of 248 days.

In general, the fruit held at 35° F. suffered severely from internal breakdown, while that at 41° F. developed more or less severe superficial scald. A small amount of brown-heart of very mild intensity appeared at all temperatures in certain of the atmospheres, particularly the 10 per cent. carbon dioxide 11 per cent. oxygen, and the 5 per cent. carbon dioxide 2·5 per cent. oxygen. A trace was also found under 7·5 per cent. carbon dioxide 13·5 per cent. oxygen, and under 5 per cent. carbon dioxide 7·5 per cent. oxygen. No brown-heart appeared in atmospheres containing 5 per cent. carbon dioxide with either 16 per cent. or 10 per cent. oxygen. These results suggest that the Sturmer will, in general, tolerate only a small amount of carbon dioxide, and that there must be a fairly liberal amount of oxygen present. As far as they have gone, the tests suggest the most promising conditions as being a temperature in the neighbourhood of 38° F. with moderate carbon dioxide and slightly subnormal oxygen, as represented by 5 per cent. carbon dioxide and 10 per cent. oxygen in the series chosen. In respect of colour, hardness, and general quality, the fruit stored under these conditions was vastly superior to the air-stored controls.

Superficial Scald on Granny Smith

Wrapping Test.—The work carried out last year was repeated. By wrapping various lots of fruit in oiled paper for a three-week period at progressive stages in the storage life of the fruit it was confirmed that the greatest protection—and, therefore, the period of maximum susceptibility to scald—occurred from the ninth to the twelfth weeks after commencement of storage. Fruit that spent most of its storage life in oiled wraps but was left unwrapped for a three-week period at progressive stages in its storage life again remained free from scald throughout the twenty-four weeks duration of the experiment. In view of these results, it is now proposed to determine how long it is possible to leave the variety without oiled wraps on either side of its period of maximum susceptibility before scald appears. Core-flush was the only other storage disorder appearing during the commercial life of the fruit, and was unaffected by the wrapping treatments. A detailed report of the work is being prepared.

Delayed Storage Test.—Fruit of two pickings, stored in both plain and oiled wraps, was subjected this season to delayed storage, at weekly intervals, up to six weeks. Examinations of the fruit were made on removal from storage, and also after a further fourteen days at 68° F. and 90 per cent. humidity. In 1942, scald was least in fruit either stored immediately or subjected to four weeks' delay, but this season quite different results were obtained. The greatest freedom from scald occurred in the various lines when storage was delayed for the periods shown in the following table:

Picking.	Wrapper.	Storage Delay.
First	Plain	5 weeks.
First	Oiled	6 weeks.
Second	Plain	3 weeks.
Second	Oiled	5–6 weeks.

Core-flush, and the form of breakdown that arises from extension of core-flush into the cortex of the apple, were in all but one sample decreased by delay before storage. Fungus tended to increase after four weeks' delay, and beyond this time, also, the colour of the fruit became excessively yellow. Irrespective of the scald position, therefore, a delay of more than four weeks between harvesting and storing could not be recommended.

Oiled wraps again very substantially delayed the first appearance and the severity of scald, though not entirely preventing it. Fruit of the various treatments was left in storage till some scald had developed, so that differences in scald susceptibility could be assessed, but this involved an erroneous impression of the effect of delay and wrapping treatments on other storage disorders. In view of this and of the divergence in scald results for the two seasons, the work is to be repeated on a larger scale to facilitate a better assessment of the overall significance of delayed storage treatment of this variety.

Effect of Fertilizers on Cold-storage Quality

This long-term project has been continued by the Appleby Research Orchard.

Cox's Orange Pippin.—This season the complete PNK treatment has given fruit as resistant to fungus and wilt as the untreated control fruit and very much more resistant to breakdown and to storage pit. Fruit from nitrogen-treated trees has again been outstanding for its high susceptibility to breakdown and fungus. Fruit of later pickings has once more been rather less severely affected by pit, and, while superficial scald was relatively slight, even in the first picking it has been virtually absent from the later ones. Breakdown susceptibility has been increased in the later pickings only when nitrogen is included in the fertilizer treatment, more especially when potash is absent. No consistent effect on storage quality has yet been seen from the use of dried blood as a source of nitrogen in comparison with ammonium sulphate.

Dunn's Favourite.—There has again been little difference in the storage characteristics of fruit from no-nitrogen trees and from those receiving 2 lb. ammonium sulphate additional to phosphate and potash. The use of 4 lb. ammonium sulphate, however, has greatly increased breakdown, fungus, superficial scald, and, to some extent, pit. This season the use of 2 lb. ammonium sulphate, without addition of phosphate and potash, has caused only a moderate rise in superficial scald, and the inclusion of phosphate and potash has failed to improve the position. The crop of Dunn's has been light on some trees, however, and this year's data probably have to be treated with some measure of reserve. Fruit from limed and unlimed trees has shown identical storage characteristics.

Jonathan.—This season the variety has shown very good keeping-quality, a feature characteristic of fruit produced in the "on" year of bearing. In fruit from the plots on which 0 lb., 2 lb., and 4 lb. ammonium sulphate are being used in conjunction with phosphate and potash, only the 4 lb. application has lowered the storage quality to any great extent, and this is in respect of breakdown, ripe-spot, and fungi other than ripe-spot. Potash has again conferred resistance to breakdown and fungus, but its effect on the incidence of pit and Jonathan-spot could not be ascertained because these troubles were virtually absent.

Delicious.—No appreciable differences in storage quality have been shown by fruit from various manurial blocks.

Sturmer.—The variety has held particularly well this season, and such storage disorders as have developed are of very minor severity. The differences noted are very similar to those recorded last year. Without phosphate and potash, nitrogen has increased breakdown susceptibility but has reduced the amount of wilt. With or without phosphate and potash, nitrogen has increased somewhat the development of superficial scald. Fruit from trees receiving a balanced mixture of phosphate, potash, and nitrogen has shown no more breakdown, fungus, wilt, or pit than the untreated control fruit.

Effect of Rootstock on Cold-storage Quality

The small rootstock area at Appleby is now coming into production to some extent, and this year it has been possible to carry out a storage trial with Jonathan as the scion variety. Jonathan grown on East Malling No. XII stock has been much less subject to internal breakdown than when grown on Northern Spy stock or on Malling types I or XV. Fruit on M I appears to be slightly less resistant than the others to ripe-spot, but otherwise there are no outstanding differences. With other scion varieties the crop weights are as yet too divergent to enable any valid comparisons to be made.

Control of Wilt in Cold-stored Pears and Apples

Tests of waxed-paper case-linings for reduction of shrivelling of cold-stored pears have been continued on the varieties Winter Cole and Winter Nelis, and have also been extended to the variety P. Barry. It has so happened that the only wilt encountered on these three varieties this year has been of an intensity so slight as not to cause the fruit to be rejected commercially. Subject to this reservation, however, it has been evident that the waxed-paper liners have very largely checked any tendency of the fruit to shrivel, and have not caused any marked increase in loss from rots. With Winter Nelis the rots were substantially less in the waxed-paper-lined boxes than in the controls. The results, taken in conjunction with those of previous seasons, show clearly that under circumstances in which loss of cool-stored pears through shrivelling is thought likely to arise, it is practicable and economic to use a case-lining of waxed paper as a preventive measure. Increases, if any, in the amount of rots are likely to be more than offset by the absence of wilt. The weight of the paper stock does not appear to be critical so long as it is fairly close grained and possesses adequate mechanical strength. The waxing should be fairly liberal and should be applied superficially rather than as a "dry" impregnation.

In view of the fact that cold-stored Sturmer apples frequently suffer rather heavily from wilt, it was decided to try the waxed liner on some of this fruit. Here, again, only a relatively small amount of wilt developed in the control fruit, totalling 3 per cent. severe and 12 per cent. slight, but the waxed liners reduced this to a total of 3 per cent. slight. The liner did not increase the amount of rots and apparently actually reduced the incidence of ripe-spot.

Orchard Storage of Apples

This investigation was continued during the current season, but it has not as yet been possible to analyse the records.

FRUIT RESEARCH

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

Apple

(*a*) *Long-term Manurial Investigations.*—Data obtained by the Department on its Research Orchard at Appleby continue to show the advantages of balanced manurial treatment of apple-trees on Moutere loam. It is now eleven years since treatments were commenced on most of the blocks, and the yields from untreated control plots are now falling off to a marked degree. The following table shows the average increase in yield, expressed as bushels per tree per year, resulting from various treatments on various varieties, as compared with the yield from the untreated controls:—

	Treatment.				
	P.	PK.	N.	PN.	PNK.
Cox's Orange	..	$\frac{3}{5}$	1	..	$1\frac{1}{2}$
Dunn's Favourite	..	..	$\frac{1}{3}$	..	$\frac{5}{8}$
Delicious	..	..	$\frac{3}{8}$	..	$1\frac{1}{2}$
Sturmer	$\frac{1}{2}$	..	1	$2\frac{2}{3}$	$2\frac{7}{8}$

The above figures are average values covering the whole eleven-year period, and the increases attributable to manuring are even greater in the last few years.

A liming test on the variety Dunn's Favourite is now beginning to show some differences that are thought to be due to the better growth of cover-crops obtained on the limed plot. Over the past three seasons the trees that have had lime in addition to a balanced fertilizer have produced 40 per cent. more fruit than the unlimed trees.

Tests of the rate at which nitrogenous fertilizers are applied continue to suggest 2 lb. ammonium sulphate as being about the most satisfactory. With Jonathan the 2 lb. dressing continues to give a yield increase without any great lowering of the colouring of the variety, whereas 4 lb. has caused a substantial drop in colouring—this season, without any increase in yield of fruit. With Dunn's Favourite this season, also, a 2 lb. dressing has almost doubled the yield, but a 4 lb. dressing has not given any further increase.

The plots of Jonathan that received heavy potash applications in 1933 and 1934 are still carrying a heavier crop of larger-sized fruit with better overlying colour.

(*b*) *Rootstock Trials.*—The trials of East Malling stocks at the Plant Diseases Division have been continued. Trees on M XII—the most vigorous stock—are now rapidly overhauling, and have in some instances passed, in yield of fruit the earlier-fruiting trees on Northern Spy stock. Under similar conditions of exposure to sunlight, fruit of the varieties Jonathan and Cox's Orange on Spy stock has not been superior in colour to that of the larger trees on East Malling stocks.

Seven-year-old Sturmers on Sturmer roots are now almost as large as trees of the same variety and age on M XII stock and are carrying a heavier crop. This is conclusive evidence that the weak and stunted growth so frequently observed on this variety is not inherent, but has resulted from the use of an unsuitable stock—viz., Northern Spy.

Approximately five hundred East Malling stocks of types XII and XVI have been despatched to the nursery of the New Zealand Fruitgrowers' Federation, where they are being used to establish propagation beds for future production in quantity.

In a small block of Gravenstein planted by the Division in 1938, and consisting of three trees on Spy stock and three on Gravenstein roots, slight "gnarling" has developed in all trees of the former, whereas the latter are as yet quite free from the trouble. This suggests that gnarling of Gravenstein—a widespread phenomenon detrimental to both tree and crop—is a symptom of stock-scion incompatibility. In this experiment, trees growing on Gravenstein roots were raised in the nursery by layering, and are equivalent to cuttings, as there

is no bud union. On Spy stock symptoms of gnarling first appeared immediately above the bud union, and in the worst case are spreading fairly rapidly up the trunk towards the crotch.

At Appleby the vigorous M XII stock has nearly caught up to Northern Spy in yielding capacity with Jonathan as the scion variety, but with other varieties it is still well behind. As a semi-dwarfing type M I has proved rather similar to Northern Spy, except that its top growth is less and that with Cox's Orange and Delicious as scion varieties it is at present cropping much more heavily.

(*c*) *Varietal Trials.*—Following the earlier work of classification and trial of strains of Delicious and Cox's Orange, the Plant Diseases Division has made final selections for future propagation by the New Zealand Fruitgrowers' Federation. These comprise one red Delicious, one striped type of the same variety, and one Cox's Orange of normal colour.

In the varietal collection a large number of new varieties is undergoing trial, but has not yet been sufficiently tested to enable any recommendations to be made.

(*d*) *Plant Protection.* (i) Ripe-spot: Field experiments conducted by the Plant Diseases Division over the past three years have shown that adequate control may be secured by the use of Bordeaux-mixture sprays applied during the critical months of January and February. Injury to fruit is liable to follow the use of Bordeaux. This may be reduced by increasing the quantity of hydrated lime, or by addition of cotton-seed oil. Applications of Bordeaux to fruit after picking have not improved control, and have materially increased spray residues. Fruits sprayed with Bordeaux, when held in cool store, show marked freedom from ripe-spot and soft-rots.

(ii) Black-spot: Bordeaux sprays applied in the late summer have served to control the development of black-spot in cool store.

(iii) Spray Damage: Lead arsenate, which produces a characteristic type of injury on fruits and foliage, is responsible for more damage than is generally recognized. Addition of hydrated lime to arsenate sprays considerably reduces injury. The Division has found that, contrary to the general belief, lime sulphur does not appear to increase the degree of arsenate injury.

Stone-fruit

(*a*) *Apricot.*—Field trials have been undertaken by the Plant Diseases Division to ascertain the possibility of reducing brown-rot losses in apricots by dipping. "Shirlan A.G." gave a high degree of control under the severe conditions of the experiment, whereas sulphur was not only ineffective but caused fruit blemish.

(*b*) *Plum.*—Work carried out in an infected orchard at Henderson, Auckland, has shown that a substantial control of bacterial-spot is secured by a Bordeaux programme, although spray injury has followed the applications. A study made of this phase has shown that, of some forty varieties, Japanese plums are readily injured by copper sprays, but English varieties suffer no damage. These forty varieties were inoculated with a vigorous strain of the organism, when it was found that the English varieties were immune or very highly resistant, whereas the Japanese varieties were mainly susceptible, a few only being resistant.

(*c*) *Peach.*—The Plant Diseases Division has tested the susceptibility of the peach to bacterial-spot of plums, and has found that all twelve of the varieties tested have been susceptible to infection.

Full descriptions have been compiled of the fruit of fifty-seven varieties, rather more than half the total number planted in the collection at Owairaka. The remainder are not yet in bearing. Recording of the incidence of brown-rot, both before and after picking, has been continued for the second year in succession.

Citrus

(*a*) *Rootstock Trials.*—Washington Navel orange, planted at Oratia by the Plant Diseases Division in 1942 on sweet and sour orange, citronelle, and *Poncirus trifoliata* rootstocks, continues to show marked variation in tree size. The largest trees are those growing on citronelle and sweet-orange roots.

The trial has been duplicated on a smaller scale by a planting on the volcanic soil at Owairaka.

(*b*) *Entomological Studies.*—As the proprietary "Ostico" is no longer available as a banding-material for the control of dicky-rice weevil, the Plant Diseases Division has manufactured some 2 cwt. for supply to citrus-growers in the Auckland Province.

In field-work carried out by the Division it has been found that soft-wax scale is controlled by a 3 per cent. spray of summer oil.

Miscellaneous

Early in the year a nursery was established at Levin by the New Zealand Fruitgrowers' Federation for the purpose of raising true-to-name trees from selected budwood and on selected stocks. In addition to supplying a nucleus of apple stocks, as previously mentioned, the Plant Diseases Division has advised the federation in the layout and development of the nursery, and has given practical instruction to the nursery staff in approved methods of propagation.

On the recommendation of the Division, bud-selection committees have been formed in the chief fruitgrowing areas, the function of these being to select the best available trees of stone and pip fruits, from which budwood is being secured by the federation nursery, after fruit samples have been approved as true to type by officers of the Division.

As a result of collaboration among the Fruit Research, Dominion Laboratory, and Plant Chemistry Laboratory sections of the Department, a modern apple-dehydration plant is now in commercial operation in the Dominion. The Department was responsible for the design of the plant, and continues to function in a technical advisory capacity to the Internal Marketing Division of the Marketing Department, on whose behalf the factory is being operated.

Fruit Research at the Cawthron Institute *

Magnesium Deficiency of Apples.—At Braeburn two applications of 6 lb. ground dolomite or of 2 lb. magnesium carbonate per tree, applied in the 1939–40 and 1940–41 seasons, have now almost completely controlled magnesium deficiency in the Sturmer. Magnesium sulphate, even with two applications of 7 lb. per tree, has not proved so satisfactory, probably on account of more rapid leaching. At Tasman, on an orchard formerly receiving liberal potassic manuring, the recovery has been rather slower.

Chemical analyses show that treatments have increased the magnesia content of the leaves, and the data correlate well with the appearance of the trees.

Micro-chemical Methods.—To determine more closely the distribution of magnesium and potassium in different parts of the leader growth, analytical methods have been elaborated to permit their determination in a single leaf or part of a leaf, using cobaltinitrite for potassium and an improved Titan yellow method for magnesium. The latter method has been developed into a quantitative colorimetric micro-method.

Distribution of Magnesium and Potassium in Leader Growth.—Striking variations in distribution have been found in magnesium-deficient and healthy trees. In magnesium-deficient trees, five lower leaves on the leader contained less than half the magnesium of the top five leaves on the same leader. The magnesium content of the lowest leaves decreased as the season advanced. In healthy trees the differences between upper and lower leaves were much less marked, usually not exceeding 25 per cent. Leaves of magnesium-deficient trees had more potash than those of healthy trees. Potassium was invariably concentrated more in the lower than in the upper leaves of the leader.

Vitamin C Content of Nelson-grown Apples.—Chemical analyses made in 1942–43 showed Sturmer to contain up to 36 mg. ascorbic acid per 100 g. fresh fruit, Ballarat and Granny Smith to have progressively less, and Rome Beauty and Delicious to be relatively poor. Further data obtained this season are as follows: Cox's Orange 6–8 mg., Gravenstein 7 mg., Cleopatra 10 mg., Jonathan 11 mg., and Delicious 12 mg., per 100 g. fresh fruit.

Apple-juice Concentrates.—Vacuum concentrates have been prepared from the juices of a number of apple varieties, and varietal differences are reflected in the products. Those from Sturmer and Lord Wolseley have a sharp acid character and make very pleasant drinks on dilution. It was thought that the products might be valuable for the Armed Forces, particularly in tropical or semi-tropical climates.

Apple-juice concentrate is now being used in the United States of America for moistening and flavouring tobacco, and samples have been furnished to a local manufacturer for trial.

Long-term Manurial Experiment at Upper Moutere.—Maintenance of the area had to be discontinued during the past season, but notes have been made on the residual effect of the past twenty years' treatments. PNK trees are much the best. Ammonium sulphate, with phosphate and potash, is still giving better foliage and growth than dried blood. Marked decline is noticeable in PN and NK trees, and the worst trees are those untreated or with nitrogen only.

Apple Rootstock Experiments at Annesbrook.—Twelve-year-old Statesman trees on Double Vigour (French Crab Seedling) stock are now carrying ½ bushel more fruit per tree than those on Northern Spy stock. This higher yielding-capacity has been in evidence over the past three seasons.

Brown-rot and Black-spot.—The usual notification of the maturity date of ascospores of these fungi has been given for the benefit of Nelson orchardists.

Codlin-moth Parasite.—The three parasites being studied are *Ephialtes caudatus*, *Aenoplex carpocapsae*, and *Cryptus sexannulatus*. The first was reared in considerable numbers and liberated in an abandoned orchard early in 1943. Beyond making further liberations in 1944, it was decided not to disturb the material, but to study the extent of establishment next season. Comparatively small numbers of the other two parasites were available, so attention has been devoted to building up supplies before liberation. The rearing of these two has so far been less successful than of *E. caudatus*.

General.—Preliminary tests have been carried out with dichloroethyl ether on the winter eggs of red-mite, and some attention has been paid to the parasitic control of the mealy bug. This work will be extended next season.

INDUSTRIAL PSYCHOLOGY DIVISION

Advisory Committee.—Mr. H. E. Moston (Chairman), Mr. F. Sandys Wunsch, Mr. Adam Black, Mr. D. I. MacDonald, Dr. T. R. Ritchie, Mr. N. S. Woods, Wing-Commander Carter, Mr. E. H. Langford, Dr. E. Marsden, Mr. L. S. Hearnshaw (Director).

The Establishment and Aims of the Division

The Industrial Psychology Division was established towards the end of 1942 as the result of a survey carried out by the Director into firms engaged on munitions-production. The report on this survey was submitted to a committee comprising representatives from the Departments of Scientific and Industrial Research, Health, Labour, and Supply, and from the Manufacturers' Federation and Engineers' Trade-union. The report made it clear that there was a need in the industries of the Dominion for the application of the findings of industrial psychologists, and scope for research work into the human aspects of New Zealand industry. The committee to which this report was submitted recommended that an Industrial Psychology Division be established as part of the Department of Scientific and Industrial Research.

Industrial psychology sets out to make a scientific study of matters connected with the welfare and efficiency of the human being in industry. It is based on the proved truth that the human being can only give his best to his work when he is healthy, free from fatigue, happy, and interested. Therefore, the reduction of fatigue and monotony, the adaptation of the environment to the needs of the worker, and careful attention to placement, training,

* This report was received late and could not be incorporated in the main report as in previous years.

and supervision are among its goals. In all industrial countries of the world, Great Britain, the United States of America, Russia, and Australia, it is an established science which is making an important contribution to human well-being and efficiency both in war and peace; and we cannot escape the fact that our enemies, Germany and Japan, have used this approach with beneficial results in building up their war potential.

Recent investigations indicate that in New Zealand there is a great need for the application of the work of industrial psychologists if industry is to meet the increasing demands placed upon it both now and when peace returns. There is little doubt that fatigue, ill health, accidents, labour turnover, absenteeism, and discontent have proved a quite unnecessary burden to our secondary industry, and it is surprising that, in the past, manufacturers generally have not realized the economic significance of these important factors in production.

The isolation of New Zealand makes it imperative that there should be specially-constituted bodies whose duty it is to keep in touch with developments abroad, and spread information within the Dominion. The small size of most New Zealand manufacturing concerns makes it impossible for the majority of them either to employ specialists or to send their principals overseas more than occasionally, if at all; therefore they must rely to a considerable extent on services provided co-operatively or by Government agencies.

The work of the Division, therefore, is filling a long-felt need in New Zealand industry, and there are many hopeful signs that considerable progress will be made in the immediate future. There are many among our manufacturers who realize what can be achieved by the application of science to industry, and that is no doubt one of the reasons for the friendly reception given to the officials of the Division and the wide interest being manifested in the work not only by business executives, but also by the labour unions affected.

The aims of the Division fall under three main heads:—

(i) *Research.*—To collect information about any matters which affect the well-being and efficiency of the human being in industry:

(ii) *Information.*—To spread among manufacturers, trade-unionists, and the relevant Government Departments information about the work of industrial psychologists:

(iii) *Service.*—To assist in solving specific problems submitted by individual organizations:

(iv) *Relations* with other bodies.

1. Research

Three research investigations have been in progress during the year.

Absenteeism

This investigation covered forty-six factories in the four main centres of the Dominion. Statistical data were taken from the firms' records; the views of managers and foremen on the question of absenteeism were collected; and approximately four hundred workers who had been absent for not less than three days during a three-month period were interviewed. An attempt was also made to assess the effect of fines on reducing absenteeism. A report based on this investigation was printed, and some seven hundred copies have been privately circulated to manufacturers, trade-union secretaries, and Government Departments. It was decided not to publish the report, as the publicity given to the question of absenteeism probably has the effect of increasing, rather than diminishing, it. Means for the reduction of absenteeism were suggested in the report.

The Ventilation and Heating of Factory Buildings

Readings of air temperature, humidity, and air movement have been made in twenty-one factories, in each case over a period of time. A report on the investigation is in preparation. The work has left no doubt that there is room for considerable improvement in the ventilation and heating of factory buildings in New Zealand. Not only in old buildings, but also in buildings of very recent construction, adequate standards are frequently not reached. In the case of new buildings, this seems to be due to, among other things, the poor design of roof ventilators. In many factories artificial means of changing the air are needed to supplement the flow through natural openings. Other common defects are the inadequate removal of heat from furnaces, gas burners, and other sources, and the imperfect removal of fumes. The heating of some factories also leaves much to be desired, and more consideration should be given to finding the most economical and efficient methods of heating for each building. A more widespread realization is undoubtedly needed of the adverse effects, both on health and working efficiency, of ventilation and heating which fall below adequate standards.

Reduction of Fatigue and Monotony: Factory Seating

Facilities were given by an engineering firm to make a detailed study of a repetitive munitions job upon which an average of twenty girls were employed. A record of individual outputs in half-hourly periods, together with a daily report on working-conditions, sickness, and workers' attitudes, was obtained over a thirty-two-week period from 14th June, 1943, to 29th January, 1944. An investigator was present in the workroom during working-hours throughout this period. As the investigation proceeded, various changes were made. Periods of music were introduced to relieve the monotony of the job. These proved almost universally popular among the girls. Thanks are due to the National Broadcasting Service for lending the gramophone records used. To reduce fatigue, an adjustable factory seat, specially designed for the occasion, was introduced, and modifications were made to the benches, which greatly increased the comfort of the operatives. These changes were much appreciated. It remains to be seen what quantitative effect they will have. A great deal of information was collected during the process of this investigation, and this is now being analysed.

Arrangements are in progress for the manufacture on a larger scale of the factory seat designed for this experiment. Visits to factories of all kinds have revealed, even in factories where a good deal of attention has been paid to working-conditions and staff welfare, a very general weakness in the type of seating provided. There is a real need in New Zealand for an adjustable factory seat, built on posture lines, which is strong, inexpensive, and made of materials available in wartime. It is hoped the "Churton adjustable seat," designed by the Division, will go some way to meet this need. In those factories where preliminary models of this seat have been tried out so far, satisfactory results have been obtained. A pamphlet on factory seating is also in preparation.

II. Information

Bulletin

In pursuance of the policy of spreading information about the work of the Division and of industrial psychologists in other countries, it was decided to issue a brief quarterly bulletin, and to circulate this among the manufacturers, trade-union secretaries, and others directly concerned with industrial questions. Three issues of the bulletin appeared in 1943, each issue having a circulation of approximately five hundred.

Lectures and Addresses

A course of lectures on industrial psychology was given by Dr. Winterbourn at Canterbury University College, Christchurch. This was attended by an average of between thirty and forty persons, mostly members of the manufacturing community. A deputation was received by Dr. Winterbourn at the end of the course from a number of local manufacturers asking that the substance of the lectures should be written out and circulated. Arrangements have been made with the Director of Extension Work at Canterbury University College for the preparation of a discussion course in industrial psychology, which should meet this need.

During the course of the year addresses have been given by the Director to manufacturers' associations in Wellington and Dunedin, and to trade-union secretaries in the same cities. Addresses were given by Dr. Winterbourn and the Director to the annual conference of the N.Z. Vocational Guidance Association.

Contacts with Firms

During the year individual contact has been made with approximately one hundred and twenty manufacturing concerns in the Dominion. Without exception the receptions have been courteous, and in nearly every case the officers have been shown over the factory. Some factories have been visited several times, and in many cases on return visits it has been noted that improvements have been made, sometimes based on suggestions, sometimes spontaneously introduced by the firms. In some cases very great advances have been made on the initiative of the firms themselves, such as, in one firm, the installation of a complete medical unit with a trained nurse and a well-equipped first-aid room.

These visits have enabled officers of the Division to obtain an understanding of the problems confronting manufacturers and to pass on information likely to interest them.

Many contacts have also been made with trade-union secretaries, and every endeavour has been made to provide them with as much information as possible on those questions which they have raised.

III. Service

Under this heading the work has fallen into three main sections: (*a*) Investigations and other services for manufacturing concerns; (*b*) co-operation with the Government Vocational Guidance Centres: (*c*) Work for the Armed Services.

(*a*) *Investigations and other Services for Manufacturing Concerns*

Investigations have been carried out, or other services rendered, for eighteen manufacturing concerns during the year. In addition, individual reports on the ventilation of their factory buildings have been prepared and sent to eight firms which were amongst those providing facilities for research into factory ventilation and heating. It has been the policy not to undertake such investigations unless both the management and the union in question are agreeable. A brief summary of the investigations, which involved from half a day up to one month's work, follows:—

(i) *Biscuit-factory.*—Improved packing-benches with a view to reducing fatigue.

(ii) *Boot and Shoe Factory.*—A survey covering working-conditions, working methods, and personnel practices. Further investigation was recommended, and has been agreed to by the firm. This it is hoped to carry out next year.

(iii) *Box-factory.*—Advice about music during work.

(iv) *Canister-factory.*—A general report covering hours of work, lighting, load-carrying, design of work places, occupational misfits, supervision, first-aid; a second report dealing with ventilation. A suggestion that the bonus scheme be amended to remove inequalities was accepted.

(v) *Chemical Factories.*—(*a*) Vocational examinations of from two to three hours each were given to thirteen members of the managerial, office, and supervisory staff, and reports on each individual prepared.

(*b*) An account prepared of a very successful Works Committee. This account has been sent to an English journal for publication, and reprints have been circulated in New Zealand.

(*c*) Advice given in respect to certain aspects of a new layout, involving considerations of bench and seat design, methods of transport, the relation of benches to the natural light sources. These suggestions are now being carried out.

(vi) *Clothing-factories.*—(*a*) A general survey, and report covering lighting, colouring of walls and ceilings, floor surfaces, first-aid equipment, design of benches and seating, and ventilation.

(*b*) Constant contact has been maintained with this concern, and advice given on such matters as lighting and heating, methods of staff selection, methods of staff training, factory seating, &c.

(vii) *Engineering-factories.*—(*a*) An investigation into conditions of strain in employees. Slight reprimands, the whistling of men on the job, the grumblings of an old employee of over seventy years of age all seemed to have a greater irritating effect than they should. It was recommended that, as far as possible, hours should be kept below fifty-five per week; that as far as possible twelve-hour shifts should be avoided, that hours should be so planned, or other arrangements made, that the men all get at least one good meal each day. (Two scratch meals a day on four days a week are undoubtedly likely to cause ill health and strain if continued for a period).

(*b*) Reports on absenteeism and on ventilation. The report on absenteeism recommended steps for the reduction of fatigue, steps for the reduction of monotony, and an attempt to improve personnel relationships.

(*c*) Investigations into strained relationships among the girls employed in the office. Their quarrels were affecting the efficiency of the office and the relationships between the office and the works. All the girls were interviewed individually, and a satisfactory working arrangement was achieved without any of the girls having to be dismissed.

(*d*) Suggestions for improved design and layout of benches.

(*e*) A general discussion on personnel problems and working-conditions. This firm has, as a result, asked for a comprehensive survey to be made with a view to introducing improvements.

(viii) *Foodstuffs-factory.*—An investigation into the fatigue of girl workers engaged on food-preparation. Output curves obtained showed that the rate of work during the middle of the afternoon was 50 per cent. lower than at the beginning of the morning, a clear indication of fatigue and monotony. Fatigue was partly due to unsatisfactory design of benches and lack of adequate seating. Plans for new benches and seats were submitted. There was also some suggestion that poor heating was having an adverse effect on the output of the night shift during cold weather.

(ix) *Radio-factory.*—Measures suggested for coping with persistent lateness of staff.

(x) *Stationery-factory.*—Brief talk given to supervisory staff on methods of supervision and the duties of works supervisors.

(xi) *Woodworking-factory.*—An investigation into a high rate of absenteeism. The investigation showed that the high absence rate was mainly due to fatigue resulting from continued long hours, involving much work throughout the week-ends. Hours have now been reduced to fifty-three per week. Another cause of absenteeism was an alarmingly high accident rate, the equivalent of 50 per cent. of a staff of over one hundred men suffering from compensatible accidents within the year. An endeavour was made to persuade the management of the firm to establish a safety committee, with workers as representatives, and to appoint a part-time safety officer. Experience overseas has shown that these are necessary steps for an effective reduction of accidents. Unfortunately, the management could not agree to this, but rest pauses were introduced and other steps taken.

(*b*) *Co-operation with Government Vocational Guidance Centres*

Vocational guidance is closely linked to industrial psychology, and not unnaturally relations with the Vocational Guidance Centres have also been close.

In Christchurch arrangements have been made for Dr. Winterbourn to spend two half-days a week at the Centre to give psychological examinations to selected cases. Since this arrangement commenced at the middle of July some forty young persons have been examined and reported on. Dr. Winterbourn also planned a testing programme for primary-school leavers whose next step was causing the Vocational Guidance Officers some concern. The seventy-six examinations involved were carried out by voluntary workers, and the final recommendations made after joint consideration by the district Vocational Guidance Officer and Dr. Winterbourn.

Dr. E. Beaglehole has from time to time examined cases at the Wellington Centre.

In Auckland Mr. Churton has been elected to the Vocational Guidance Advisory Committee.

(*c*) *Work for the Armed Services*

Every endeavour has been made to give assistance to the Armed Services when requested to do so. On several occasions information has been supplied to both Army and Air Force about psychological work carried out in the Armed Services of other countries. There have also been carried out a number of practical investigations and experiments relating to the use of psychological tests for placement purposes involving the testing of about three hundred persons. One longer investigation involving a fortnight's field-work was carried out for the Army Education and Welfare Service and a report prepared.

IV. Relations with Other Bodies

In all investigations the relationships with the Manufacturers' Federation and manufacturers' associations have been close. The secretaries of the associations have been of considerable assistance in preparing the way for investigations and in giving introductions to firms.

Relations with trade-unions have been friendly, and trade-union secretaries have called attention to a number of problems for investigation. As stated in Section III (*a*), the policy has been not to undertake investigations unless both management and the union in question are in agreement on the desirability of the investigation.

The Division has maintained contact and exchanged reports and information with the Industrial Welfare Division of the Australian Department of Labour and National Service, and the National Institute of Industrial Psychology, London.

LEATHER AND SHOE RESEARCH

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

Leather Research Association

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

Standards for Sole Leather.—The difficulties attached to the formulation of standards for sole leather are great. Research workers in many countries, as well as in New Zealand, are attacking the problem from many angles. Up to the present little progress appears to have been made on the positive side, but the information obtained has increased the knowledge of the properties of leather. It will only be when this store of knowledge has grown sufficiently to fill in the necessary details that the problem of standards for sole leather will be solved.

Flexibility of Sole Leather.—The investigation of the factors affecting the flexibility of sole leather in both the wet and dry states, begun in 1942, was continued during 1943. Quality in sole leather is generally determined by feel, handle, and appearance in the dry state. Some people, however, judge quality by its feel and handle after being tempered in water. Factors affecting flexibility in both wet and dry conditions have been determined.

Field Trial.—A field trial on a small scale was made to determine whether any relation could be established between wet rigidity and actual wearing value. Thanks are due to the Army Department for their co-operation. As a result of tests in two military camps it has been demonstrated that there is no relation between wearing value and rigidity while wet. One set of soles which in the wet condition was twice as rigid as the other set wore equally well during the very wet winter of 1943. Another result from these trials was that some of the soles which wore out first were from the best part of the hides. The life of a sole is determined by the amount and type of abrasion. If the abrasion be concentrated by continuous wear under severe conditions, such as children continually running about on concrete playgrounds, or soldiers marching along shingle roads, then the life of a sole will be short. A life of three weeks or less may be a better performance under certain conditions than three months under other conditions. These field trials are still being carried out under drier and hotter conditions than was previously the case.

Abrasion Values of Sole Leather.—During the year further investigations have been made to determine whether it is possible to correlate wear values with abrasion values obtained on the abrasion machine. The results are not as yet far enough advanced to draw definite conclusions. Factors affecting abrasion values and abrasive index have been established, but it remains for the field trial to show whether these have any important relation to actual wear values.

Routine Work.—Checking of factory processes, raw materials, and finished leathers has, as usual, been carried out during the year.

Shoe Research Association

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

Sole leather tends to be a variable product. When once the bend is cut up and indications as to what position on the hide the soles have come from are lost, the question of quality or the establishment of standards of quality becomes very involved. The demand for lighter and still lighter soles for town wear, irrespective of the fact that wearing-quality is directly related to the thickness, places a very severe test on sole leather and on the grader of soles, who has only his own personal experience of feel, handle, and colour to guide him in his selection. Failures, which are not always avoidable, can be reduced if the general public will buy sturdier footwear for general use and not use footwear for purposes other than those for which it was originally intended.

Flexibility of Shoes.—For foot comfort to reach a maximum in a well-fitted shoe the latter should be as flexible as possible so as to impose the minimum amount of work on the foot muscles during the flexing of the shoe at every step. Shoe flexibility depends on the flexibility of materials and on methods of construction. An investigation is being made on the effect of method of construction on the flexibility of the shoe. When this has been determined it will be linked up with the results of the work on flexibility of sole leather carried out during the year.

Shoe-construction.—The importance of attention to details of construction, especially in connection with sole attachments in welt shoes and sandals, has been demonstrated during the year. When skilled labour and suitable raw materials are becoming scarcer, very good supervision is essential if quality is to be maintained. The full effects of the investigation into sandal-sole attachments will not be fully appreciated until stocks, which may or may not be defective from a constructional point of view, have been exhausted.

Factory Problems.—During the year many difficulties outside the scope of the Association's activities have tended to overshadow technical difficulties of less immediate importance. The value of the Association to the trade has again been confirmed by the confidence with which technical problems are submitted on a broader basis than before.

Circular Letters.—The monthly circular letters have maintained their reputation as a very valuable asset to the activities of the Association.

Pelt Research.—Though carried out on a much less extensive scale than formerly, pelt research is producing concrete results due to the institution of chemical controls in processes and the checking of the curing process in the finished pickled pelts.

MINERAL CONTENT OF PASTURES

INVESTIGATIONS AT CAWTHRON INSTITUTE

Field Trial at Sherry River

This trial was commenced in the spring of 1941 to compare the effectiveness of applications of 2 oz. and 4 oz. of cobalt sulphate per acre, the first amount to be given in each of two seasons, while the second was given only in the first season of the experiment. A plot treated in August, 1940, with cobaltized superphosphate and receiving no further applications of cobalt since that time was also available, together with a control area on which no cobalt had been used. While at the end of the first season the animals on the area top-dressed with 4 oz. cobalt sulphate per acre were slightly better than those on the 2 oz. area, at the end of the second season those on the 2 oz. area (with two applications at this rate) were better than those on the 4 oz. area. In both cases all the sheep on these two areas at the completion of the experiment in July, 1943, were in good health, all except one being in fat condition. Sheep on the cobaltized superphosphate area did the best of all. On the control area some losses occurred and surviving sheep were in poor condition. The following average live-weights at the end of the season illustrate the effects of the various treatments: Control, 69·8 lb.; 2 oz. cobalt sulphate per acre, 127·2 lb.; 4 oz. cobalt sulphate per acre, 114·4 lb.; and cobaltized superphosphate, 153·8 lb.

As a continuation of this experiment, another was begun in the spring of 1943 to run over two seasons to compare the effectiveness of 4 oz. and 8 oz. cobalt sulphate per acre applied only at the beginning of the trial. To date no differences in live-weight have been noted, although the sheep on the 8 oz. area have the better appearance.

Mowing Trial

(*a*) *Soil Analysis.*—Determinations of exchangeable base content of samples taken at 0–2 in., 2–4 in., and 4–6 in. from the plots receiving different fertilizers with or without magnesium compounds present and also with or without further applications of muriate of potash have been carried out. Complete sets of samples were taken on three occasions during the course of the experiment. The results of analysis show that on the experimental area there were great decreases in the exchangeable lime and magnesia contents with depth and a marked decrease in exchangeable potash. Increases in exchangeable ions following the applications of magnesium compounds or of potash have not been demonstrated with certainty in all cases.

(*b*) *Pasture Analyses.*—Owing to the large number of samples obtained during the mowing trials, composite samples have been used for the analytical work. Some appreciable differences in chemical composition have been noted in the various samples. For example, the application of the muriate of potash markedly increased the potash content of the pasture, especially in the second season. The nitrogen content was increased also, but this may be a secondary effect following the increased clover growth on the potash-treated plots. Potash also seemed to reduce slightly the magnesia and phosphoric-acid contents of the mixed pasture. The use of serpentine superphosphate and superphosphate with added magnesium carbonate or magnesium sulphate resulted in slight increases in the magnesia content of the pasture.

Pot Trial with Serpentine Superphosphate

A pot trial employing a sandy loam soil from Sherry River was set up to compare the effects of certain treatments:—

Treatment.	Relative Yields on Dry-weight Basis.
(i) Control (no manure)	100
(ii) Superphosphate	297
(iii) Basic super (made with $Ca(OH)_2$)	305
(iv) Serpentine superphosphate	403
(v) Superphosphate and serpentine, added separately in amounts equivalent to (ii) and (v)	375
(vi) Superphosphate plus limestone	320

Western Wolths was used as a crop.

These results show that the greatest growth of Western Wolths followed the use of serpentine superphosphate, the next best yield being given by superphosphate and serpentine added separately. The other phosphates gave essentially the same yields.

Samples of grass from these pots have been reserved for chemical analysis for observations on intake of phosphate.

MINERAL RESOURCES COMMITTEE

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

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

Clarendon Phosphate Deposits.—A geologist directed the prospecting and boring of these deposits during the year and estimated the depth and probable extent of the phosphate-bearing horizons in selected areas. A geological report discussing the origin of the deposits and summarizing the present knowledge of their quality and extent has been prepared for publication. There are indications that the phosphatic horizons may extend considerably farther afield than the Clarendon area.

Serpentine.—Known outcrops of serpentine in the Kaukapakapa district and some in the Wellsford district were geologically surveyed and bored to obtain information as to the available quantity of serpentine suitable for serpentine superphosphate. To date this work has disclosed that some 100,000 tons of suitable rock is available from reasonably accessible and workable deposits.

Clays.—Prospecting of ceramic and other refractory clays and of Fuller's earth was continued in North Auckland, Canterbury, Otago, and the West Coast under the direction of a geologist. By arrangement with the National Service Department, the services of University students were made available during the vacation to enable the field-work to be expedited.

A report on the fireclays of New Zealand by the Director of the Geological Survey was published as a departmental bulletin.

Limestone.—As opportunity offered, a geologist has been quantitatively examining and sampling limestone quarries and deposits in Southland. This work was undertaken at the request of the Limestone Controller to provide information as to the available resources of agricultural lime in that province. Limestone deposits in other parts of New Zealand have been reported on for similar purposes.

Chatham Island Peat-wax.—A comprehensive report on the chemical examination of wax extracted from Chatham Island peat was received from the Imperial Institute, London. This report stated that the Chatham Island wax had properties comparable with those of montan-wax, except that it contained a much higher percentage of asphaltic material, which would need to be reduced considerably before the peat-wax could substitute satisfactorily for montan-wax. The results of the quantitative surveys of the Chatham Island peat deposits, together with chemical work at the Dominion Laboratory and the Imperial Institute, have been published.

NEW ZEALAND WOOL MANUFACTURERS' RESEARCH ASSOCIATION

Director: Professor F. G. Soper

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

Non-shrink Treatments of Wool.—Work has continued through the year on improvements to the wet chlorination process for rendering woollen fabrics resistant to shrinkage, a process which has been operative in New Zealand for a number of years. The results which have been obtained by the use of the improved wet chlorination process represent a very great increase in the useful life of garments. Simultaneously with improvements to the existing process, the mills have, through the Research Association, continued to conduct tests on other non-shrink processes, and data have now been accumulated showing the effect of various treatments. Different non-shrink process give slightly different surface finishes to the wool fibre, and some are more desirable for certain uses than others. The work on the dry chlorination plant lent by the Wool Industries Research Association, England, has been extended to include the chlorination of tops, and experience has been obtained of considerable value to those members who intend to operate the dry chlorination process. This process is the one associated with the trade-mark "Woolindras" when the goods are processed in the United Kingdom.

On behalf of members, some hundreds of tests of shrinkage have been carried out through the year using the standard test machine which gives the effect of twenty to thirty average launderings.

Service to Members.—Investigations of interest to members continue. These have included dyeing problems, analyses of soap samples, of worsted lubricants, determinations of grease and of alkali in samples of scoured wool, and examination of wool-scouring effluents. Assistance has been given to the mills in setting up improved wet chlorination equipment, in the preparation of test solutions, and in the designing and equipment of mill laboratories.

Bulletins containing results of recent work are circulated to members.

Allied Research.—The location of the Wool Manufacturers' Research Association in the University of Otago buildings has stimulated research on wool-manufacturing problems by science graduates in the chemistry department. One such research has studied the chemical reactions which occur when mild alkali comes in contact with woollens which have been wet chlorinated and which have not been treated with the anti-chlor sulphite solution. The chemical action is to cause a very rapid splitting of the polypeptide links in the long chains of atoms which are characteristic of the wool structure, and this is paralleled by a loss in strength of the material.

Influence of Hairiness on Processing.—The vertical set-up of the New Zealand wool-manufacturing industry renders manufacturing trials possible which would be difficult in the more highly-specialized and horizontal set-up of Great Britain.

The trial, for which a grant was made to the Association by the New Zealand Wool Council, had as its object the determination of the effect of a known degree of hairiness in wool on its processing properties. A test has been completed using 48's quality, and a report will shortly be published. Wool of 56's quality is now being collected for a further trial.

PLANT CHEMISTRY LABORATORY, PALMERSTON NORTH

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

Vegetable Dehydration.—Research has continued on the suitability of different varieties of vegetables for dehydration. Satisfactory results have now been obtained in the dehydration of peas and beans. Tests are being carried out to determine the storage life of dehydrated vegetables and the vitamin retention on storage, at room temperature and at elevated temperature. Daily samples are received for examination from the dehydration factory at Hastings, which has now been in full production for a year. Particular attention is being paid to the moisture content and the vitamin retention as well as to palatability.

Tests show that a high-quality product is being made. In addition to the dehydration of vegetables, investigations on apple dehydration have been made in this Laboratory, which formed the basis of dehydration on a commercial scale at Hastings. The factory is now in full production. A problem closely connected with dehydration is the determination of vitamins in plant materials. Methods have been adapted for carotene, ascorbic acid, thiamin, riboflavin, and nicotinic acid. These methods can now be used for routine determinations. The necessity of a convenient, accurate, and rapid method for measuring the moisture content of dehydrated material has led to an investigation of different methods. Wide variations in apparent moisture content as determined by various methods have been observed, and this is subject to further investigation.

Vitamin Extraction.—The production of sweets from parsley concentrate gave a very palatable sweet, but the loss of ascorbic acid in manufacture was high, about 50 per cent. being lost in the cooking. Attempts are to be made to produce a soft sweet at a lower boiling temperature. Spray drying of parsley extract was not successful on account of the hygroscopicity of the final product, although its ascorbic-acid content was high. The preparation of a palatable B-complex concentrate from waste brewer's yeast has proved successful, and large-scale production is planned. Lack of suitable equipment in the meantime has led to the production of a much less palatable product which can, however, be used for therapeutic purposes.

Silage and Pasture.—In collaboration with the Grasslands Division, investigations on silagemaking and pasture-production have continued.

General.—A method is being worked out for the determination of fructose in the presence of large quantities of glucose. Some success has already been achieved.

PLANT RESEARCH BUREAU

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

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

—	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 Division	Owairaka, Auckland	Dr. G. H. Cunningham.
Sugar Beet Section	Lincoln	†Dr. O. H. Frankel.

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

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

AGRONOMY DIVISION, LINCOLN

Acting-Director: Mr. R. A. Calder

The chief aim of the Division is to develop and make available improved types of arable crops, and the advance to this objective is along three main approaches—crop-introduction, plant-breeding, and pure-seed production. During recent years, however, long-term investigations have been suspended and the main effort has been directed towards the raising of pure seed of both farm crop and herbage species.

Approximately 63 acres have been under crop during the past season.

Wheat

To provide pure and relatively disease-free seed for distribution under certification, the production of nucleus reselected stocks raised from hot-water-treated seed is a routine procedure, and during the past year the following varieties were grown: Cross 7, Solid Straw Tuscan, Fife Tuscan, Hunters II, Dreadnought, Tainui, and Marquis.

The produce from the Division is increased mainly by Lincoln College and is distributed as certified wheat.

Oats

Although for some years now the acreage sown in oats has shown a steady decline, the crop is still of sufficient importance to warrant efforts directed towards its improvement; selection, hybridization, and the testing of new introductions are the methods adopted at the Division for this purpose.

The development of reselected lines of Garton's Abundance and Algerians is now in the final stages, and increase areas of each are to be grown this coming season.

Several seventh-generation selections from a cross between Resistance and Onward were grown in a replicated yield trial; some of these show promise of being good milling types, but further testing is necessary. S.17, a selection from a cross between Garton's Abundance and Ruakura, was grown at Lincoln College and on neighbouring farms, and its behaviour confirmed the opinion that it is a satisfactory early chaff oat.

The following introductions were again grown for trial and increase:—

Victoria × *524;* obtained from Canada and now called Achilles; is highly resistant to leaf and stem rust and gives a high yield of good-quality grain of the Algerian type:

Binder; obtained from Holland; is a high-yielding, good-quality milling oat with short, stiff straw:

Line 834; obtained from Belgium; is a high-yielding, good-quality milling oat.

Barley

Both the two-row malting barleys and the six-row feed barleys are under consideration, the work being concerned mainly with the testing of new introductions and the selection of single plants of the most promising as the basis of future nucleus lines. Increase areas of the best two-row types are being grown by the Canterbury Seed Co. with a view to full-scale malting trials when sufficient seed is available; Newal, the smooth-awned feed type obtained from Canada, was increased both at Lincoln College and at the Division.

Garden Peas

Garden peas for seed are grown largely for export, and thus a high standard of varietal purity is required. The Division undertakes the production of reselected stock which is grown on contract for merchants, and during the past season the following varieties were propagated: Greenfeast, William Massey, Onward, Little Marvel, and Harrisons Glory.

The new variety, "Greencrop," developed from a cross between Greenfeast and Greatcrop, was increased by the Department of Agriculture for distribution to merchants; a nucleus area was also grown at the Division.

Approximately one hundred selections from the cross (Greenfeast × Greatcrop) × William Massey were grown for observation and further selection, the object being to isolate a high-yielding early variety.

Field Peas

The main field pea types grown in New Zealand are—

(*a*) *Partridge.*—Used either for stock-feed, for pigeon-feed, or for splitting for soup;

(*b*) *Blue.*—Used chiefly for boiling purposes; and

(*c*) *White.*—Used almost entirely for splitting.

(*a*) *Partridge Peas.*—A renewed effort is being made to develop an improved Partridge type, and of the hybrid material grown for observation during the past season Partridge × White Elephant and Partridge × Black Eyed Susan show promise.

(*b*) *Blue Peas.*—Approximately 2,000 bushels of Mammoth Blue (Blue Prussian × Harrisons Glory) were distributed; a mother-seed area was grown by the Department of Agriculture and a nucleus area at the Division.

(*c*) *White Peas.*—Approximately 300 bushels of White Prolific (Blue Prussian × Greenfeast) were distributed and a mother-seed and a nucleus-seed area were grown by the Department of Agriculture. Mammoth White (Victoria × Stratagem) has not yet been released.

Rape

Sufficient certified rape-seed for all local requirements is now produced annually under the supervision of the Department of Agriculture. Reselected stock is raised at the Division, and during the past season nucleus- and mother-seed areas of both the Giant and Broad Leaf Essex types were grown. A small nucleus area of a new type developed from a cross between Giant and Broad Leaf Essex and now called B.L.E.H was also propagated; this is to be released shortly.

Kale

The two marrow-stem kale types developed at the Division have now been named "Giant" and "Medium-stemmed," and seed stocks, increased under the supervision of the Department of Agriculture, will be available commercially this coming season. Nucleus- and mother-seed areas were again grown. A considerable amount of hybrid kale material is under observation, and some promising crosses are marrow-stem kale × thousand-headed kale, marrow-stem kale × cabbage, and marrow-stem kale × kohl rabi.

Swedes

Owing to the difficulty experienced in over-wintering selections successfully at Lincoln, only a limited amount of breeding-work on swedes has been undertaken. A new type, however, selected from a cross between Grandmaster and Sensation has given indications that it might be a satisfactory type for Canterbury conditions; it is a deep-rooted, somewhat fangy, yellow-fleshed swede. A small increase area is being grown this year in Central Otago to provide seed for large-scale trials.

Sweet Lupins

Nucleus areas of sweet blue and sweet yellow lupins are grown each year, and single plant selections have been made with a view to improving the fodder-production per acre. Great difficulty has been experienced in judging the value of individual selections because of extensive damage caused by hares and birds, which, in common with other live-stock, seem to find them extremely palatable. Fencing against hares, and netting against birds until they are 8 in. to 10 in. high, is apparently not sufficient for small plots, because, when the bird-netting was removed at this stage, birds trimmed back the leaflets almost to the petioles, and then ate all the main-stem flower buds from one selection block 11 yards square, although this was in a 2-acre block of sweet blues. The relatively high incidence of mosaic in the selections compared with the main block increases the difficulties of selection. It is suggested that birds may be the agents for distributing the virus, since aphids have not been found on them, and the Plant Diseases Division have failed to transmit the disease experimentally to lupins with thrips.

White-flowered mutants found in a crop of sweet blues have been grown on, and have proved to be low in alkaloid. These are being grown on again for comparison with the sweet blues for fodder-production and alkaloid content. If equal in these respects, their potential value lies in the fact that the difference in flower colour would greatly simplify certification in the future.

Linen Flax

Pure-seed Production.—Nucleus areas of Liral Crown, Liral Prince, and Stormont Cirrus were grown during the past season. In all cases the seed sown was hot-water treated to free it from disease. A continual output of seed raised from single plant selections appears to be a matter of the greatest importance to the industry, for the following reasons:—

(i) The present improved varieties are of very recent origin and are not fixed:
(ii) High seed-production appears to be antagonistic to production of high quantity and quality of fibre:
(iii) In a mixed population the high-seed-producing plants must rapidly increase in numbers in relation to those that produce few seeds but much and good fibre. Therefore, continual selection of fibre types is essential.

Variety Testing.—This is being continued on a diminished scale, because the varieties Liral Crown, Liral Prince, and Stormont Cirrus (in order of increasing value) appear to be as good as anything in sight, and seed of these is being increased as rapidly as possible for distribution. Further, it is believed that any improvement must be in the direction of resistance to disease.

Breeding.—The dominant requirement is for a variety that is resistant to rust. Rust seems likely to be a serious limiting factor in flax-production, and is, so far as one can judge at present, by far the most important disease in the country. Other diseases that must be considered in any programme of breeding for resistance are browning (*Polyspora lini*), wilt (*Fusarium lini* and possibly other fusaria), seedling blight (*Colletotrichum lini*), pasmo (*Sphaerella linorum*), and *Phoma* spp.

Many crosses have been made between the best fibre varieties and Rio, a seed variety that is immune from rust and highly resistant to browning and wilt.

None of the first crosses appear to be worth considering as a fibre flax. Some back crosses to fibre varieties made last season are at present under test by the Plant Diseases Division, and if satisfactory from the disease point of view will be further tested for fibre-production. Many additional back crosses have been made this season, and will be tested next season.

Manurial Trials.—Advice received from England strongly suggests the possibility that microscopic examination of sections of flax stems and/or fibre specimens may be a valuable guide to fibre quality. With this in view a series of field plots were laid down to test the effect on quality of N, P, K, Ca, boron, magnesium, and manganese. Unfortunately, the season was so dry that growth was extremely poor and the average height of the plots at harvest was only 14 in., so that no useful results can be expected.

A further experiment was laid down in pots in a glasshouse, using two parts of soil to one part of quartz sand, and the same nutrients as above. An additional pot trial was laid down using pure washed quartz sand, and the same nutrients plus sodium chloride, zinc, copper, and iron. The results are not yet available.

Weed Control.—In the variety trial twenty-six plots were sprayed with a 2 per cent. Sinox (sodium dinitro-ortho-cresylate) solution at approximately 100 gallons per acre, and four plots were left unsprayed as a control. The plots were drilled on the 15th November, the spray applied on the 6th December, and counts were made of the number of plants per foot of row on the 23rd December. There was no reduction in the number of plants in the sprayed plots compared with the controls. The control of fat-hen, on the other hand, was most striking. By harvest, a considerable number of weeds had appeared in the sprayed plots from germination after spraying, but the extent of control can be gauged from the total crop yield of 20·2 cwt. per acre on the sprayed plots, compared with 11·2 cwt. on the unsprayed plots.

Sinox has no toxic effect on the ground (this is confirmed by other experiments here and by American reports), and thus will not prevent the development of weeds that germinate after spraying. Unfortunately, in heavily-infested land fat-hen continues to germinate throughout the season, so that complete control by spraying cannot be expected. Nevertheless, the advantage to the crop of freeing it from weed competition in the early stages is so great as to make spraying with Sinox an essential part of our flax-production programme.

The cost of materials for spraying at the above rate works out at £1 5s. per acre.

Linseed

Work on linseed has been limited to developing a pure line of Rio from the Division's rather mixed material by single-plant selection, and to producing an equally disease-resistant variety but with longer straw by crossing it with long-strawed fibre varieties.

Forty-five varieties and selections from Australia were grown in a nursery for observations on disease resistance. Unfortunately, from this point of view, the season was not favourable, and no disease developed.

Lucerne

Intensive breeding-work on lucerne has been temporarily suspended and efforts have been directed mainly to testing and increasing the first pedigree strain known at present as Strain B. Favourable reports on the behaviour of this strain have been received both from within New Zealand and from overseas. A seed-increase area of approximately 10 acres was grown during the past season by Lincoln College.

Additional observations were recorded on the spreading species, *Medicago glutinosa*, and selections were made for the development of a mass selected strain.

Potatoes

An Empire collection of potato species from South America is at present being studied in detail at the Potato Research Station at Cambridge, and until tested material is available from this source no further breeding-work is being undertaken. Trials are still being carried out, however, with the most promising lines derived from crosses between commercial varieties and various South American species obtained some years ago from a Continental collection; a few of these are giving high yields of good-shaped tubers.

Mangels, Carrots, Chicory, Coriander, and Beans

Small seed-increase areas of Yellow Globe mangel, of Holmes Improved carrots, of chicory, of coriander, and of three varieties of beans were grown for seed-production.

Rye-grass and Clover

On behalf of the Grasslands Division, Palmerston North, 4 acres of short-rotation rye-grass, 2½ acres of Italian rye-grass, 2½ acres of perennial rye-grass, and 2 acres of broad red clover were grown for seed. For the coming season 5 acres of short-rotation rye-grass, 4 acres of Italian rye-grass, 2½ acres of perennial rye-grass, 1 acre of timothy, 1 acre of broad red clover, 1 acre of Montgomery red clover, and 1 acre of white clover have been sown down.

BOTANY DIVISION

Director: Dr. H. H. Allan

Identification and Advice

Over one thousand six hundred specimens were reported on from the usual sources, schools accounting for 50 per cent. Special interest was shown in seaweeds, possible rubber plants, dye plants, and fibre plants. Several new records were made, and further information on distribution obtained. Advisory work covered a wide range of topics, mainly concerning plants of economic importance.

Herbarium

Over two thousand sheets were added to the general herbarium, including large collections of grasses and weeds. Mr. Geo. Simpson, Dunedin, contributed a very full set of *Carmichaelia* specimens and type specimens of recently-described species. Several important extensions of range were noted for indigenous species. To the cryptogamic section (seaweeds, lichens, liverworts, mosses) some three thousand sheets were added, making this a very strong reference collection. Mr. G. O. K. Sainsbury and Mrs. E. A. Hodgson very kindly made or checked identifications of mosses and liverworts. These collections will be of increasing use for work on grassland and forest ecology. The seed herbarium has been augmented by both local collections and overseas exchange. We have to thank the Director of the Auckland Museum for the loan of their seaweed herbarium, and the Director of the Dominion Museum for the loan of groups under study. Much critical work has been done on grasses, sedges, seaweeds, and alien weeds.

Plant Introduction

Seed samples of strains of broomcorn, Russian dandelion, hemp, and roses (with high vitamin content) have been received from overseas. Edible shrubs and range grasses have been received from South Africa and the United States of America for trial in the tussock grassland experimental areas. Cuttings of athel tree (*Tamarix aphylla*) received from the manager of the Zinc Corporation mine at Broken Hill have been satisfactorily struck.

Fibre Plants

(*a*) *Phormium*.—Routine work on the experimental area has been continued, but no trials are yet ready for sampling. A considerable quantity of nursery stock has been raised and further seed harvested, especially of the varieties 56 and 37. A programme of work on yellow-leaf disease has been planned jointly with the Plant Diseases Division and the Soil Survey Division, and the botanical experiments commenced. Multiplication of stocks of white-butted flax is proceeding.

(*b*) *Hemp*.—Last season's trials showed a production of stook-dried material of from 12,000 lb. to 13,000 lb. per acre. The yield was reduced by unevenness of the crop and severe weathering. Material for fibre trials had to be taken from the plants threshed for seed. The percentage of fibre from retted material was 17 (nearly 8 per cent. from green material). Fibre sent for appraisal was favourably commented on; fibre from material harvested at the normal period was weak and discoloured owing to mildew, but fibre from female plants used for seed-production was reported on as of similar quality to the best of that imported prior to the war. Small trials made in various localities were disappointing, largely owing to attack by birds. The present season's crop has been retted.

(*c*) *Cabbage-tree Leaf*.—Retted material was reported on as good for fibre-board manufacture. It was not found possible to arrange for a trial of stripped material. It was demonstrated that methods could readily be devised to propagate cuttings vegetatively and establish a stand.

(*d*) *Linen Flax*.—General botanical and anatomical work was intensified, an officer being stationed for a period at the Linen Flax Experimental Factory, Washdyke. A full series of sample sheaves from a number of crops has been sectioned for a thorough analysis of the value of anatomical evidence as regards importance of varieties, times of harvesting, soil conditions, and improvement of strains, and relation to field conditions generally.

Seaweed Utilization

(*a*) *Agar.*—Surveys during 1943 showed extensive reserves of agar seaweed between Cape Turnagain and Castlepoint, as yet little collected. *Pterocladia lucida* is in fair quantity at Kaikoura, and in Taranaki useful amounts, especially of the smaller *P. capillacea*, can be obtained. The total weed collected in 1943 was over 70 tons, about half coming from the Bay of Plenty, a quarter from Hokianga (a new district), and the remainder from the East Cape, Southern Hawke's Bay, and Coromandel areas. At least two hundred families are involved in collecting agar seaweed as a profitable side-line. Manufacture of agar began in July, 1943, and the product is being used for culture media and for meat-canning. For both purposes the agar is quite satisfactory, being characterized by good colour, high gel strength, low ash content, and rather high melting-point. It has been favourably reported on by manufacturers of condensed milk, cosmetics, and pharmaceutical preparations. The product is standardized for sale, but there are irregularities in the weed, and the botanical basis of these differences is being investigated. Spore-production has been found to be continuous throughout the year, so that there appears to be no objection to harvesting at whatever season fits best in the local routine. A smaller weed, *Gelidium caulacanthum*, submitted for test yields a satisfactory agar. Local supplies of *Gracilaria* are being explored, as this weed, though more difficult to deal with than *Pterocladia*, yields a low-melting-point agar that is needed for certain shake cultures. Contact is being maintained with agar-workers in other countries, where, except in California, more difficulties seem to be encountered than in the local project.

(*b*) *Carrageen.*—New Zealand requirements for industry are being met satisfactorily from local sources, but inquiries about domestic and culinary use are still numerous. Known sources could supply many times the present demand.

Weed Investigations

General.—Survey work during the year has given special attention to weeds of tobacco and linen-flax crops, and to tussock-grassland and forest-pasture weeds. Cape tulip (*Homeria collina*), native to South Africa, is recorded for the first time in New Zealand. This plant causes serious stock-poisoning in parts of Australia, and has come under suspicion in the area in which it occurs in this country. Some 4 acres are known to be infested in Marlborough with odd plants on the adjacent hillsides to a distance of over two miles. The presence of a variety of salt-root (*Salsola kali*) was noted in 1920 in Central Otago by the late Dr. Cockayne, but was not recorded. While so far not proving aggressive, this weed should be watched carefully in view of experiences in Canada and the United States. The coastal variety, recorded as early as 1854, gives no trouble.

Nassella Tussock.—A survey has been made of an hitherto unrecorded infestation in the Black Hills-Medbury-Kaiwarra River area in North Canterbury. From 150 acres to 200 acres are heavily infested, some 2,000 acres have a medium infestation, and roughly 22,000 acres have scattered plants. An area is being studied in Marlborough where the tussocks appear to be dying off. Definite evidence was obtained of seeds being carried by wind and deposited some six miles from the nearest source of infestation. Trial plots have been laid down to ascertain the effects of (1) firing at different intervals; (2) value of different weed-killers.

Poisonous Plants

Material of the following species has been supplied to the Animal Research Station, Wallaceville, where feeding tests are being conducted: Pigeonwood (*Hedycarea arborea*), akakiore (*Parsonsia* spp.), tawa (*Beilschmiedia tawa*), mahoe (*Melicytus ramiflorus*), titoki (*Alectryon excelsum*), five-finger (*Nothopanax arboreum*), monkey-musk (*Mimulus guttatus*), rangiora (*Brachyglottis repanda*), and kohuhu (*Pittosporum tenuifolium*). Pigeonwood and tawa proved definitely toxic to rats, while kohuhu and akakiore remain doubtful.

Medicinal Plants

(*a*) *Atropa belladonna.*—Plants raised in cold frames, hardened off, and transplanted in spring or early autumn establish successfully; direct sowing gives, in general, unsatisfactory results. Dull or wet weather depresses the alkaloid content, hot sunny days being best for harvesting. Upper leaves are highest in alkaloid content (0·39 per cent.) as plants complete flowering; the large lower leaves are low in alkaloid content except when the plant is mature (content then rising to 0·20 per cent.). Liquid manure decreased yield of leaf significantly, but the assay was higher (0·60 per cent.; control, 0·43 per cent.). Sulphate of ammonia increased yield but lowered assay (0·34 per cent.). Nitrate of soda and blood and bone gave no significant results. Selection work suggests that high alkaloid content may not be inherited. Individual plants showed a range of 0·1 per cent. to 1·0 per cent. total alkaloids; the general harvest figures are 0·25 to 0·4 for leaf, and 0·33 to 0·4 for root.

(*b*) *Digitalis.*—*D. purpurea* experiments showed that temperatures of 210° F. cause a significant reduction in glucoside content. High-temperature drying, up to 180° F., is now recommended overseas. *D. lanata:* Rosette leaves yielded 0·5 per cent. to 1·0 per cent. total glucosides. Yields have exceeded 1 ton of dry leaf per acre, and it appears likely that this species will replace *D. purpurea* owing to the easier estimation and the higher glucoside content.

(*c*) *Datura stramonium.*—Seed drilled in late spring, plants thinned to 3 ft. apart each way, gives satisfactory results. Analyses indicate that alkaloid content is highest as the last flowers are opening. Five acres at Hastings failed to set a single capsule, the leaf assay being very high (0·60 per cent.; B.P. 0·25). Selection work indicates same position as obtained for belladonna. Heavy applications of liquid manure reduced alkaloid content (0·39 per cent.; control, 0·50). Blood and bone and sulphate of ammonia gave no significant differences. Drying at 200° F. did not significantly reduce alkaloid content as against drying at 140° F. (0·42 per cent.: 0·45 per cent.). The yield of dry leaf of the "Wellington" type is about 1,500 lb. per acre. Large lower leaves of mature plants tested 0·27 per cent., the flowering tops 0·45 per cent.

(*d*) *Hyoscyamus niger.*—The annual type tested satisfactorily when harvested at an advanced stage. The biennial type suffered badly from virus.

(*e*) *Papaver somniferum.*—The Indian type is frost-tender and very subject to bolting if planted late in the spring. Total alkaloid content, 0·28 per cent. The Chinese type is frost-hardy, can be autumn-sown, and overwintered if the soil is well drained. The yield was about 1 ton of capsules per acre, and the total alkaloid content from 0·35 per cent. to 0·52 per cent.

(*f*) *Ricinus communis.*—Yields of good-quality castor-oil have been obtained, varying between 43 per cent. and 57 per cent.

(*g*) *Mentha piperita.*—The strain grown yielded 0·72 per cent. of peppermint-oil, deficient in esters and menthol.

The analyses quoted were carried out by the Dominion Laboratory on samples harvested by the Division.

Vegetable-seed Production

(*a*) *Beetroot.*—Seed glomerules were vernalized for fifty-five, forty-five, thirty-five, twenty-five, and fifteen days. These were sown simultaneously with untreated glomerules on 1st October, 1943. At Waiwhetu, Lower Hutt, the percentages of seeders in the different treatments counted on 1st March were 50, 75, 57, 66, 40, and control 10 respectively. At an area near Blenheim the percentages were 92, 44, 56, no test, 12, and control 5 respectively. Methods for a more satisfactory control of moisture during vernalization are being studied.

Beetroot plants in the cotyledon stage were treated for forty and twenty days at 3° C. in nursery flats and planted out with untreated controls. There was a heavy mortality in the forty-day treatments, and these were discarded. The twenty-day treatments yielded 100 per cent. seeders, and the control series none. The bulb development in the majority of the trials was excellent.

(*b*) *Cabbage.*—Seed and plants (at the cotyledon stage) of four varieties were pretreated before sowing. Only one type responded to the plant treatment. Results: Forty-day treatment, 30 per cent. seeders; twenty days, 15 per cent.; ten days, 13 per cent.; control, nil.

(*c*) *Lettuce.*—Seed of a cabbage type was vernalized for twenty days at 50° C. Results: The Waiwhetu plot was attacked by soft-rot and no results were obtained. At Blenheim the treated group were in full flower (at the date of examination) and uniform in development; of the controls, 50 per cent. were in the hearting stage, the remainder unevenly developed in the flowering stage.

Russian Dandelion

Four plots were established in co-operation with the Department of Agriculture and the Cawthron Institute. The plots were planted with seedlings from seed sown in mid-November (this proving rather late). The results for rubber content at the end of the first growing season were: Hastings, 1·5 per cent. (of green weight); Nelson, 1·6 and 1·8; Waiwhetu, 2·4. One half of the Nelson plot received 300 lb. per acre of superphosphate, the other half 500 lb. of "tomato" fertilizer. This plot produced the heaviest yield, estimated at 245 lb. and 279 lb. of rubber per acre. Growth on the other trials at various places in New Zealand was too poor for significant results to be obtained. A good harvest of seed has been obtained, especially from the Waiwhetu plots. Only one small area was successfully established from direct sowings. Failure in other plots appears to be due to a combination of causes: too deep burial of seed, poor water-retaining capacity of soil, dry weather immediately after sowing. Solution of the difficulties involved in direct sowings is crucial to the development of Russian dandelion areas.

Teasel

Some fifty thousand heads were harvested from the small trial area. Samples were reported on as being of good quality. It has been demonstrated that teasel of satisfactory quality of the different sizes required by the trade can be grown without difficulty in New Zealand.

Tussock-grassland

The experimental areas selected at Molesworth, Tekapo, and Te Akatarewa are now rabbit-proof fenced. Vegetational survey of the Molesworth plot has been completed, and is in progress on the remainder. A further area near Dansey's Pass is projected. Transect and quadrat studies will be made, as well as experimental sowings of native species and from the material obtained overseas. The Pisa Flat experimental area and the "Cockayne" plots on the Dunstan Range were examined and reported on to the Department of Agriculture. A joint programme for further work is being arranged. In the Pisa Flat area certain exotic grasses show distinct promise. On the Dunstan plots the growth of tall oat-grass, yarrow, *Poa pratensis*, zig-zag clover, and Chewing's fescue is noteworthy, as is the decline in the cover of lucerne.

Erosion

An examination of the Onetapu desert area gave evidence that the erosion there is mainly natural, due to the action of strong wind on the light volcanic ash cover. Large areas on the western side of the divide between Ruapehu and Ngauruhoe are affected by vigorous wind and water erosion, in part accentuated by tracks made by man and animals. The almost completely barren area now covers some 10 square miles and is expanding. Work is in progress on slipped areas in the Orongorongo and adjacent areas. Some streams on the western side of the Tararua Range have been traversed, with a view to selecting a drainage area for intensive study. Work on the experimental tussock-grassland areas is proceeding.

Camouflage

Advice on botanical aspects was given to the Army authorities. Experiments on fire-proofing manuka and other material yielded a method that gave very satisfactory results.

ENTOMOLOGY DIVISION, NELSON

Director: Dr. D. Miller

Diamond-back Moth (*Plutella maculipennis*)

Completion of field surveys of cruciferous crops throughout the Manawatu, Rangitikei, Hawke's Bay, and Masterton areas in the North Island, and Marlborough, Kaikoura, North and South Canterbury, and as far south as the Taieri Plains in the South Island, show that, over the whole of the area covered, both species of parasites (*Angitia cerophaga* and *Diadromus collaris*) are well established and for the most part are exercising a very good control over the diamond-back moth.

Details of the survey have yet to be completed, but it can be said that the degree of control attained in the North Island has this year, at any rate, reached a high peak of efficiency. The survey in the South Island, however, while a good control of the moth is revealed, shows that the same degree of success has not yet been reached as in the North. The explanation of this difference at the present time is perhaps the fact that the parasite liberations commenced two years earlier in the North than they did in the South Island. With our present knowledge of the position, however, there does not appear to be any reason why control should not eventually reach the same degree of perfection in both Islands. This feature will be elucidated by the future annual surveys.

The above facts are in relation to farmers' crops and do not refer to the home garden, where cruciferous crops grown for home consumption require a greater degree of protection from insect attack, and where insecticides must be used.

Consignments of *Diadromus collaris* have been sent to the Government Entomologist at Suva for use against the diamond-back moth in Fiji.

Cocksfoot Stem-borer (*Glyphipteryx achyloessa*)

Considerable progress has been made with the researches into the biology of this insect, the larvæ of which extensively infest the stems of cocksfoot in the seed producing areas and elsewhere in New Zealand. As far as can be ascertained, the insect is a native species. Apart from cocksfoot, other hosts include four species of native grasses (two of which are the hard and silver tussocks), nine introduced grasses, and, to a small extent, wheat.

The infestation of a cocksfoot crop varies according to the locality in which it is grown and the age of the area. In Ashburton and Banks Peninsula very high infestations are found in the old areas, showing a percentage of 50 to over 70. In Rangiora, where the areas are more scattered and younger, the maximum infestation was 37 per cent., whereas in Timaru the highest infestation found in a sampled field was 16 per cent. On the whole young stands were found to be more lightly infested in comparison with the older ones. In Eiffelton a young paddock was sampled in 1943 and again, using the same method, in 1944, when the infestation was found to have increased from 12 per cent. to 29 per cent. A twelve-year-old area was also sampled and the infestation in 1943 was 86 per cent., while in 1944 it had dropped to 62 per cent. This drop in the older paddock may have been due to variation in climatic conditions at the time that the moth was active.

The moths are on the wing during September and until November, and place their eggs on the blades of cocksfoot near the base of the plants. The incubation period is from nineteen to twenty-two days. Though some of the young larvæ enter directly into the cocksfoot stems, most of them first burrow in the supporting tissues, thus cutting the majority of the scattered vascular bundles. This encirclement of the stems is the cause of injury to the seed-head, the heads of damaged stems often assuming a whitish appearance.

After encirclement is complete, the larvæ enter the hollow interior, where the remainder of the cycle is completed. At first most of the larvæ migrate upwards, and then descend when the cocksfoot ripens. During autumn, 75 per cent. of the larvæ were found below the crown in the underground tiller of the plants. Later, in winter and early spring, they again ascend, and pupation commences during July.

Experiments are being carried out with the object of ascertaining whether any measure of control can be secured by cutting the stubble at varying heights at different times of the year. Inquiries overseas have failed to secure any data on parasites that might be of use against the cocksfoot stem-borer.

Cheese-mites Research

The survey of cheese-mites in cheese-factories has brought to light additional information. It has been found that the constitution of mite colonies differs specifically in different factories. As the species differ in their physical reactions, information is being sought on the factors determining the incidence of each species. These observations are being carried out both in the factory and laboratory. The morphological taxonomic characters of all stages of each species have been studied, together with the duration of development of each stage of each species. These data are fundamental in the application of control measures.

The control of cheese-mites and the protection of cheese against them has been investigated. In this the influence of waxes, dusts, and fumigants has been studied. The experiments with waxes and dusts have shown that a measure of control and protection can be secured. In regard to fumigants, these have given promising results under some conditions.

The fumigants experimented with were ammonia, carbon dioxide, methyl bromide, and dichloroethyl ether. The first two proved unsuitable. Methyl bromide was found to be effective, but has certain disadvantages, and in searching for other substances it was decided to try dichloroethyl ether.

Though this substance has been experimented with as an insecticide against wireworms, woolly aphis, and as a glasshouse fumigant, it had never, until the present occasion, been used as an acaricide. The results of the experiment have been extremely satisfactory so far, in that the dichloroethyl ether has been found to be highly toxic to the common cheese-mite, *Tyroglyphus siro*, even at extremely low concentrations. For example, a concentration of 0·046 lb. per 1,000 cubic feet of air space gave 100 per cent. kill of the mites after twenty-four hours' exposure at 70° F. and 80 per cent. relative humidity. It was also found that timber such as shelving, crating, &c., which comes in contact with cheese, if treated with dichloroethyl ether, gives a very definite measure of protection to the cheese.

Another point considered is the effect of the acaricide on the cheese itself. A cheese kept for six weeks in an atmosphere saturated with dichloroethyl-ether vapour presented no foreign flavour in the interior of the cheese and only a slight off-flavour in the rind. Other cheeses were exposed to the vapour for shorter periods and no foreign flavour could be detected.

This work is being extended in order to procure more detailed and conclusive data.

Linen Flax

An investigation was carried out into certain physical factors that influence the presence of the mite, *Tyroglyphus farinae*, on flax-seed. Experiments indicated that (apart from effects on germination) if seed moisture is the factor determining the presence of mites, then the seed should not be stored under cool, but under higher, temperatures.

Damaged Pasture

An Australian species of fly, *Metoponia rubriceps*, was found breeding in large numbers in damaged pasture at Opotiki. Though this type of insect is not generally found to be injurious, observations in Australia reveal that the larvæ of *M. rubriceps* insert their mouth parts into, and apparently draw nourishment from, the roots of certain pasture plants.

Grass-grubs (Odontria spp.)

A comprehensive investigation has been inaugurated into the grass-grub problem in New Zealand. The biology, ecology, and systematics of the species are being studied as a preliminary to developing means of control by cultural methods (if possible), and by parasites. So far the only parasites in New Zealand are certain species of tachinid flies, but steps have been taken to ascertain what species of Australian parasites, of types not present in New Zealand, could be of service in the solution of the problem.

GRASSLANDS DIVISION, PALMERSTON NORTH

Director: Mr. E. Bruce Levy

Despite shortage of labour and technical assistance and dearth of specialist supervision, the work of the Station has been well maintained. The season has been difficult owing to an early cold and dry winter followed by excessive wet during the late winter and spring and an exceedingly dry summer that has persisted up to the time of writing. The one redeeming feature has been the excellent harvesting weather for all grass and clover seeds and the good yields obtained.

Plant-breeding

The use of pedigree strains of pasture species is fundamental in any attempt to increase the efficiency of pastoral production. The aim of the Grasslands Division is to supply high-producing bred strains of the more commonly used pasture species, and further, by hybridization, to evolve entirely new types by combining the desirable characters of different strains or even of different species. Pedigree strains of perennial rye-grass, Italian rye-grass, white clover, and red clover are now available to farmers, and next season seed will be available of a new type of rye-grass, known as H1 rye-grass, evolved by hybridization between perennial and Italian rye-grass.

The plant-breeding programme has been maintained as far as possible with perennial rye-grass, Italian rye-grass, H1 rye-grass, Western Wolths rye-grass, cocksfoot, timothy, white clover, and red clover.

Perennial Rye-grass.—Breeding is being continued with this species, some 8,500 single plants from controlled pollinations being studied in the field. Thirty-seven bushels of nucleus-stock seed have been obtained at Palmerston North for increase, and 78 bushels from the area at the Agronomy Division. The investigations into the possibility of breeding a strain of rye-grass less susceptible to the blind-seed disease than the standard strains are being continued. From crosses made between resistant and susceptible plants it appears that resistance and susceptibility to the disease are inherited characters. The majority of the resistant plants so far obtained are, however, not of the best agronomic type, and breeding is being continued to ascertain the possibility of combining desirable agronomic type with resistance to the disease. This season approximately one hundred plants have been artificially inoculated with the blind-seed-disease organism, and forty-two further crosses have been made.

Italian Rye-grass.—The nucleus-stock area at Palmerston North has produced 17 bushels of seed, and the area at the Agronomy Division 68 bushels. Breeding is being continued with this species, and some 3,800 plants from controlled pollinations have been studied in the field. A new glasshouse isolation to provide a nucleus-seed supply has been made. Reports from trials in Great Britain indicate that pedigree Italian is markedly superior to any other lines of Italian rye-grass included in their trials.

Short-rotation or H1 Rye-grass.—Twenty bushels of nucleus-stock seed have been harvested this year at Palmerston North, and 104 bushels at the Agronomy Division. It has been decided to release this new type of rye-grass under certification, and next year mother seed will become available to farmers.

Breeding is being continued with different types of this rye-grass. These are being studied as single plants and under sward conditions. Some 9,500 single plants from controlled pollinations are under study. Comparisons under pasture conditions of various bred types are being made at Palmerston North, Marton, and Lincoln.

Western Wolths Rye-grass.—There is a need, particularly in the South Island, for a Western Wolths type of rye-grass—*i.e.*, an annual rye-grass which, when autumn-sown, will produce a greater bulk of feed in the autumn, winter, and spring than will Italian rye-grass. Although seed is sold on the New Zealand market as Western Wolths, the great majority of the lines are Italian rye-grass or types of false perennial rye-grass. As a preliminary to the breeding of a true Western Wolths line, a survey was made of 104 New Zealand lines described as Western Wolths. Only one of these proved to be predominantly of the true Western Wolths type. This line, together with ten others obtained from Great Britain through the New Zealand Scientific Liaison Officer, will be used to provide single plants as a basis for selection and breeding.

Cocksfoot.—A two-year study of some 10,000 single plants from New Zealand and overseas lines has been completed, and mass selections have been made of three different types which will be used for comparative tests as single plants and in plots. Seed has also been obtained from 290 plants and will be planted out as single plants to provide initial progeny tests of the selected plants.

Timothy.—Thirty-two pounds of nucleus-stock seed have been obtained this season. Some 2,500 single plants obtained by hybridization of different strains are under study in the field.

White Clover.—The nucleus-stock area this season yielded 171 lb. of seed. No further breeding-work is at present being undertaken with white clover, the strain produced being, if anything, already on the aggressive side, particularly under high soil fertility conditions.

High and Low Cyanogenetic Glucoside White Clovers.—Two experimental lines of white clover have been bred—one is 50 per cent. higher in the glucoside than pedigree type 1 white clover, and the other contains no glucoside, and on these, grazing trials have been conducted. No deleterious effect has been noted on sheep grazed solely on the high-glucoside clover. Palatability trials with these clovers are also being carried out, but have not yet been completed.

Montgomery Red Clover.—A further nucleus isolation has been made this season. The nucleus-stock area yielded 707 lb. of seed for increase.

Broad Red Clover.—Three hundred and fifty pounds of seed have been obtained from the nucleus-stock area. Some 7,000 single plants from controlled pollinations are under observation in the field. The study of 3,500 single plants obtained by hybridization of broad and Montgomery red clover has indicated distinct possibilities of obtaining a highly-productive persistent red clover from hybrids between these two types.

Strain-testing and Nucleus-seed Production

Plot-testing for Certification.—Plot tests were completed on 2,500 plots sown in 1942. Samples for testing continue to increase, and this year sowings of 3,600 plots show a 40-per-cent. increase on those of the previous year.

Field Trials.—Field trials of improved strains have been laid down at Waitoa, Levin, Palmerston North, Marton, Rangiora, Kirwee, Methven, and Waitaki, and data have been collected on these and existing trials.

Trials in Great Britain.—Favourable reports of New Zealand strains of grass and clover seeds are being received from pasture trials in Great Britain. In most cases New Zealand strains are equal to or superior to English or Continental strains. Further seed has been despatched for a continuation of these trials.

Nucleus-seed Production.—Although the season was very late for the grass-seeds, favourable climatic conditions during harvesting resulted in good yields. Excellent conditions prevailed for the clover crops, and excellent yields were obtained. The establishment of additional nucleus-stock areas at the Agronomy Division has resulted in the requirements of the Department of Agriculture being met for all grass and clover seeds.

Field Ecology

Work in this section has continued on last year's lines, with an additional trial to test short-rotation rye-grass types. The trial aims to test persistency of four hybrid types and to study the role of these for short- and long-rotation pastures alone and in combination with perennial rye-grass. It is felt that the inclusion of long-lived hybrid rye-grass strains will enhance palatability, will give a longer seasonal spread of production, and will materially assist grazing management. The above trials are being conducted under a technique that permits return of stock residue proportional to the feed each plot has produced.

The Influence of the Animal on Pasture Development.—The trials laid down in 1941 have been continued, and continue to show marked influence of animal residues not only in total yield but also in relation to botanical composition, the variations in rye-grass being very marked in relation to clover. The somewhat more lenient grazing adopted this year has given a marked increase in cocksfoot. The following table sets out the total dry-matter and relative yields of the four treatments over the three complete years the trial has run:—

Yields of Dry Matter per Acre (in Pounds), and Relative Figures. (No return = 100)

	1941.	1942.	1943.
Full return	17,082 = 158	15,915 = 132	12,104 = 126
No return	10,791 = 100	12,016 = 100	9,578 = 100
Urine return	12,544 = 116	14,272 = 119	11,114 = 116
Dung return	12,473 = 115	14,473 = 120	11,000 = 115

The poor autumn recovery, cold wet winter and early spring, together with the early dry summer, will partly account for the lower yields in 1943.

Nutritional Block, Massey Agricultural College.—Yield and botanical composition of this trial have been kept up to date. During the past year a much better correlation has been obtained between stock carried per acre and dry matter of pasture produced, but the difficulties of accurate measurements and the running of pasture and animal trials together still present great problems. Relative yields of dry matter per acre over the past year are as follows:—

Strain Trial (Pedigree + Pedigree = 100)		Manurial Trial (1 cwt. super. = 100)	
Pedigree rye-grass + pedigree white clover	100	1 cwt. super.	100
Pedigree rye-grass + low HCN white clover	103	4 cwt. super.	108
Pedigree rye-grass + Mother seed white clover	102	4 cwt. slag	102
Mother seed rye-grass + Mother seed white clover	103	4 cwt. super. + lime	108
Mother seed rye-grass + pedigree white clover	109	4 cwt. super. + lime + potash	111

Botanical analyses for all treatments and also individual paddocks were continued and considerable improvement is noted, whereas eighteen months ago *Poa triviadis* and *Poa annua* were becoming dominant. An improvement in grazing technique has brought about a gradual return to the more desirable rye-white sward.

Silage.—Silage work has continued. During the winter the material ensiled the previous spring was reweighed and dry-matter losses in various treatments determined. These are as follows:—

	Loss of Dry Matter ensiled. Per Cent.
Addition of molasses	27·1
Sulphuric acid	20·3
AIV (hydrochloric acid, sulphuric acid)	25·5
Control	27·5

The acid silage proved difficult to feed to stock. Lime was added to reduce the acidity, but although this was well mixed it did not dissolve rapidly enough, and this, with handling between pit and paddock, resulted in the silage arriving in the paddock in a condition that proved unpalatable. This year a more soluble form of soda-lime mixture is to be used, and better results are expected.

During the present season work has been continued on the same scale in order to confirm previous seasons' results, and various methods are being tried experimentally to reduce losses in dry matter.

Exudate has been collected from all pits and stacks, pH having been determined at intervals. Digestibility trials were carried out on the material ensiled, and further trials will be made on the resultant silage.

Botanical Analyses.—Samples are still being received from all parts of the country, and trials both on the Station and elsewhere benefit from this service.

Short-rotation Trial, Conway Area.—Since the last report, trials of various rye-grasses and clovers have been started. The technique of proportional return has been followed, this method enabling several types of pasture to be measured within the one enclosure without transference of fertility, yet being grazed by and receiving trampling from sheep. The method briefly is to collect all animal residue from the grazing sheep and return to the plots the same proportion as the dry matter yielded by that plot. The trial has not yet been in operation long enough to give conclusive results.

Aerodrome-turf Production

There has been no slackening of the aerodrome grassing and turf work during the past year. The officers engaged on this work have been continuously employed in an advisory capacity and at times have given full-time supervision to certain undertakings. Several new areas have been sown to grass, and existing flying-fields have been given appropriate treatments to maintain or improve them. Some 7,500 acres are now under aerodrome in New Zealand. Aerodrome-maintenance has consisted of (1) oversowing with grass-seed as necessary, having regard to all ecological factors; (2) appropriate top-dressing with artificial fertilizers; (3) improvement of surface drainage; (4) proper management of grass turfs by mowing; and (5) chemical spray treatments of the turfs to define landing-areas for pupil pilots.

Proper turf-management on aerodromes will be possible now that adequate mowers have been made available through recent importations. A more rapid building up of a tough, hard-wearing turf can be expected now that grass growth can be properly controlled.

The phosphate status of the soils on many aerodromes has been raised to a satisfactory standard, and considerable economies in phosphate fertilizer for aerodromes is assured. Nitrogenous fertilizer, mainly as sulphate of ammonia, is still required in large quantities, although the rate and frequency of application has been reduced on certain aerodromes where a satisfactory turf and a suitable soil condition has been created through the earlier use of heavy applications of sulphate of ammonia. Very satisfactory progress has been made in grassing fields having soils which are peculiar in character and unsuited to any of the grasses normally used in agriculture or turf work.

A conference of the Royal New Zealand Air Force and Public Works Department personnel engaged in aerodrome-maintenance was held during the year at Palmerston North.

General

Greenkeeping Research.—This work has continued, and arising out of it has come the call for additional advice on turf-maintenance. The extension of the work under practical playing conditions on some bowling and croquet greens in Palmerston North has demonstrated the value of the information gleaned from the research turf plots at Hokowhitu. Resistance of turf to play, however, can only be measured under actual playing conditions, and there are yet many problems for study under such practical playing conditions. One of the outstanding problems is the question of soil structure and the

relation of a physical condition in the soil that permits of a uniform water-holding capacity, the correct blending of topsoil and subsoil, and the elimination of deep layers of fibrous materials that tend to accumulate unduly over the years where acid-promoting manures are used. The incorporation into this fibrous material of sand and similar light, friable topsoil has intensified the burning-out and drying-out of many greens during the present dry summer. Weed greens, particularly among bowlers, tend to increase in popularity, but it is difficult to arrive at a satisfactory conclusion regarding these weed greens owing to the lack of definite ecological measurement as to their persistency and spread. After the war there is bound to be a big demand for playing-greens, and the problems associated with the laying-down and maintenance of these are still far from solved. Particularly difficult is the reconditioning of old-established greens where the physical conditions of the soil have become entirely unsuited to the growing of a grass or weed sward wherever copious watering is not permitted.

Vegetable-production.—Crops continue to be produced for the dehydration of vegetable work by the Chemical Laboratory.

Substations.—For some time work has been conducted at Lincoln in order that pasture types selected at Palmerston North might be thoroughly tested under the drier arable conditions of Canterbury. In the past it has not been possible to use the animal for trials under grazing conditions, but it is hoped to extend the facilities so that this may be done in future.

The possibility of establishing additional substations located in Southland and North Auckland is also being explored, in order to ensure that types developed at Palmerston North are suitable for the wide range of climatic and farming conditions existing in these areas.

PLANT DISEASES DIVISION, ÔWAIRAKA, AUCKLAND

Director: Dr. G. H. Cunningham

I. Plant Diseases Investigations

(1) *Cereal Diseases.*—Corn ear-worm (*Heliothis armigera*): This introduced pest is becoming increasingly troublesome to maizegrowers, since it enters the cob and damages the apex of the husk. A series of experiments was run with a view to working out an economic means of control, infestation being reduced, in one trial, from 15 per cent. in the checks to 9 per cent.

(2) *Legume Diseases.*—Two further trials have been made to ascertain the relative resistance to bacterial-wilt, anthracnose, and mosaic of some eighty-three lines of beans. Results, in general, confirm those previously secured—namely, that runner varieties are resistant to all three diseases; the Burnley selections of Canadian Wonder and Dun french beans are highly resistant to bacterial-wilt and mosaic, though the former is susceptible to anthracnose; white-seeded varieties are highly resistant to bacterial-wilt; and Black Prince, Blue Pod, Wood's Centenary, Dun, and Zulu King varieties are moderately resistant to all three diseases. For production of green beans the runner varieties are the most highly resistant to grow.

(3) *Linen-flax Diseases.*—A detailed survey was made of all crops grown in the four South Canterbury factory areas of Geraldine, Washdyke, Makikihi, and Fairlie. Owing to the unusually dry season, diseases were found to be of minor importance, save in a few crops. Browning (*Polyspora lini*) was found in one crop only, whereas in previous seasons it was widely distributed. A species of *Phoma* was isolated from plants in three crops, associated with a canker near the base of the stem. Rust (*Melampsora lini*) was present in all crops to a slight extent, but caused moderate or severe infection only in a few late-sown ones. It was found to be common also on the introduced *Linum marginale*.

A series of thirty-eight crosses and strains of linen flax produced by the Agronomy Division are being tested for resistance to browning.

(4) *Fruit-tree Diseases.* (See Fruit Research report, p. 12).

(5) *Small-fruit Diseases.*—Tomato Leaf-mould (*Cladosporium fulvum*): Further quantities of seed of the resistant tomato Vetomold have been collected and distributed to growers throughout the Dominion. In some localities during the past season individual plants of this variety have been found infected with the leaf-mould organism, indicating that a strain of the latter to which Vetomold is not resistant has made an appearance. Consequently, work has been commenced with a view to producing F_2 plants resistant to both strains. Work of a similar nature is in progress to produce a leaf-mould-resistant dwarf tomato variety.

Fig Mosaic: Positive transmissions were obtained by budding and grafting, demonstrating the presence of this virus in figs in New Zealand. It closely resembles one recorded from the United States of America.

Grease-spot of Passion Fruits: Further work on control of this disease has been undertaken, adequate control being secured with Bordeaux 3–4–50 sprays applied during the autumn months, provided vines are pruned and trained on wires.

Raspberry Cane-spot and Septoria-spot: Field spraying trials were continued in a commercial garden at Riwaka, Nelson. Canes were cleaner, brighter in colour, and foliage more healthy in Bordeaux-sprayed plots. Bud-moth infection was reduced from 44 per cent. in check plots to 8 per cent. in those sprayed with lead arsenate.

(6) *Vegetable Diseases.*—Carrot Rust-fly: Field-work has been continued on the seasonal cycle of this pest, mechanical traps being employed to indicate the abundance of adults throughout the year. Results show the presence of three distinct generations, with a partial fourth in early April.

Work is being continued on effects of naphthalene dusts for control of the pest, results showing a marked reduction in the percentage of infestation when frequent applications are made.

Lettuce Ring-spot (*Marssonina panattoniana*): Applications of Bordeaux mixture and Cuprox materially reduced infection on winter-grown lettuce; yields were considerably increased.

Onion Downy-mildew: Concentrated Bordeaux sprays gave a significant increase in yield of 18 per cent. over checks, but did not prevent infection from spreading to the sprayed from unsprayed plots.

Onion Thrips: Nicotine sulphate only slightly reduced infestation, and tartar emetic gave somewhat better results.

Tomato Late-blight: Cuprox has again proved superior to Bordeaux as a spray. It had much less damaging effects on plants, resulting in increased yields, and gave adequate control of late-blight.

Cabbage Pests: Work has been continued on treatment of cabbages for control of white butterfly, diamond-back moth, and aphides. Derris dust has proved equal to nicotine-sulphate/lead-arsenate sprays for control of white butterfly and diamond-back moth, but inferior in control of aphis. Promising results were secured with derris dust impregnated with nicotine.

Soft-rot of Vegetables: Extensive losses have occurred in cabbages, cauliflowers, swedes, turnips, and carrots produced by the Services' vegetable-production projects. Investigation showed bacterial soft-rot organisms to be the main cause of wastage, and preliminary trials have demonstrated how such losses may be substantially reduced.

Dry-rot of Swedes: Five lines of New-Zealand-grown swede-seed were tested for presence of *Phoma lingam*. Only one sample showed infection to a slight extent—0·1 per cent.

(7) *Diseases of Medicinal Plants.*—A survey was made of diseases attacking medicinal plants being grown by the Botany Division at Lower Hutt. It was found that many had spread from adjoining market gardens, or the soil which had previously been used for market-gardening.

A virus disease attacking henbane has been studied and found to be unrecorded overseas.

II. Plant Protection

Therapeutant Testing.—Routine check tests have been made with samples of lead arsenate and lime sulphur. All certified brands have been found to comply with certification standards. Owing to short supplies from overseas, it has been necessary to allow import of lead-arsenate paste which does not comply with the standard set for lead-arsenate powders. Further, some slight modification has been made necessary by war conditions in the standard for oil emulsions.

Little further progress has been made in the general technique of biological testing owing to labour scarcity.

A high degree of disease control, and marked improvement in plant growth, was secured in small-scale trials in glasshouse soils when chloropicrin was used as a soil therapeutant for control of nematodes and soil fungi.

Spergon was compared with several copper compounds as a seed dust for control of pre-emergence damping-off. There was no significant difference between treatments and checks, though a higher percentage germination was secured with Spergon and Cuprocide at 2½ oz. per bushel than with the other products tested.

To reduce damage in stored beans caused by *Bruchus obtectus*, a New Zealand earth has been employed in place of hydrated lime and other inert materials commonly employed. This kaolin gave adequate control at a concentration of 1 per cent., as against the 50-per-cent. dosages necessary with those other products commonly used.

III. Timber Preservation

(See Building Research report, p. 4.)

IV. Pomology Investigations

(See Fruit Research report, p. 12.)

V. Miscellaneous

Lucerne Culture.—Cultures sufficient to inoculate 169,500 lb. of seed have been supplied to 1,450 famers, a substantial increase of 20,000 lb. over any previous season's supply.

Glasshouse trials of six strains of the nodule organism taken from different parts of New Zealand showed slight differences in effectiveness. The present strain being supplied to farmers is as efficient as any of those tested.

Clover Cultures.—Field trials at Owairaka of several strains of clover-nodule organisms confirmed results secured in the glasshouses that marked differences exist in effectiveness of strains of nodule bacteria.

Rotproofing of Fabrics.—Work has been commenced on methods for proofing canvas fabrics, cordage, &c., against destruction by mould fungi. Several species of fungi have been isolated, and means are being evolved for testing various therapeutants.

Pyrethrum.—Samples of flowers harvested this past season showed a higher percentage of pyrethrin than those of the past two years. Plants have been raised from cuttings and despatched to the Botany Division for developmental work. Seed from both high-yielding lines produced by the Division has been forwarded to those interested in commercial production.

New Records of Diseases and Pests.—During the year the following additional diseases were identified: *Entyloma calendulae* on marigold; *Cylindrosporium concentricum* on cauliflower; *Peronospora obovata* on spurrey; *Ramularia primulae* on polyanthus; *Peronospora parasitica* on twin cress; *Bacterium pruni* on peach; and fig-mosaic on cultivated fig.

Two new pests were also identified. A Scolytid beetle, regarded as a serious pest of forest trees in California, *Phlocosinus cupressi*, on *Cupressus lawsoniana;* and a pest of vegetables and small fruits, *Otiorrhynchus ovatus.*

SUGAR-BEET RESEARCH SECTION

Research Officer: Dr. O. H. Frankel

Sugar-beet Crop, 1942–43.—Growth on the new experimental area at Tai Tapu, 2½ acres in size, was very satisfactory. The average weight of roots tested was 1,108 grams, against 809 grams in 1942, and the estimated yield of topped beets was about 20 tons per acre, against 12 tons to 13 tons in the preceding year. Mean sugar percentage was about the same in both years—17·5 per cent. The total number of sugar tests made was 24,183, involving over 35,000 beets.

Of the thirty-four progenies of selected beets under test, six were significantly superior in sugar yield to the level of 105 per cent. of Kleinwanzleben E. In a variety trial of eleven varieties, including American and Canadian lines, the standard (Klein E) and Schreiber S.S. were significantly better than all other varieties. The American lines are specifically selected for resistance to leaf-spot or virus, neither of which is a major factor in New Zealand. New-Zealand-grown commercial seed, which was included in the trial, showed signs of natural hybridization with silver and spinach beets.

Seed Beets.—Of the 2,000 beets selected for further breeding, nearly all produced satisfactory seed in 1944. They were planted out in ten locally-isolated groups. About 500 beets, selected to produce commercial seed for feed beets, yielded about 140 lb. for multiplication.

Sugar-beet Crop, 1943–44.—The same area as in the preceding year was used. Four trials were sown containing progenies of our own selections and a number of German and American varieties.

Polyploidy.—Work on the production of polyploid beets by colchicine treatment of seeds as well as of growing points has been continued.

SOIL SURVEY

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

Soil Survey Advisory Committee.—Sir Theodore Rigg (Chairman), Mr. J. Bell, Mr. F. R. Callaghan, Mr. P. Smallfield, Mr. A. H. Cockayne, Dr. L. I. Grange (Secretary).

The above Committee was set up during the year by the Council of Scientific and Industrial Research to facilitate co-operation and co-ordination of the work of the Soil Survey Division with that of other Divisions and Departments and to suggest avenues along which soil research could be directed.

Soil Survey Division

General Survey, North Island.—The soil map of the North Island is being corrected and prepared for printing.

During the year the staff compiled from the soil data a fertility map of the North Island on a scale of 4 miles to an inch. The classes identified are as follows:—

Class I.—Level or undulating land, not too elevated, with deep soils and favourable moisture conditions, and which are, or can be, converted into high-quality farming-land:

Class II.—Ploughable land which can be converted into only fair- or medium-quality farming-land on account of some limiting factor to productivity—

Group (*a*): Soils in which moisture is a limiting factor;

Group (*b*): Soils in which some other factor such as texture, structure, drainage, elevation, or depth of soil is a limiting factor.

Class III.—Ploughable land which has severe limitations to productivity and requires further investigation before development is attempted:

Class IV.—Hilly or steep land which will maintain grass pasture with little or no top-dressing. Both topsoil and subsoil are of high fertility and erosion is not a serious problem:

Class V.—Hilly or steep land of moderate to low fertility. Light top-dressing is required to maintain a cover of grass, and careful management is necessary to prevent serious erosion:

Class VI.—Hilly or steep land which has severe limitations to utilization, such as low fertility or erodibility. This class is probably more suited to forest than to grass.

From this table it can be seen that there are three classes of fertility on the easy land and three on the hilly and steep land. The easy land amounts to 30 per cent. of the total area of the North Island. The map provides valuable data to those responsible for the development of farming-land and in land-utilization problems generally. One of the broad matters the fertility map raises is that the problem soils of Class VI occupy about half the area of the Island. Being so widespread, it is obvious that investigations should soon be commenced to ascertain what use should be made of this class of land.

General Survey, South Island.—A soil map on a scale of 4 miles to an inch has been constructed of the district lying between the Conway and Rakaia rivers in Canterbury, of the district between the Wither Hills (Blenheim) and the Awatere River, and of the greater part of Southland.

Linen-flax Surveys.—Mapping of soils in the Timaru-Geraldine area is well advanced, and the field officer was able to co-operate with the Fields Division of the Department of Agriculture in the selection of paddocks for the growing of linen flax during last season. Further mapping has been done in the linen-flax areas in the Leeston and Rangiora districts.

Aerodrome Surveys.—The soils of all aerodromes in New Zealand have now been examined to obtain information on their physical and chemical properties. This information has been used by the Aerodromes Branch, Public Works Department, and the Grasslands Division, Plant Research Bureau in the selection, construction, and maintenance of many of the airfields within New Zealand.

The main conclusions are—

(i) Drainage is of paramount importance in the maintenance of a firm and stable surface under all climatic conditions. Drainage properties, therefore, are an essential consideration in the selection and construction of airfields:

(ii) Where the rate of percolation is insufficient to remove water from the soil surface layers, surface drainage must be installed. The most satisfactory drains for this purpose as shown by Public Works Department trials are trenches filled to the surface with permeable material. Subsurface drainage alone is inadequate:

(iii) Except in dry climates, where a shallow layer of topsoil is essential for the conservation of moisture, the most satisfactory soil surface for grassed airfields is obtained from a soil of sandy loam texture in which topsoil and subsoil are blended together in the surface 2 in. or 3 in. and there is no topsoil below this depth. For drainage purposes the best subsoil is sand:

(iv) The turf developed under a mixture of brown-top and Chewing's fescue, which the Grasslands Division has shown provides the best grass surface for airfields in New Zealand, requires soil conditions of strong acidity, low lime content, and a plentiful supply of nitrogen, phosphate, and moisture.

Soil Erosion.—The soil-erosion maps prepared from the survey of the high country of the South Island have been supplied to the district committees of the Soil Conservation Council and the information obtained from the surveys explained.

Plots several acres in extent have been fenced on Molesworth (Awatere Valley), Te Akatarewa (Waitaki Valley), and Mount Edwards (near Lake Tekapo). In conjunction with the Botany Division, experiments are being conducted on these plots to devise methods of minimizing soil loss.

Pot Experiments.—Preliminary trials with indicator plants have shown Virginia stock (*Malcomia maritima*) to be an excellent lime indicator, and catchfly (*Silene gallica*), staggerweed (*Stachys arvensis*), cudweed (*Gnaphalium* sp.), catsear (*Hypochaeris radicata*), and cornflour (*Centaurea cyanus*) good phosphate indicators. These plants are especially suitable as indicators, because under adverse conditions there is continuous slow growth of tiny plants. This means a wide range of growth response can be obtained and allows of several classes to evaluate response. Virginia stock can absorb a high amount of lime. When growth is poor, the lime content of the plant is 1·4 per cent.—an amount equal to that of good pastures—and when lime is added to the pots in which the stock is growing the percentage of lime in the plants increases to as much as 5·6 per cent. Our main soil types have been tested with Virginia stock and some disagreement with chemical analyses obtained. These anomalies will be investigated to see whether they are due to a deficiency of soil elements or to some shortcoming in the chemical methods.

A trial was made of suckling clover to find the changes in nutrients with the addition of fertilizers. These conditions arose as a result of these experiments:—

(i) On soils of low fertility the application of lime plus phosphate increased lime from 1·1 per cent. to 1·7 per cent. and phosphate from 0·5 per cent. to 0·8 per cent. in the clover:

(ii) On some soils of moderate fertility the lime content of the plants is 1·7 per cent. and the phosphate 0·6 per cent., and is not increased by top-dressing with fertilizers containing these elements.

(iii) On some soils of low fertility the application of lime alone depresses the phosphate from 0·5 per cent. to 0·3 per cent.

From this it can be seen that nutrient content must be taken into account in assessing response of suckling clover to top-dressing. Further experiments on similar lines are now laid down on the same soils with suckling clover, rye-grass, and white clover to ascertain whether the uptake of nutrients by rye-grass and white clover is similar to that for suckling clover.

Fluorine Survey.—Estimations of fluorine in soils are being undertaken at the request of the Nutrition Committee of the Health Department, which is interested in the claim that fluorine controls the incidence of dental caries.

Soil Mechanics.—The survey of soils to determine their suitability for soil cement as a surface for runways, roads, &c., has been completed and an account written for publication. Several types of soil have been reported as suitable.

Appropriate tests of materials available for the proposed Nihotupu (Auckland) earth-dam were made.

With the Railways Department tests were carried out to estimate the probable settlement of piers of the proposed Waltham Road (Christchurch) overbridge.

Muds suitable for use in drilling were surveyed in the Gisborne district.

Likely shrinkage and expansions in tunnels for fuel storage were estimated.

Tests to provide data for calculation of pressure against a retaining-wall were made.

A shrinkage problem in connection with pottery clay was investigated.

Failure of existing bitumen aprons on aerodromes has been investigated, and shown to be due to the fact that soil conditions are such that shear strength of the soils is insufficient to carry loads transmitted to it.

Miscellaneous.—Chemical reports have been supplied on the progress of reclamation of Kaipara Harbour soils.

Analyses have been made of soils for the growing of vegetables both in New Zealand and on Pacific islands.

A report has been made on Kerikeri citrus soils.

Quick methods of estimation of moisture in seeds, tobacco, and linen flax have been developed.

Cawthron Institute

Soil Survey.—Soil-survey work has again been curtailed owing to the absence of several members of the staff with the Armed Forces. Soil maps for the Moutere Valley have been completed, and special maps showing the classification of the soils for the culture of flue-cured tobacco have been prepared and copies made available to the tobacco companies and the Director of the Tobacco Research Station.

During the spring of 1943 a detailed soil survey of the alluvial soils of the Waimea Plains was commenced. The soil mapping on the Appleby–Brightwater section has been completed, and soil maps covering 7,710 acres will shortly be available. When assessed from the point of view of suitability for flue-cured tobacco, 2,096 acres come within the first three grades of tobacco soils.

The following table shows the acreages and grading of soils suitable for flue-cured tobacco in the districts which have so far been subject to detailed soil mapping:—

Locality.	Soil Group 1*.	Soil Group 2†.	Soil Group 3‡.	Total.
	Acres.	Acres.	Acres.	Acres.
Motueka—Riwaka–Sandy Bay	1,324	1,279	573	3,176
Moutere Valley—Jubilee Bridge to Holdaway's Road	..	156	..	156
Moutere Valley—Holdaway's Road to head of valley	..	658	340	998
Motueka River Valley	633	606	372	1,611
Orinoco–Ngatimoti	13	45	60	118
Waiwkero	..	20	..	20
Dovedale–Thorpe	15	174	488	677
Waimea Plains—Appleby to Brightwater	35	840	1,225	2,100
	2,020	3,778	3,058	8,856
Acreage at present in tobacco, hops, and orchard	1,128	1,171	350	2,649

* Soil group 1 includes fine and medium sands and sandy loams of good depth and satisfactory drainage. † Soil group 2 includes gravelly sands, sandy loams, and silt loam on sand or gravel where depth is less satisfactory than group 1. ‡ Soil group 3 includes soils of satisfactory texture but of general shallow depth and likely to be adversely effected in dry seasons unless irrigation water is available

Land Utilization.—A land-utilization map covering the Appleby–Brightwater section of the Waimea Plains has been prepared. Most of the land is devoted to arable farming, but considerable areas of canning peas, tomatoes, and a small area of tobacco are grown.

Owing to lack of staff it has not been possible to revise the tobacco maps for the Nelson District, but a study of the acreages supplied by the Tobacco Board shows that there has been an increase of 145 acres of tobacco over the 1942–43 season. The increase in acreage is mainly in the Motueka Valley, Dovedale and Thorpe districts, and Ngatimoti and Orinoco valleys.

Chemical Work.—The routine examination of soil samples collected during the soil surveys of the Moutere Valley and the Waimea Plains has proceeded steadily. Further work has been done on the effect of steam sterilization on the plant-food content of Nelson tomato soil. Samples of soil for ammonia and nitrate determinations were taken regularly from both unsterilized and sterilized plots in the Cawthron tomato-house. The results from the past season confirm those of the previous year in showing a very large increase of ammonia nitrogen on the steam-sterilized plot. In the steamed soil the ammonia figures slowly increased from 20 p.p.m. to 60 p.p.m. on the 20th September. In the unsterilized soil the ammonia nitrogen increased from 20 p.p.m. to 30 p.p.m. on the 17th August, but then fell to 25 p.p.m. on the 20th September.

TOBACCO RESEARCH

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

During the past year four meetings of the Tobacco Research Committee have been held to consider reports of officers connected with the tobacco research programme, and to advise on policy matters connected with the development of the Tobacco Research Station.

Notwithstanding the bad season, the yield of tobacco should approximate closely to that of last season, but the quality will probably be somewhat lower. The crop in the 1942–43 season was particularly good, amounting to 14,295 lb. from 14 acres. The quality was good, an average price of 2s. 4d. per pound being realized.

As in former years, the tobacco research work has been carried out jointly by the staff at the Research Station and by officers of the Cawthron Institute. Work at the Research Station has consisted of fertilizer studies involving both quantitative and qualitative estimations of fertilizer applications, seed-production trials, variety trials, and mosaic investigations. At the Cawthron Institute the work has included tobacco disease surveys, mosaic investigations, and chemical studies dealing with the intake of plant nutrients, the chemical composition of cured leaf, and nicotine extraction from waste tobacco leaf. In addition, good progress has been made with the soil survey of tobacco lands on the Waimea Plains.

Fertilizer Experiments

Fertilizer results from the 1942–43 season may be summarized as follows:—

Where the standard fertilizer was applied in varying quantities, 1,200 lb. per acre again appeared to be the optimum amount. Increasing the quantity of nitrogen in the fertilizer gave increased growth with somewhat delayed maturity. Extra potash resulted in smoother leaf. Tobacco after oats showed little difference from tobacco in continuous cropping. The

effect of nitrogen from different sources was in striking contrast to the results from the same treatments last season. This season during the dry spell those plots receiving the readily-available forms of nitrogen made the best growth, while those receiving only organic forms were slow and backward. In the method of application it appeared as if all the fertilizer in side bands resulted in too slow a start, and that a proportion of the fertilizer should be within easy reach of the root system.

Intake of Plant Nutrients by Tobacco

The chemical data for tobacco plants of the 1942–43 season showed that in the toppings the dry matter was rich in all constituents determined, especially in potash and nitrogen, which reached 5·06 per cent. and 3·31 per cent. respectively. Ripe leaves were higher in lime, potash, and phosphoric acid, but lower in nitrogen than neighbouring nearly ripe leaves. As sampling progressed, leaves being taken higher and higher up the plant, the ripe leaves became increasingly richer in nitrogen but lower in potash content. The stalk was relatively poorly supplied with all constituents determined.

On an acre basis the plants at the time harvesting began had absorbed 36 lb. CaO, 9 lb. MgO, 12 lb. P_2O_5, 69 lb. K_2O, and 27 lb. N. Further absorption occurred as the remaining leaves developed and reached maturity. Even in the stalks, absorption of nutrient appeared to continue until the end of the season.

In the 1943–44 season observations were commenced earlier than in the 1942–43 season, but a similar procedure of harvesting sample material was adopted as had been used in the former season. Dry weather restricted growth in the earlier part of the season, and irrigation was resorted to; later on rain came, with the result that excellent final growth developed in the experimental area. The plants were larger in 1943–44 than in the previous season, but the increase in dry matter resided mainly in the stalks of the plants. The following data show the rapid development of dry matter that occurred in the five weeks preceding the beginning of the harvesting period (expressed in pounds of dry matter per acre):—

Date of Sampling.	Leaves.	Stalks.	Whole Plant.
13th January, 1944..	800	199	999
25th January, 1944	989	489	1478
2nd February, 1944	1237	754	1991
15th February, 1944	1612	1377	2989

Magnesium Deficiency

The value of finely-ground dolomite and magnesite for the control of magnesium deficiency in tobacco has been tested in the 1943–44 season. Owing to seasonal conditions, magnesium-deficiency symptoms were ill-defined on all plots, so no conclusions could be drawn concerning the relative value of these magnesium compounds for the control of "sand-drown."

Experiments in Raising Tobacco Seedlings

Although the main object of the seed-bed experiments was to study the effect of soil treatment on incidence of mosaic in the field, a good deal of valuable information concerning the raising of tobacco seedlings was obtained. Probably owing to the very wet conditions which prevailed in the early spring, fertilizer applications in the seedling beds did not produce the striking differences in growth that were noticeable in the previous season. In general, however, the same trends were observed as in the previous season. On the sandy soils of the Research Station, using steam-sterilized soil, mixed fertilizer at the rate of ½ lb. per square yard of seedling bed gave optimum results. When the proportion of organic constituents was increased in the mixed fertilizer, a retardation of germination of tobacco-seeds was noticed. The elimination of nitrogen from the fertilizer mixture seriously retarded the growth of plants. A noticeable feature of the seed-bed experiments was the association of more sturdy and better-rooted plants with reduced rates of seeding in the beds.

Mosaic Investigations

Officers of the Research Station and the Cawthron Institute co-operated in the conduct of an extended programme of mosaic investigations covering the use of fertilizers in the seed-beds, the effect of fertilizers under field conditions on the incidence of mosaic, the transmission of mosaic through handling of plants, and the value of milk and tannin sprays for the prevention of mosaic distribution.

(i) *Seed-bed Experiments.*—The most important experiments dealt with the effect of different treatments in the tobacco seedling beds on the final incidence of mosaic in the field. The results from this experiment confirm those of previous years in indicating again the greater freedom from mosaic of bed-sown plants as against pricked-out seedlings. In addition, the results indicate that the use of fertilizers at rates exceeding ½ lb. per square yard is frequently associated with higher percentages of mosaic when the seedlings are transplanted to the field. The lowest incidence of mosaic was associated with the fertilizer which contained no nitrogen at all. The highest incidence of mosaic was associated with the pricked-out plants where 1 lb. of mixed fertilizer had been used per square yard.

(ii) *Field Studies of Mosaic Incidence.*—Mosaic results from manurial experiments have not given any very significant differences. Increasing the mixed fertilizer from 800 lb. to 1,400 lb. per acre has made relatively little difference to the initial percentages of mosaic in the tobacco plants. When the proportion of nitrogen in the field dressings has been increased from 2 per cent. to 5 per cent. nitrogen, no significant difference in the amount of initial mosaic was found. The pulling and removal of tobacco stalks did not result in any apparent benefit in mosaic reduction, nor was there any increase in mosaic on continuous tobacco plots as compared with tobacco alternating regularly with oats.

A valuable experiment showing the ease with which mosaic can be transferred by workers handling plants at different stages in the pulling and planting of seedlings in the field was arranged at the Tobacco Research Station. The following figures illustrate the great importance of observing simple precautions in connection with the handling of plants.

Treatment.	Percentage Mosaic.	
	9th December.	24th December.
Control (clean hands)	2·3	6·4
Plants pulled with infected hands	59·0	68·5
Plants laid out with infected hands	63·5	74·5
Plants planted with infected hands	25·5	34·5
Plants planted after infection by rolling four cigarettes ..	49·5	58·5
Plants planted after thorough washing of infected hands ..	1·0	7·5

(iii) *Value of Milk and Tannin Sprays.*—The value of both milk and tannin sprays as preventives of mosaic spread has been tested. In the seedling-bed experiments carried out at the Cawthron Institute the application of milk sprays conferred significant protection against virus infection via wounds. Where, however, the leaves were not bruised, the use of a virus spray did not result in heavy infection of mosaic.

Both tannin and milk sprays at the Tobacco Research Station gave a significant reduction in the amount of mosaic in tobacco seedling beds where the number of plants had previously been inoculated with mosaic virus.

Further experiments have dealt with the longevity of the virus in the soil and with common weeds as possible carriers of tobacco mosaic. Results in the past season show that mosaic virus can persist in infected soil for a period of at least four months after the incorporation of infected tobacco trash. In connection with the possibility of weeds acting as carriers of tobacco mosaic, the results of the past season indicate that only in one case (*Solanum nigrum*) is the weed likely to transmit tobacco mosaic.

Other Tobacco Diseases

Black Root-rot.—This fungus disease was isolated for the first time during the past season from stunted tobacco plants taken from a commercial field at Dovedale. Three further cases of black root-rot infection were identified at Umukuri and Motueka. In each case affected plants were situated in a restricted area of the properties.

This disease is severe in certain seasons in the United States of America and causes a dwarfing of the plants. The roots are infected, and unless very satisfactory growth conditions occur, the yield of tobacco is greatly diminished. Unless resistant varieties of tobacco are used, affected land must be spelled from tobacco for a number of years.

Angular Leaf-spot.—This bacterial disease has been identified in both living and cured tobacco leaves. Bacteria have been isolated and inoculated into tobacco plants which have given positive results with all the bacterial strains isolated. This disease causes a spotting of the leaf blade angular in outline. Heavy rain may cause distribution of the bacteria, resulting in the coalescence of the spots, causing considerable damage to the leaf.

A survey was made during the season of fifty-three typical tobacco-fields covering every important tobacco-growing locality in the Nelson District. In six cases heavy infection of angular leaf-spot was found, in six cases moderate infection, in fourteen cases light infection, and in twenty-seven cases the tobacco was free from this disease. The survey shows that angular leaf spot had a fairly wide distribution already in all tobacco-growing localities, with the exception of the Moutere Valley and Braeburn.

Verticillium Wilt.—One case of *Verticillium* wilt in tobacco has been identified in Motueka. The property affected with this particular disease has shown an extension of infection during the past season. This disease is not confined solely to tobacco, and persists in the soil for several years. It will be necessary to rotate the land in selected crops for a number of years.

Collar-rot.—A number of chemicals, including Semesan, red copper oxide, zinc oxide, copper sulphate, and formalin, were tested for the control of collar-rot in tobacco seedling beds. Probably owing to the heavy artificial infection of the beds with *Sclerotinia*, no chemical gave satisfactory control of this fungus.

Seed-production and Plant-breeding

There has been a continued demand by the manufacturers responsible for growers' contracts for tobacco-seed produced at the Research Station. During the past season 16½ lb. were sold to the manufacturers, as against 17 lb. in the previous season. The seed demanded by the manufacturer is produced from once-tested single-plant selections from imported seed. Tobacco-seed, however, is also being raised at the Station in successive generations, so that shortly a comparison will be possible between seed raised in New Zealand over a number of years and seed once or twice removed from imported seed.

Plant-breeding work to obtain mosaic-resistant varieties has been continued. Ambalema variety was used as the resistant parent, but some crosses have been made with *Nicotiana glutinosa*, another resistant type. Of the Ambalema crosses, two in the second generation segregated for resistance, and the resistant plants were then back-crossed to the flue-cured parent. Other crosses are in the first generation.

In view of the identification of black root-rot in the Nelson District, the chief commercial varieties of flue-cured tobacco have been crossed with Little Dutch, a resistant cigar variety.

Preliminary trials of flue-cured varieties, Burley varieties, and cigar leaf have been carried out at the Research Station. The test with the flue-cured varieties indicates that the common commercial varieties grown in the district are among the best in yield and are of satisfactory quality.

Chemistry of Curing

In 1943 three experiments to study changes occurring in tobacco-curing were carried out. These showed that appreciable losses of dry matter occurred in the colouring stage of the curing operations, these being of the order of 10 per cent. to 15 per cent. It is interesting to note that the moisture content of the leaf remains practically constant during the colouring stage. No further losses of dry matter occurred in the later stages of curing. Determinations of glucose, fructose, and sucrose on samples taken at different stages indicated that in the colouring stage a large increase in glucose content and an appreciable increase in fructose content occurred. Later on a further small increase in fructose content was found, but it may be said that in the colouring stage the transformation of reserve carbohydrates to reducing sugars was almost completed. At later stages of curing, changes in reducing-sugar content were negligible. Sucrose throughout remained at a low figure.

In 1944 five curing experiments have been carried out using material from plants in the nutrient intake experiment. Except for the first picking of sand leaves, the successive harvests of leaves passing from bottom to top of the plant are represented. Data for changes in weight and moisture content of the leaves confirm the results of the previous season. Chemical data for these trials will be available later.

Nicotine Recovery

A small-scale commercial plant has been erected and used to extract nicotine from waste tobacco. Over 90 per cent. of the nicotine present has been recovered. Some alteration of the plant is required, and when this has been done, continuous running will be undertaken to obtain more information concerning the cost of production of nicotine sulphate.

Soil Survey of Tobacco Lands

Soil maps for the Moutere Valley have been completed, and copies showing the classification of the soil for flue-cured tobacco have been prepared for the tobacco companies. A commencement has been made with a detailed soil survey of the Waimea Plains, and soil mapping has been completed for the Appleby-Brightwater section. Over 7,000 acres of alluvial land have been mapped in the Waimea survey, and 2,096 acres of land are texturally suited for flue-cured tobacco. A large proportion of this acreage, however, falls into a soil group, which requires particular seasonal conditions to give optimum yield of tobacco.

At the request of the Tobacco Research Committee, a report was prepared on the amount of land which was likely to be available in the Nelson District for the extension of the flue-cured-tobacco industry. Although the Wakefield-Belgrove district and the Motupiko-Tapawera districts will require to be mapped, it was estimated that the total acreage of land which was texturally suitable for flue-cured tobacco was 10,000 acres. After making allowance for individual preferences of farmers and the rotation of crops, it was considered that 5,000 acres per annum would be the probable limit of flue-cured tobacco in the Nelson District.

Owing to lack of staff, it has not been possible to revise the tobacco maps, but a study of the acreages kindly supplied by the Tobacco Board show the following changes:—

Locality.	1943 Acreages.	1944 Acreages.
Motueka-Riwaka (including Umukuri and Sandy Bay)	1,593½	1,615½
Motueka Valley	451	476
Dovetail and Thorpe	277½	286½
Ngatimoti and Orinoco	135½	157
Stanley Brook and Tapawera	217	241
Wai-iti and Waimea	186	224
Moutere Valley, including Mapua	100	105½
	2,960½	3,105½

WHEAT RESEARCH INSTITUTE

Advisory Committee.—Mr. R. J. Lyon (Chairman), Mr. C. E. Boon, Mr. F. R. Callaghan, Mr. J. Carr, Mr. G. Fleetwood, Mr. J. F. Frew, Mr. R. K. Ireland, Mr. W. W. Mulholland, Mr. J. P. O'Connor, Mr. W. O. Rennie, Sir Theodore Rigg, Mr. P. R. Talbot, Mr. R. B. Tennent, Mr. A. H. Yarrow. Acting Chief Executive Officer: Dr. O. H. Frankel. Chief Chemist: Mr. E. W. Hullett.

In December, 1943, the Institute completed its third five-year term of service. All the interests who pay levies—wheatgrowers, millers, and bakers—as well as the grain-merchants, who collect the growers' levies, having signified their willingness to support the Institute for another five-year term, legislation was passed renewing the Act under which the Institute operates for another five years.

Wheatgrowing

The threshing returns for the 1943 harvest were analysed as usual. Cross 7 advanced further from 48·7 per cent. to 59·4 per cent. of the wheat area. Fife Tuscan, a new variety produced by the Institute, increased from 0·9 per cent. to 3·3 per cent. Tuscan decreased further from 33·5 per cent. to 23·9 per cent., Hunters from 7·0 per cent. to 4·8 per cent., and Dreadnought from 6·3 per cent. to 4·5 per cent. Tainui, a recent production of the Institute, is now the dominant variety in the Rangitikei and Manawatu districts. As in the two preceding years, it yielded substantially more—6 bushels per acre—than the previous standard variety, Jumbuck. Over the 4,000 acres of Tainui grown in that district in 1942–43, this has meant an increased production of 24,000 bushels, or an added value of some £8,000. Moreover, Tainui is suitable for "heading," now widespread in that area, whilst Jumbuck is not.

An experiment conducted to test the value for wheatgrowing of a new sowing device for sub-surface broadcasting gave inconclusive results and is to be repeated.

Wheat-breeding

The full scope of operations has been resumed and much of the accumulated material has been sown. A large amount of hybrid material from compound crosses is now under test. Of the more advanced lines, one resulting from a cross Tuscan × Tainui (78, 01) shows good promise. It has yielded more than Cross 7 in all but one of the eleven trials conducted during the last six years; it ripens distinctly earlier than Cross 7, it equals Cross 7 in baking quality, it has equally tight chaff, it is more resistant to Hessian fly and stem weevil, but it is not as resistant to lodging as Cross 7.

Genetic studies of the inheritance of grain size and other economic characters, and genetic and cytological studies, of a number of variants in wheat have been carried forward and are approaching conclusion.

Laboratory Work

Moisture Testing.—The same seven stations for moisture testing have been available to the wheat industry as during the harvest of 1943. Favourable harvest conditions in most districts were reflected by relatively small numbers of samples submitted and satisfactory moisture contents, the only major exception being South Canterbury, where humid conditions delayed harvesting and caused a certain amount of sprouting.

Milling and Baking Tests.—Milling and baking tests and routine chemical work were carried out as in previous years.

Work for Armed Forces.—The Institute's travelling baker has visited a number of camps and Air Force stations to give guidance in breadmaking, and several bakers from the United States Forces spent a week at the laboratory having instruction in the Institute's methods for using dried yeast. Routine examination of Service biscuit meals and oatmeals have been continued.

Research Work in Progress.—While the main lines of previous baking-quality investigation are still interrupted because of absence or partial absence of staff, a considerable amount of chemical work in this connection has been done.

At the request of the Nutrition Committee of the Health Department, a commercial experiment in the production of high-extraction flour is being undertaken. Preliminary work for this has included analyses for vitamin B_1, fibre, &c., to determine by what changes in milling practice the vitamin B_1 content can be increased with the minimum increase of fibre. In addition, vitamin B_1 determinations have been made on all bread flours in New Zealand. Further work is in progress.

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 Investigation

Mr. J. W. Calder

The fifth grazing season, completed at the end of March, 1944, will mark the end of a period during which the main objective was to measure the production of subterranean-clover pastures on the light, stony land of the Canterbury Plains under four different fertilizer treatments. Production was measured in terms of sheep returns in the form of carrying-capacity, live-weight increase, wool weights, and fat-lamb weights.

The carrying-capacity during the five years is as follows:—

	Ewes per Acre.				
	First Year.	Second Year.	Third Year.	Fourth Year.	Fifth Year.
A treatment: 1 cwt. super. alternating with 5 cwt. lime ..	1·0	1·3	1·6	2·1	1·8
B treatment: 2 cwt. super. annually	1·3	1·2	1·2	1·4	1·5
C treatment: 1 ton lime initial, 2 cwt. super. annually ..	1·6	1·7	1·8	2·0	1·9
D treatment: 1 ton lime initial, 2 cwt. super. annually, ½ cwt. potash annually	1·6	2·1	2·3	2·3	2·0

The detailed results of live-weight increase, wool weight, and fat-lamb production for the current season are not yet available.

In the fifth season the number of stock carried was less than in the fourth season following a dry spring and summer. No hay was cut, the ewes being wintered on hay which was left over from the previous season. This was not of high quality, and though the ewes fared reasonably well it was considered advisable to graze the hoggets off the plots for one month.

The investigation has produced valuable information during the five years, and it is considered that a continuation of the work on the same plan would not add much to our knowledge of the differential production of the four fertilizer treatments. A full report covering the costs and returns of each treatment over the five-year period, as well as a detailed report on the management and technical problems encountered, will be presented at an early date.

Consideration is now being given to modification of the scheme to investigate further problems of management and technique.

Entomological Investigations

Mr. L. Morrison

Sheep-dipping Experiments.—An experiment to test the effect of derris dip on lice-infested sheep was commenced on 18th September, 1942. A group of eleven sheep infested with body lice (*Bovicola ovis*) was employed in the trial. One large and two small double-fenced pens were erected to receive the animals. The seven undipped sheep, to serve as controls, were confined in the large pen. The remaining four animals, which were fairly heavily infested with lice, were dipped and placed in pairs in the two small pens. The dipping-bath was a tank with a capacity of 40 gallons. The fluid was prepared from artesian water and derris-root powder (5 per cent. rotenone content) and made up to a strength of ½ lb. powder to 100 gallons water. The period of immersion for each animal was half a minute. About five weeks after the experiment was laid down, two of the dipped animals gave birth each to one lamb. The two lambs were allowed to run with their mothers until the experiment was finished.

A thorough examination of the dipped animals was carried out on 10th November, 1942. No live lice were found. Dead and shrivelled lice and numerous dead keds were found. A few unhatched ked pupæ were seen, but they were all dried up and apparently dead.

A second examination of the seven controls was carried out on 16th November, 1942. Lice were present and readily found on some of the animals, but the numbers had diminished considerably. On some of the controls no lice were found at this examination.

A second examination of all the experimental sheep was carried out on 29th March, 1943. The four dipped sheep and the two lambs were completely free from lice. Some of the undipped controls revealed a light infestation with lice, while on others no lice could be found.

The final examination was carried out on 9th October, 1943, on all the experimental animals. One of the dipped animals which had broken out of the pen was discarded from the experiment. The three remaining dipped sheep plus the two lambs of 1942 were entirely free from lice. With the exception of one, all the undipped controls were lice-infested. Some were very heavily infested, but others were still lightly infested.

The trial demonstrated that, under the conditions of the experiment, derris dip at the normal strength for ked control—viz., ½ lb. per 100 gallons water—and with an immersion period of half a minute was effective in controlling lice. It also demonstrated that the lice population on untreated animals may vary to a considerable degree from season to season, and that lice may entirely disappear from certain sheep even when left undipped.

Another set of trials was commenced on 8th November, 1943. Four double-fenced pens, each approximately ¼ acre in area, were erected. A group of twelve lice-infested animals was procured—viz., six Border Leicester and six English Leicester hoggets. The dipping-bath was the same as employed in the previous experiments, and the time of immersion was again half a minute per animal. The derris fluid was prepared in the same manner as previously, and the strength was ½ lb. powder (5 per cent. rotenone content) per 100 gallons water:—

(*a*) Three Border Leicester controls were placed in pen No. 2 and shorn on 18th November, 1943:
(*b*) Three Border Leicesters were shorn and dipped the same day and placed in pen No. 1:
(*c*) Three English Leicesters were dipped "in the wool" and placed in pen No. 3:
(*d*) Three English Leicester controls, undipped and unshorn, were placed in pen No. 4. These animals were shorn in February.

A preliminary examination of the dipped groups carried out one month after dipping failed to locate any live lice on any of the animals.

An examination of the sheep on 8th February, 1944, showed that the unshorn and dipped English Leicesters were perfectly clean, but that the shorn and dipped Border Leicesters were fairly heavily infested with lice. The reason for this breakdown is not clear, but it is possible that those attending the sheep may have failed to take the necessary precautions to prevent carrying lice from infested to non-infested pens.

In order to repeat the experiment, the lousy English Leicester controls were shorn and dipped in the third week in February, and the reinfested Border Leicesters were again dipped, but now carrying three months' wool.

An inspection of the 9th March showed that all the dipped sheep were apparently free from lice at this date; further inspections at monthly intervals require to be made for some considerable time to ensure that no reinfestation occurs.

Insect Pests of Wheat Crops.—To test the varietal resistance of wheat to Hessian-fly and stem-weevil attack, experimental plots were laid down on the Wheat Research Institute area at Lincoln and as on the farm of Mr. J. D. Hall, Hororata. Ten varieties of wheat were sown, one variety per plot, and each plot was 16 ft. long and contained four rows. Each group of ten plots was replicated three times. In addition, six varieties were sown in beds at Lincoln only. The beds were replicated twice. The Lincoln beds were sampled on 18th November, 1943, and the plots on 6th December, 1943. The Hororata plots were sampled on 13th December, 1943. Data collected from these samples will be used to show the degree of attack and the resultant mortality of tillers during the active growing phase of the plants. The Hororata plots were examined again on 26th January, 1944, and the Lincoln plots and beds on 27th January, 1944. The data collected on these latter dates will be examined to determine the breakage which occurs in the different varieties prior to harvest, due to attack by Hessian fly and stem weevil.

To ascertain the actual mortality caused by Hessian fly and stem weevil, closely-controlled pot experiments were laid down in the insectary. The varieties Hunters, Cross 7, Tuscan, Dreadnought, and Fife Tuscan were employed. Wheats were sown in twenty-five pots, five grains per pot, and one variety in each of five pots. The wheats were allowed to grow throughout the winter in an insect-proof house. In spring, prior to removal to the field, two pots of each variety were covered with scrim, proof against insects, and three

pots of each variety left uncovered to act as controls. All the potted plants were then removed to the field and placed alongside wheat plots in the Wheat Research Institute area. The pots were sunk into the soil to prevent excessive drying out. After being exposed to insect attack for two months the plants were returned in late December to the insectary and the covers removed from the scrim-covered pots. The data supplied by these experiments are expected to throw light upon the problem of tiller mortality and show the effect of insect attack on the ultimate number of tillers which form ears.

Wheat Crop Survey.—A number of wheat crops in the Darfield-Hororata area were inspected during the last week in January, 1944. A fairly severe infestation of Hessian fly was found to have occurred. The great majority of the crops in the area were Cross 7. The infestation was evidently due to the second generation of flies which would attack the plants in early December, for the insects were located chiefly at the third node above the ground. Much straw-break had resulted from the strong nor'-west winds which prevailed during the latter half of the month. It was estimated that the amount of straw-break varied from slight up to approximately 5 per cent.

A short article dealing with the attack and the methods which should be adopted in controlling Hessian fly was prepared and forwarded to the various newspapers throughout the South Island.

Animal Production Research

Mr. J. W. McLean

Progeny Test Studies in Sheep.—This work was continued in the stud flocks, particular attention being paid to a fairly large scale trial with Southdown Rams.

Carcass Quality of Canterbury Fat Lamb.—This work will be continued by comparisons of the carcass quality of the following crosses of lambs raised under the same conditions: Southdown × Romney × Corriedale; Southdown × Corriedale; Romney × Corriedale. Also measurement of growth and carcass quality of Southdown × Corriedale lambs raised under high nutritional conditions, associated with the progeny test work above.

Teeth Studies in Sheep.—This is a continuation of work commenced some years ago at Ashley Dene. Important data have been collected concerning the influence of pregnancy and lactation on tooth structure and development and rate of attrition. This work is being continued, particular attention being paid to (*a*) the accurate establishment of the times of eruption of the incisor teeth and the factors that influence them; (*b*) the determination of the causes of variation in the rate of attrition and the onset of dental disease from the point of view of prenatal nutrition, early and late post-natal nutrition, the influence of parasitic infestation and mineral supplements, and the physical nature of the food. Further work is also required on the influence of pregnancy and lactation.

Inbred Strain of Romney Sheep.—Work on the establishment of an inbred line of Romney sheep for experimental purposes is being continued.

Control of Contagious Abortion in Dairy Cattle.—This work is being done in collaboration with the Animal Research Division of the Department of Agriculture. It consists of the calfhood vaccination of all cattle entering the herd and the collection of all data relating to abortions in the herd.

Mastitis Studies in the College Herd.—This work is being done in collaboration with the Animal Research Division of the Department of Agriculture and the New Zealand Dairy Board. It consists of the application of various forms of treatment to clinical and sub-clinical cases of mastitis as diagnosed by the leucocyte smear technique.

Pig-breeding.—Work in establishing a pure-breeding red strain of pigs derived from a Large White-Tamworth cross is being continued. The initial difficulty of colour variation has been overcome, and the work of multiplication and selection with a view to fixing productive qualities is to be proceeded with. Results so far have been promising.

Wool Metrology Laboratory

Dr. P. R. McMahon

Wool Survey.—Fleeces have been weighed and graded during the past shearing season at the majority of the locations previously visited in the Hawke's Bay and Canterbury Districts. Difficulties arising from the man-power situation prevented extension of the work. In the South Island a few steeply-sloping curves for fleece weight against count have been found on environments which must be regarded as giving a relatively low plane of nutrition, and one relatively flat curve where plane of nutrition is high. It is suggested that breed and perhaps strain modify the simple picture, presented in earlier reports, found in North Island Romney flocks. Thanks are due to the New Zealand Wool-buyers' Association, who have recently provided facilities for the expression of curves for wool count against fleece weight on a value-per-sheep basis. The results indicate that much North Island hill country could utilize a slightly finer grade of ram with profit, even at the present time. Stud-sheep data have been analysed to discover the effect of such a change on the fat-lamb industry. In over 813 dam-offspring pairs in a Romney stud flock no significant difference in fleshing grade of hoggets was found between the progeny of fine-wool ewes and the progeny of strong-wool ewes. The investigation is proceeding.

Progeny Tests and Strain Trials.—Data collected on the Canterbury Agricultural College flocks and on the Romney stud flock of Mr. R. Oakley, of Ashburton, have been analysed. Progeny-test graphs and breeding programmes have been prepared for these two flocks. Progeny-test investigations are being undertaken at the request of three other breeders.

In the North Island, sons of rams ranking high on progeny tests for fleece weight have now been compared with rams of average pedigree, chosen on appearance for high wool-production. Two-tooth ewes sired by rams of the progeny-test high-fleece-weight strain showed a 4 per cent. increase in wool-production over ewes of the same mob sired by rams chosen on appearance. Further trials are being laid down during the present mating season, including a comparison of Romney and half-bred rams on fine-wool ewes under North Canterbury conditions.

Intensive Investigations.—A small number of stud Romney and Corriedale ewes and their progeny have been kept under high and low planes of nutrition since June, 1943, to discover the effect on wool-production. A very marked break occurred in the fleeces of the low-plane group at a time when the ewes showed clinical symptoms of pregnancy toxæmia. The possibility that acidosis and ketosis associated with this condition may interfere with oxidative processes necessary for fibre growth is being investigated.

Unscoured fleece weights for the ewes of this experiment after six months' treatment averaged as follows:—

	High Plane of Nutrition.	Low Plane of Nutrition.
	lb. oz.	lb. oz.
Romney (five sheep in each group)	12 10	6 14
Corriedale (six high-plane and five low-plane sheep) ..	11 6	7 12

These weights include approximately six months' wool grown before the start of the experiment, during which time all the sheep were treated alike.

Count Standards.—British (Wool Control) and United States standard tops have now come to hand and are being used to fix the designations of fineness standards in use here.

Manufacturing Trials.—The first manufacturing trial in conjunction with the Wool Manufacturers' Research Association, Dunedin, of the effect of small amounts of hairy wool on processing has been completed. The presence of medullation equivalent to about 6 per cent. of coarse, hairy fibre did not appreciably affect the processing properties of sound, well-grown Romney wool of 48–50's quality. This was the average amount of hair found in the least desirable 200 lb. of britch and hindquarter wool from seven hundred unculled stud Romney ewe hoggets not shorn as lambs. The fleeces had been skirted in the normal way. A full report has been prepared for publication. A second trial using 56–60's half-bred and Corriedale wool has been arranged. Fleeces for this trial have been collected, sorted, and sampled. Measurements of the raw material for hairiness, fibre length, and diameter are practically completed. Acknowledgment is made to the Wool Council for a grant, in aid of this work.

MASSEY AGRICULTURAL COLLEGE

Sheep Nutrition Experiment

Mr. W. M. Webster

In view of statements by fat-lamb producers that the type of feed produced by the new strains of clovers and grasses plus heavy top-dressing was not the most suitable for their purpose, it was decided to carry out tests on productivity, thrift, and finish of breeding-ewes and "fat" lambs of-

(*a*) The following pasture mixtures—
- (i) Pedigree perennial rye-grass plus pedigree white clover:
- (ii) Pedigree perennial rye-grass plus low HCN. white clover:
- (iii) Pedigree perennial rye-grass plus mother-seed white clover:
- (iv) Mother-seed perennial rye-grass plus mother-seed white clover:
- (v) Mother-seed perennial rye-grass plus pedigree white clover.

(*b*) The following manurial treatments of a basic pasture mixture—
- (i) 1 cwt. superphosphate:
- (ii) 4 cwt. superphosphate:
- (iii) 4 cwt. basic slag:
- (iv) 4 cwt. superphosphate plus lime:
- (v) 4 cwt. superphosphate plus lime plus potash.

The trial was commenced in March, 1940, and data have now been obtained for four seasons. In spite of shortage of staff, it has been possible to collect during the present season the full set of data required.

A marked feature of the season was the prolonged wet spell covering the latter half of the winter and the majority of the spring, resulting in very strong spring growth, which necessitated the use of cattle earlier than usual. This was followed by a prolonged dry spell which commenced early in December and still continues. In spite of these unusual climatic conditions, the behaviour of the experimental animals was very satisfactory. No abnormal trouble was experienced, and the lambing percentage was again good. The lambs proved to be remarkably thrifty and fattened in record time. This season's lambs were ready for killing earlier than usual, and all except two injured lambs were killed by mid-January, approximately a month earlier than usual. Fat-lamb quality is up to the same standard as in previous seasons, and no significant differences between groups have been noted. The ewes were shorn early in December. Fleeces were lighter in weight and of poor colour in all groups. This can be attributed largely to the wet winter and spring conditions.

During the early spring flush of feed, cattle were used as previously to control the pastures. Two yearlings per acre were carried until mid-January, when, owing to the prolonged dry spell, they were no longer required. The pastures have remained in good condition in spite of the drought.

The ewes on the area are now early in their sixth year, and although most of them would satisfactorily bear another lamb, the numbers are too small to fully stock the area. Arrangements have been made with the Longburn Freezing Works for the ewes to be killed when required so that the thyroid glands can be collected and weighed.

The results of the four years' work conducted to date may be summarized as follows:—

So far as thrift is concerned, and this term covers a wide field, and so far as rate of growth and quality of fat lamb goes, no significant differences have been observed between the treatments in either of the two main experiments. The data obtained over the four years indicate a high degree of uniformity in management. From the mass of data obtained it will be possible to provide much valuable information on various aspects of growth and reproduction in the Romney ewe and growth and fattening qualities of the Southdown × Romney lamb.

Taking the two major experiments together, it seems clear that the strongest growing and most lush types of rye-grass and white clover, even when consistently manured at a very heavy rate, do not have any deleterious effect on the health and thrift of ewes and fat lambs (presupposing, of course, sound pasture control with cattle). The high HCN content of some of the modern selections of white clover has no apparent ill effect on the health of sheep. The strongest of the selections of rye-grass and white clover under trial proved extremely difficult to control as sheep pastures, when heavily manured with superphosphate. It has also been shown, as stated by Beveridge, that it is possible to clean up a property and keep it free of foot-rot for very considerable periods.

A number of lesser facts obtained from the data will be contained in the full report of the work which is being prepared for publication.

Drainage Research Work

Mr. A. W. Hudson

The 1943 winter and spring from June to October was marked by an extremely wet period. The benefits of drainage on the college sheep-farm were very obvious in reduction of fouling of pastures and markedly increased and earlier growth. From the stock point of view these benefits must be considerable, and a measure of them should be attempted in the future.

Drainage Experiments on College Farm.—No new experiments have been undertaken. The experiments for measurement of outflows are as follows:

(i) Tile experiment to determine effect of type of backfill, including gravel, straw, turf, and clay immediately over tiles, and a mole-tile system in which tiles were pushed into a 6 in. mole drain:
(ii) Spacing of tiles versus close jointing:
(iii) The effect of slow and fast pulling of the mole plough, combined with the effect of pulling to and away from the outlet:
(iv) The effect of depth of mole drains: 16 in., 19 in., and 22 in. depths are being compared:
(v) Thin versus thick blade of mole plough:
(vi) A comparison of the common type of torpedo and plug with new design in which the blade extends behind the plug:
(vii) The observation of the effect of different types of plugs:
(viii) Observation of different types of junctions between moles and tiles.

On account of the lateness of getting meters into the field and subsequent difficulties with them, the season's records are not complete.

Sheep-breeding Methods

Mr. R. Waters

The primary objects of the investigation may be summarized as follows:—

(*a*) To measure, judge, and record sheep characters accurately:
(*b*) To accumulate lifetime records of the measurements, judgments, and performances of each sheep:
(*c*) To enable studmasters to use their records easily and quickly:
(*d*) To estimate the relative values of sires by a comparison of the characters of their progeny.

Obviously the main measurement is that of the performance of each sire as indicated by the characters appearing in his progeny. The certainty, however, with which this complex measurement can be made depends upon the accuracy with which can be evaluated the body and wool characters of the progeny. Even if this were assured, there would still remain the problem of applying all accumulated knowledge to the practice of breeding. Hence any scheme for the application of breeding methods for better mutton and wool production must, to succeed, be accompanied by an efficient recording system—one in which all observations can immediately be turned to useful account, more particularly in that brief space of time when the decision must be made as to how each breeding-ewe can be mated to best advantage.

The recording system, however, does not end with the designing of a card, with the "letter symbol" and "line symbol" devices for all descriptions, and with the "needle sorting" device for quick reference to sheep families, &c. Records have had to be devised for reducing the very considerable error liable to be introduced in calling and recording large numbers of tag numbers for recording the observations and complex operations of the shepherds during the various tupping periods at mating-time, &c. We can report very considerable progress in this field recording. Our miniature card system (1½ in. by 3½ in.), for instance, quickly provides a running tally of the number of ewes as they are being allotted to each sire at mating-time. It acts as a check list of ewe numbers at mating and docking; as a record of mating originally decided upon, and of matings subsequently

changed through force of circumstances; and as a summary of the shepherds' diary notes as to illness, miscarriage, failure to breed, deaths, and the fostering-off of lambs. This system at first is arranged to duplicate the original grouping of all ewes as they occur in their breeding paddocks, and just as a change may be necessitated in the field through, say, an infertile sire, so is the grouping of these miniature cards made to correspond in the laboratory.

The 1942 Progeny Tests.—In the first two months of 1943 the body and wool descriptions and measurements recently collected from the seven hundred and fifty yearling progeny were examined. These data were then assembled for the progeny tests of sires and were transferred to the card recording system, where the lifetime records of each breeding-ewe are kept—one card for each ewe.

The 1943 Mating.—These cards, having been brought up to date, now included the measurements—past and present—of fleece weights and hairiness, and the evaluations of body and other wool characters. Such measurements and evaluations in course of time have now come to refer to both parents as well as their progeny as yearlings. It is from such records of performance that decisions are made as to what sheep or sheep families to cull, and what are the most hopeful lines upon which to mate the dams of dam families of the experimental stud. Guided, therefore, by previous performances, the suggested matings were then pencilled in on each card, thus facilitating collaboration with the owners in finally determining the matings, in sire marking and in splitting into mating mobs the entire stud of over one thousand ewes.

Present and Future Objects.—Here it should be explained that the immediate object of this systematic mating on the basis of performance is to build up a stud of such a quality that sires (and dams) will be found eligible to pass on from the progeny test to the more exacting close-breeding test, the results of which are judged and recorded on lines similar to those just described. Further, the close-breeding test, when successfully passed, leads on to the formation of a nucleus flock, closed to sheep outside the family—where genuine prepotency for desired vital and commercial characters is intensified.

Work at Present in Hand.—Evidence is accumulating as to the success attending this building-up process within the experimental stud, and progeny tests of twenty-six sires, based on the body and wool characters of about seven hundred and ninety yearling progeny, are nearing completion.

Pig Research

Professor W. Riddet

Previous work reported on efforts being made to study the inheritance of length in pigs has been continued.

Inbred and line-bred strains of long and short type of purebred Tamworth pigs have been bred and raised. This has been carried out in order to fix types so that the effects on length of reciprocal crosses can be closely studied in successive generations. With a view to making progress as rapidly as possible in improving the length of the long strain, several sires are being progeny tested. This is a somewhat tedious process when only about ten sows can be maintained, but it is considered that it is the soundest method of effecting improvement. As in past years, breeding results have been measured by the careful measurement of the carcasses of the progeny of pigs under observation when carried to baconer weight of approximately 200 lb.

Continuing previous work on the introduction of desirable genes of the Large White breed to the Tamworth, first-cross Large White-Tamworth sows were mated to a Large White boar and progeny of the back cross were inter-bred. The first litters from these back crosses arrived in January, 1944, and though it is too early to state what precise influence this method of breeding may have on our objective, the results expressed in the weaner pigs appear to be promising.

Variations in colour of the crossbred pigs are providing valuable material for the study of inheritance of colour in pigs. This side of the work is being followed up by Dr. Dry, of the college staff. However interesting the colour results are, care is being taken not to let the colour studies interfere with the main objective of improving the length of carcass side and thickness of hams.

Root-development Work

Mr. W. A. Jacques

Unfortunately, due to difficulties in securing labour, experimental work on this project has been suspended. It may therefore be a suitable time to review the scheme as a whole and indicate progress, together with a summary of work to be completed.

The work was commenced in 1935 and a paper read to the New Zealand Grassland Conference on "Some Preliminary Observation on Fertilizer Placement in Relation to Root Growth in Some Grasses." The position regarding fertilizer placement for grasses was there outlined and a number of problems that were of importance to this country were dealt with. The preliminary work was conducted at the same time as that on crested dogstail was being concluded.

The first trial was concerned with the effect on rye-grass of the intensity and time of defoliation on the root bulk and penetration. As a practical outcome of this, the effect of taking a hay crop in the first year of establishment was determined. Samples were being taken periodically on autumn- and spring-sown plots in an effort to determine how the roots behave, particularly before and during the onset of dry weather.

A technique for root sampling and washing was evolved and has been used wherever it has been necessary to obtain comparisons of root bulk. While it has worked reasonably satisfactorily, it is considered that further improvements could be made. At the same time that root sampling was in progress, profile drawings were made to obtain a more complete picture of root form.

Mr. Hopewell undertook, for thesis work, a determination of the effect of combining grass and clover in the same sward on the root behaviour of both, but the response appears to be in some other direction than bulk of roots.

The effect of fertilizer placement on the yield of herbage and roots has extended over four seasons. The small amount of labour available was best utilized in conducting replicated pot experiments, the results of which could be confirmed later by field trials. It was found that subsurface fertilizer placement, while showing little if any increase in root weight, gave consistently better herbage yields (especially in the drier part of the year) than the same amount of fertilizer applied as a top-dressing or disced in. These trials were designed to test the respective yields for the first season following seeding down. It is considered very probable that the effect will be much longer lived than this, but this can only be satisfactorily proved by long-term field trials.

The result of root-pruning as effected by heavy harrows has been investigated in view of the statements sometimes made that root-pruning is beneficial to grass growth in that it engenders the formation of new roots. This has been proved to be wrong, and results are now being published.

The capacity of grass plants to replace excised roots has been considered from the point of view of comparable damage being done by subterranean root-eating larvæ. Some remarkable figures for root replacement have been obtained, and a paper embodying these is in course of preparation. It is clear that strain has a great influence in the number and rate of root replacement. It is interesting to note that at the conclusion of the trials a persistently high-root-producing cocksfoot plant which was handed over to Mr. Corkill, Grasslands Division, Plant Research Bureau, for use in his breeding-work has proved to be one of his best plants.

The degree of defoliation has a very marked effect on the period over which new roots can be produced and on their numbers.

A sequence of root samples taken from differentially-manured plots which were grazed with sheep has been obtained over a period of five years, and they require statistical analysis.

During the year 1943–44 an explorative trial was commenced to determine the effect of a high water-table on the root development in permanent pasture. The water-table was perched and occupied the top 16 in. to 20 in. of the soil. It had little effect on the root penetration, as the subsoil was comparatively dry and contained sufficient air for satisfactory root growth down to and even below 4 ft. 6 in. More information is needed on the effect of a perched water-table and whether the damaging effect of lack of drainage is due primarily to excess of water interfering with growth or to insufficient soil stability to prevent mechanical injury to both soil and plants by treading. Despite a very wet winter, the health of the roots did not appear to be impaired by the excess of surface water.

Trials were put down also in the 1943–44 season to attempt to determine the role of deep and superficial roots in plant nutrition. This had to be abandoned.

Pot trials to confirm plot trials conducted in 1940–42 were under way, but had to be discontinued.

A comparison of the root systems of red clovers of different origin was being made, but had to be discontinued. It is considered that the root development presents the reason for the longer life of Montgomery.

Work was commenced, but subsequently discontinued, on the effect of buried briquette and granular fertilizer on grassland. It is thought that this may lead to a partial solution of the high incidence of reversion of superphosphate in the soil and also lead to an increase in herbage-production.

DOMINION LABORATORY

Director: Mr. R. L. Andrew

The Dominion Laboratory is a service laboratory for Government Departments and has again dealt with a very large number of samples covering a very wide range of materials, and members of the staff have been called in on various problems as consultants. A very large proportion of the work arises directly out of war conditions.

GOVERNMENT DEPARTMENTS

The number of samples received at the main laboratory and branches were: Wellington, 10,677; Auckland, 7,089; Christchurch, 7,930; Dunedin, 2,581: total, 28,277.

Customs

As usual, a variety of samples were examined to afford data for classification for Tariff purposes. Samples of iodized salt, as imported, with few exceptions complied with the new standard of 1 part of iodide in 20,000. These were forwarded at the request of the Department of Health.

Police

Numerous samples of wine, beer, and spirits were analysed in connection with illicit sales of alcoholic liquors. Many exhibits were examined for poisons in order to assist in ascertaining cause of death.

Samples of blood and of urine were examined for alcohol. In a number of cases the results indicated that the deceased was under the influence of alcohol at time of death.

A fatality which occurred during welding operations in a confined space was investigated. It was established that the death of one man and the serious illness of another were due to the inhalation of a low concentration of nitrogen peroxide. It is therefore most important that the danger of nitrogen-peroxide poisoning from welding in confined and badly-ventilated spaces either by the electric or oxyacetylene method should be widely known.

Department of Health

Milk.—The numbers of milk samples examined were: Auckland, 5,807; Wellington, 4,234; Christchurch, 5,754; Dunedin, 1,313; total, 17,108.

Special interest was focussed on the question of milk-supplies, owing to the sittings of the Milk Commission, before which the Dominion Analyst and the Government Analysts at Auckland, Christchurch, and Dunedin gave evidence.

With the exception of Wellington, the condition of the milk-supplies of the main centres is by no means satisfactory, but no doubt, as the result of the recommendations of the Commission, remedial measures will be taken.

In all districts special attention has been given to milk supplied to military camps and to schools. The latter have been tested for the efficiency of pasteurization. In practically all cases it was shown to be satisfactory.

Water.—A total of 664 samples from projected and existing water-supplies were analysed in the main laboratory and the three branches. Many of these were taken in connection with supplies to military camps.

Sewage.—As in the previous year, samples of sewage, some of them taken in connection with the disposal of effluents from military camps and linen-flax factories, were examined in each of the four laboratories.

Miscellaneous.—A very wide range of articles used as food and drink were examined. They include apple-juice, apple pie, baking-powder, beer, bread, biscuits, brandy, butter, canned foods of various kinds, cheese, cider, coffee, cordials, cream, curry-powder, condensed milk, egg-pulp, fats, food-preservative, gin, honey, honey mead, ice-cream, vegetable marrow, mince meat, oysters, pickles, rose-hip syrup, sausage meat, starch, tripe, turtle soup, whisky.

A number of reputed rat poisons were examined, and it was found that many of them would be quite harmless to rats.

Samples of enamel and aluminium ware were examined to ascertain if they contained impurities which might contaminate foods prepared in them.

A number of drugs and proprietary medicines were examined.

Mines Department

As in the preceding year, large numbers of scheelite concentrates were examined, quartz and other samples were assayed for gold and silver and some for other metals. None of these was of outstanding value. Mine airs and gases and stone dusts were analysed in connection with safety measures in coal-mines.

Government Stores

As usual, a large number of a very wide range of building and other materials were examined for various Government Departments to ascertain if they complied with specifications under which they were purchased. In a number of cases special investigations into causes of failure were made. Samples of tars and other roading-materials were examined for the Main Highways Board.

GAS INSPECTION

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

RESEARCH AND OTHER ACTIVITIES

Spray work for the Plant Diseases Division mainly consisted of checking the quality and composition of some of the new importations of spray oils, lead arsenate, nicotine sulphate, basic copper chlorides, &c. Waters from Roxburgh were tested for their effect on the soluble arsenic formed when using lead arsenate. The soluble arsenic varied from 0·25 per cent. to 2·0 per cent. with the different waters. Hardness and chlorides were determined, but no simple relationship between these figures and the soluble-arsenic figures was apparent. The addition of slaked lime depressed the soluble arsenic to a safe figure.

Metals and Alloys

A large number of chemical and spectrographic analyses of both ferrous and non-ferrous metals and alloys was carried out for the Armed Services as well as for civil Departments. These examinations were frequently associated with the investigation of failures or fabrication difficulties, and necessitated the additional employment of metallographic and physical examinations and heat treatments.

Corrosion of Metals

A wide variety of examples of corrosion of metals was submitted from various sources, and investigations made to determine the cause and prevention of these. Advice was given on the choice of materials for use under specific corrosive conditions.

Chemical Engineering Section

The Chemical Engineering Section has been largely occupied during the year on work connected with the dehydration of vegetables and apples. The vegetable plant at Hastings, capable of dealing with 4,000 tons to 5,000 tons of fresh vegetables per annum, was brought into operation in March, 1943, some six months after instructions had been received to commence the designs. Apart from the special machines used for peeling and slicing the raw material, the whole of the plant was designed and its construction supervised by officers of the Chemical Engineering Section. Up to 31st December, 1943, the vegetable plant had treated successfully 1,915 tons of potatoes, 231 tons of cabbage, and 404 tons of carrots.

The plant has demonstrated its ability to handle the quantity of material for which it was designed, but owing to lack of supplies of raw material and shortage of labour it has seldom been operated to capacity. After the plant had been in operation for some time an investigation of process costs and plant performance was carried out in order to determine the course of further development work.

Since machinery for apple preparation which had been ordered from abroad did not arrive until late in 1943, it was not possible to start apple dehydration until March of this year.

New developments in technique are being closely followed, and a considerable amount of work has been done on improved methods of peeling vegetables and on the compression of the dehydrated product. The latter work has been done in collaboration with the Auckland Technical Committee.

The drying plant for Chewings' fescue seed mentioned in last year's report has now been tested in commercial operation with satisfactory results, and there are indications that other units may be installed in other commercial seed-stores.

In addition to the work outlined above, advice has been given on various drying problems, and preliminary work on other drying plants is in hand.

At the request of the Director of Scientific Developments a water-purification filter was designed for Army field use. Special attention had to be paid to lightness in weight, compactness, simplicity, and mechanical strength, and it is believed that these requirements have been fulfilled in the design submitted. Tests with prototype models confirmed the efficiency of the design.

The Chemical Engineering Section has continued to carry out the testing of aviation fuels for knock rating on the C.F.R. engine. During the year over eight hundred samples have been tested for the R.N.Z.A.F.

As in previous years, members of the chemical engineering staff have been called upon to give advice on various matters connected with industries and on problems arising in other branches of the Department.

Organic Section

Medicinal Plants.—A considerable number of medicinal plants grown at Lower Hutt and Hastings were analysed, and the results in most cases were highly promising. The plants examined were *Atropa belladonna*, *Datura stramonium*, *D. metel*, *Digitalis purpurea*, *D. lanata*, *Hyoscyamus niger*, and *Papaver somniferum*. Other samples examined included castor beans, olives, peppermint flowering-tops, and rhubarb root.

A start was also made on the examination of native plants which have been suspected of causing stock-poisoning. These included *Nothopanax arboreum*, *Beilschmiedia tawa*, *Hedycarya arborea*, *Parsonsia capsularis*, and *Pittosporum tenuifolium*. Several Fijian plants were also examined for active principles.

Miscellaneous. A number of samples of foods were analysed for vitamins B and C.

Several problems were investigated for the Armed Forces, such as research into the formulation of insect repellants and shark repellants.

Physical Chemistry Section

The work of this section is mainly spectrographic analysis. The large quartz spectrograph has been chiefly used for the examination of metals, but much miscellaneous work has included the analysis of luminescent powders and the estimation of toxic elements dissolved from a saucepan made from scrap aluminium. Spectrographic as well as microchemical and physicochemical methods have been used in an increasing number of corrosion problems, many arising from war conditions. The small glass spectrograph is much used for rapid and routine work, and a suitable method has been worked out for using it in the rapid identification of special steels. It was also used for the estimation of chromium in plant ashes.

Occasional forensic work is required. One problem was the identification of a fragment of metal from a human eye. The most interesting case was one in which various methods for the detection of traces of other metals in gold were worked out in connection with a charge of stealing bullion from a dredge on the West Coast. The most rapid method was to ignite a globule of the metal in the graphite arc, and by this method it was shown that large variations in these trace metals occurred in gold samples from different parts of New Zealand. To compare the bullion with gold from thirteen dredges on the West Coast, it was necessary to concentrate chemically the trace metals from 1 gram of gold. Finally, to detect platinum metals, the trace metals were concentrated from 10 grams of the suspect bullion, and of bullion known to come from the dredge in question. The agreement in trace-metal content by all these methods indicated strongly that the bullion came from a particular dredge, and could be distinguished from the gold from twelve other dredges.

Other physicochemical work has included the determination of the transmission of light filters and transparent plastics. The electrical resistivity of river-waters is occasionally determined for the Hydro-electric Branch, Public Works Department. Apparatus was prepared for measuring the conductivity and temperature of sea-water at small depths. Some photographic problems were also investigated.

A considerable amount of analysis and advisory work is required in connection with electroplating, anodizing of aluminium, and surface films on metals. Apparatus was improvised for determination of the thickness of electroplating on steel by a magnetic method, and two of these are now in use by Inspectors of the Munitions Department. A method was devised for the Radio Development Laboratory for plating silver rings on bakelite disks.

Ceramics

Under the general supervision of a Ceramic Resources Committee, the investigation of raw materials used by the industry has been placed on a decidedly improved basis. In furtherance of the policy of working in close collaboration with the Geological Survey, officers of the Laboratory interested in this work have been given every opportunity of inspecting clay deposits in the field. Close contact has been maintained with the industry by frequent visits to potteries, sometimes at the special request of the management. Acting largely upon a strong recommendation from the Director, Dominion Laboratory, three of the leading potteries last year appointed works chemists to their staffs. In each case the appointee was given a period of instruction in clay-testing technique at the Dominion Laboratory, a policy that has resulted in cordial relations with the industry and a welcome at all times to the works.

During the year detailed examinations were made of clay deposits from the following localities: Charleston, Waimangaroa, Whangarei, Kiripaka, and Kaka-Tadmor. In addition, the more systematic survey of the clay resources of the North Auckland district was advanced a step further by the completion of tests on a series of samples collected from bores and clay-pits in the Kauri and McLeod Bay areas. Extension of this systematic survey to the South Canterbury district is already under way.

During the year a member of the staff was sent overseas to study latest developments in ceramics in England and the United States of America. Upon his return it is hoped that finality will be reached in a scheme for the standardization of clay-testing that has been under consideration for some time.

Equipment from overseas to be used in the testing of refractories is now coming to hand.

Coal Survey

The physical and chemical survey of the coal resources of the Dominion has been continued by the Coal Survey Laboratory and by the field staff appointed by the Geological Survey. Work has continued in the Greymouth, Westport, Southland, Tatu, Mangapehi, and Waikato fields, and samples have been received from all over New Zealand.

The Coal Survey issued twenty-four reports during the year and also sent out four information circulars.

A start was made on a detailed examination of coal ashes obtained from run-of-mine samples of coal. This examination included complete analyses of the ash and the determination of fusion characteristics in oxidizing and reducing atmospheres.

Investigations were carried out to determine the washing characteristics of Wallsend, Blackball, and Strongman coals.

Two reports were issued on the occurrence of boron in the ash of Waikato coal. The amount present is phenomenal, and for seven mines averaged 3·4 per cent. B_2O_3 in the ash, and the ash was 2·8 per cent. of the coal.

In addition to the regular work of the Survey, forty samples of coal and related materials, including coal dusts and limestones, were analysed, and fusion temperatures determined for a number of substances.

The possibility of using waxes present in peats and low-grade coals for industrial purposes received some consideration, and a number of such coals were extracted with benzol to determine their wax content. A report was prepared on the suitability of New Zealand coals for use in the manufacture of plastics.

Paints and Protective Coatings

The very considerable amount of paint investigational work carried out during the year may be subdivided into requirements for (*a*) defence and (*b*) civilian use.

Defence.—In addition to routine examination of paints and varnishes to specification for the Navy, Army, and Air Force and the United States Forces, several special investigations were made involving research and the application of new methods. These included (1) evaluation photographically of the infra-red reflecting properties of pigments and camouflage paints; (2) exposure and ultra-violet light tests of green camouflage paints to evaluate fading; (3) laboratory comparison of the infra-red reflecting properties of paints for armoured fighting vehicles; (4) specular and diffuse reflection properties of camouflage finishes for aircraft; (5) camouflage of water surfaces; and (6) black and coloured skin dressings for jungle fighting.

For the Munitions Controller, special examinations of varnishes on hand grenades and mortar bombs were made. A routine salt-spray test was introduced, advice given on metal-cleaning procedure, and corrosion problems studied. For Army Inspection numerous paints and varnishes were examined to specification.

Civilian.—Routine examination of a very large number of paints for the Housing and other Departments was carried out. Members of the staff acted on the Paints and Coatings Committee of the Standards Institute and on inter-departmental committees for paint investigation. Special investigations included (*a*) suitability of New Zealand whiting for putty-manufacture; (*b*) luminous paints for gun-sights, &c.; (*c*) casein paints; and (*d*) fire-resistant paints. Advice to Government Departments on paint problems was frequently given.

Rubber

Special problems that arose during the year included (*a*) particle size and other determinations of rubber fillers; (*b*) preparation of rubber solutions; (*c*) investigation of rubber-tire preservatives; (*d*) milking-machine rubber-ware; (*e*) corrosion due to latex on mortar-bomb tail covers; (*f*) a report on the possibility of manufacturing synthetic rubber in New Zealand; (*g*) investigation of methods of analysis of rubber.

Rot-proofing of Fabrics

Analyses of rot-proofing compositions for tarpaulins and tentage were made. Conferences with Army representatives on this question were attended. This work has now been placed under the supervision of a "Rot-proofing Committee" set up by the Standards Institute.

Building Research

The accumulation of knowledge and of experimental data acquired by members of the staff over a period of several years has made it possible not only to carry out useful investigational work on building-materials, but also to assist with technical advice on several Committees set up by the Standards Institute.

Among the problems considered were (*a*) mould in houses (tests of gypsum plaster, flour pastes, and moisture contents of wallboard, &c.); (*b*) fire-resistance of wallboards; (*c*) roofing-tiles (concrete and earthenware) specification tests; (*d*) enamelled sinks (tests of enamel quality); (*e*) copper supply tanks (corrosion and water-supply problems); (*f*) timber-preservation (routine control of samples and investigation into permanence); (*g*) examination of New Zealand Portland cements, with special reference to alkali content and interaction between certain aggregates and cement; (*h*) examinations of bricks, pipes, and other items included under ceramics.

Two members of the staff were sent abroad to study building-research methods in Great Britain, Canada, and the United States of America, and the application of plastics to building. The technical knowledge now available on the staff, the experience already acquired, and the study being made of modern developments abroad all combine to place the Laboratory in a particularly happy position to play a prominent part in the field of post-war building research.

Accommodation

In view of the many and varied activities of the Laboratory, accommodation has for a long period been far from adequate, and the position during recent years has become acute. It is hoped that this will be remedied in the near future, when the Laboratory will be able to increase its usefulness to other Government Departments and particularly to meet the increasing demands of industry and of the newly-constituted Division of Industrial Hygiene of the Department of Health.

Advisory and Consulting

The Director and other senior members of the staff have been consulted frequently on scientific and industrial matters. It is gratifying to note that there has again been an increase in this part of the work of the Laboratory. They have also represented the Laboratory on various technical and inter-departmental committees, including those of the New Zealand Standards Institute. Papers by various members of the staff have been published.

DOMINION OBSERVATORY

Acting-Director: Mr. R. C. Hayes

REPORT FOR THE YEAR ENDED 31st DECEMBER, 1943

Time Service

Control of Clocks.—The Observatory clocks have been kept correct by radio time signals received daily from Greenwich and Washington, and also by occasional local transit observations. The clocks were disturbed by local earthquakes on 16th January and 26th February, but no interruption in the time service resulted on either occasion.

Time Signals sent out.—In addition to the usual time service, arrangements were made during the year for three additional time signals to be sent out daily through station ZLW for Navy and Air Force use in New Zealand and the South-west Pacific. Two of these signals are retransmitted by Auckland and Suva radio stations.

The errors of the main ZLW signals were less than 0·25 second on every day of the year except two. On one day in April an error of 0·5 second developed, due to trouble with the clocks. The signals failed or were faulty on several occasions during the year, due to faults either at the Observatory or at the radio station.

Although not part of the scheduled time service, correct time is given frequently by telephone in response to calls from all sections of the community. The total number of calls attended to in 1943 was 810, compared with 726 in 1942.

Public Clocks.—The Government Buildings clock was checked daily. The maximum errors observed during the year were 48 seconds fast and 78 seconds slow. The clock was stopped by a local earthquake on 26th February.

The synchronous electric clock ran without interruption from 1st January to 9th August (221 days). The maximum errors observed during the year from readings taken twice daily were 10 seconds fast and 27 seconds slow.

General.—During the year 103 astronomical watches were rated for the Royal New Zealand Air Force, and several others for the United States Marine Corps and the New Zealand Army Engineers.

New synchronizing-apparatus was fitted to the signals clocks to reduce the disturbing effects of earthquakes on them.

Seismology

Summary of Seismic Activity in New Zealand in 1943.—During 1943 slight or moderate activity continued in the Wairarapa region, with generally decreasing frequency. There were occasional rather strong shocks in that region in the early part of the year. Of special note was the unusual activity in the South Island, particularly in the south-western portion

of the Island. Two shocks reached minor destructive intensity (VII on the Modified Mercalli Scale). One occurred on 8th May in the Lake Wanaka region, and the other on 23rd August in the Arthur's Pass region. The shock on 8th May was apparently the most pronounced felt in Dunedin for many years. The intensity recorded there was IV–V on the Modified Mercalli Scale (equivalent to 5 on the Rossi-Forel Scale). Groups of small or moderate local shocks occurred in the Wairoa region in January and April, and in the Rotorua region in February. June was the quietest month of the year.

The total number of earthquakes reported felt in 1943 was 176. Of these, 122 were felt in some part of the North Island and 57 in some part of the South Island. Only three shocks were felt in both Islands. The maximum intensity reported in the North Island was VI on the Modified Mercalli Scale, and in the South Island VII. The above figures are based on reports furnished by officials at post-offices, lighthouses, and by several private observers.

Seismograph Stations.—The Jagger seismographs at Rotorua and Hastings are temporarily out of action owing to clock failure and the difficulty of obtaining new clocks of suitable type at the present time. All other stations have continued recording throughout the year. These are located at Auckland, Arapuni, Tuai, New Plymouth, Bunnythorpe, Wellington, Takaka, Kaimata, Christchurch, and Monowai.

Some assistance was given in connection with the establishment of a Milne-Shaw seismograph at the Meterological Office at Suva.

Introduction of Modified Mercalli Intensity Scale, 1931.—This scale was introduced at the beginning of 1943 for recording the non-instrumental effects of earthquakes, in place of the Rossi-Forel Scale.

Research.—No research work could be undertaken during the year, the whole staff being required to keep essential routine work up to date.

General

Astronomy.—Arrangements were made during the year for this Observatory to carry out daily sunspot observations, which in normal times are made by the Carter Observatory. The observations are required in connection with war activities.

In September, Colonel F. J. M. Stratton, noted English astronomer, visited the Observatory. His advice was obtained regarding future activities, more particularly in the time service.

DOMINION PHYSICAL LABORATORY

Director: Dr. E. R. Cooper

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

General

Three meetings of the Committee were held during the year. The Dominion Physical Laboratory has grown out of the Physical Testing Laboratory, which was set up prior to the outbreak of war in 1939 primarily for the testing of materials and equipment for Government Departments and to undertake investigational work for the Department of Scientific and Industrial Research of an engineering and physical nature. So great was the demand for the servicing of scientific instruments and technical equipment, however, that an instrument workshop had to be developed alongside the Laboratory to handle efficiently the repair and construction of delicate precision apparatus. The interest which the Laboratory always showed in developing standards of physical measurement led to its collaboration with the Munitions Controller in setting up a metrology laboratory for the certification of gauges for munitions-production, and later it was decided also to locate the munitions tool-room at the Laboratory. A group of related activities has therefore developed at the Dominion Physical Laboratory comprising a physical testing laboratory, electrical laboratory, metrology laboratory, metallurgy laboratory, engineering design section, instrument workshop, glass-blowing workshop, and tool-room. The war has thus led to the rapid establishment in New Zealand of an institution having a group of activities almost identical with those performed at the National Physical Laboratory, Great Britain, where a great deal of the engineering and physical testing work in England is centred. It is of interest to note that the National Physical Laboratory also has associated workshops for dealing with work of a precision nature.

Further progress towards the establishment of a national standards laboratory was made at a meeting of interested Government Departments held on the 9th March, 1944, which supported the principle of establishing at the Dominion Physical Laboratory all primary reference standards of measurement for New Zealand. Certain Government Departments already hold standards of measurement required for the administration of legislation involving the use of standard measurements, and others require periodical calibration of precise measuring-equipment. There are obvious advantages in locating in a properly-equipped and legally-recognized national standards laboratory such primary reference standards as are required for Government and industrial needs. To meet war requirements the Dominion Physical Laboratory has acquired a staff trained in precise measurement, and selected officers from the staff, together with a considerable amount of equipment that has been assembled, are available as a basis for a permanent standards laboratory. It was decided to bring the scheme to the notice of Government Departments generally to invite their participation, and a sub-committee was appointed to go into the question of what steps would be necessary to secure legal recognition of the status and functions of a standards laboratory as a permanent section of the Dominion Physical Laboratory.

Three new sections have been organized within the Laboratory during the year: (1) a luminous paint section for the development of luminized equipment for operational use by the Armed Services; (2) a separate section for the repair and construction of electrical instruments; (3) a section known as the "planning unit" now follows the progress of all work through the Laboratory and prepares weekly work-sheets with a priority denoted against each item of work. The planning section is an efficiency unit made necessary by the very large number of widely-assorted items of work which have come to the Dominion Physical Laboratory from the Armed Services, New Zealand industries, and Government Departments.

Certain optical-grinding machines were made available to the Laboratory this year by the Director of Scientific Development, and a small optical workshop is in process of being built up to supplement the general instrument-making facilities already existing.

Physical Testing and Electrical Laboratories

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

(*a*) *Pyrometric Furnace Controls.*—There has been a demand in New Zealand for controlling pyrometers for maintaining furnace temperatures constant. Last year isolated instruments were produced for industry, but as the demand grew it became necessary to make a group of twenty-four of these instruments to cover the requirements of the Air Department and Munitions Controller. The object has been to produce a reliable and accurate instrument which can be set to control any temperature up to 1,000° C. Problems have arisen in the behaviour of these instruments, and the design has been gradually modified to incorporate improvements. The Laboratory installs and services each instrument, and the results to date have given great satisfaction to factory-managers.

(*b*) *Repair of X-ray Tubes.*—The supply position of X-ray tubes for medical purposes led the Wellington Hospital to approach the Laboratory regarding the possibility of repairing X-ray tubes which have lost vacuum. The problem was given careful consideration and equipment built which enabled the tubes to be evacuated while being heated. Two tubes have been repaired and are awaiting the checking of their characteristics before being put into service.

(*c*) *Linen Flax: Quality and Yield of Fibre.*—The object has been to follow up any line of physical investigation that might lead to an improvement in the quality and amount of fibre being produced in New Zealand. The matter has been rendered difficult, since the work is best carried out close to a linen-flax factory and it has not always been possible to spare key personnel to be absent for very long from the Laboratory. The main factors which contribute to a high grading of fibre are strength, cleanness, freedom from disease, softness, and uniformity. An impact-testing machine was built to determine the strength of fibre, and a comparison of New Zealand and Irish retted fibre showed that the former was not lacking in strength. The cleanness of the fibre was judged by microscope observations, and it was in this respect that New Zealand fibre appeared to contain a great deal of adhering non-fibrous tissue. This observation was later supported by reports from Great Britain, and attention was subsequently devoted to a study of the retting process using the microscope. These investigations are still proceeding. The effect of moisture on the strength of fibre has been determined, and experiments are being made to moisten rapidly flax which is too dry to scutch and to measure the effect of moistening on the yield of fibre from the scutcher. The results to date indicate that fibre having a low moisture content will give a higher yield when moistened by the rapid method that has been developed. The ultimate object of all physical and chemical tests on flax fibre is to obtain a means of judging the spinning-quality of fibre without having to resort to spinning trials. A very extensive programme along these lines is being undertaken in Great Britain, the results of which are awaited in New Zealand, more especially since there is no suitable spinning-equipment here which would enable similar trials to be made.

(*d*) *Refrigerator Efficiency Determination.*—A special type of flow-meter has been built to measure the flow of refrigerant liquid in a completely-enclosed system, and by means of this it is intended to compare the cooling produced by a determined flow of refrigerant. This will lead to a study of the efficiency of various types of refrigeration equipment and may help to improve existing designs.

(*e*) *Repair of Mercury-in-steel Thermometers.*—A large number of this type of thermometer came to the Laboratory for repair, and great difficulty was experienced in effecting repairs rapidly. This led to an investigation to determine the most effective routine method of overcoming the various defects which arise in these instruments. Several instruments have been successfully repaired as a result of the investigation.

(*f*) *Dimensional Changes of Traceline Paper for Map Reproduction.*—Difficulties have been experienced by the Government Printing Office in the offset printing of maps using several colour processes owing to the dimensional changes that occur with certain tracing-papers from which the colour process is done. The Laboratory has made linear measurements of dimensional changes on samples of cellulose acetate, celluloid, and linen-backed papers caused by changes of atmospheric humidity. From these results certain papers have had to be rejected as unsuitable for such work. This branch of the work is expected to be increased considerably during the coming year, and comprehensive equipment is being designed and constructed.

(*g*) *Mould on Inner Wall Surfaces of New Zealand Houses.*—It was discovered early in 1943 that mould had a very much greater tendency to develop in a humid atmosphere on surfaces which had been papered by the accepted trade method than on unpapered surfaces. This aspect of the problem was then taken up by the Plant Diseases Division. The problem of reducing the tendency for moisture to condense on the inner wall surface by altering the existing wall structure or wall materials remained for the Dominion Physical Laboratory to investigate, and this work is still proceeding.

(*h*) *Tire-retreading.*—Following on work that had been done for a local company on the retreading of motor car and truck tires, in which assistance was given with respect to curing-times for the vulcanizing of the retreads, further assistance has been given in overcoming lack of adhesion of rib-type retreads by vulcanizing for definite times with pressure applied and with controlled solutions of rubber adhesive. In addition, drawings of a new type of internal-heating retreading-mould were inspected and a report furnished as to its probable usefulness for the purpose intended.

(*i*) *Effect of Humidity and Temperature on Radio Components.*—The Army inspection department referred components from field radio equipment to the Laboratory for tests as to their probable behaviour under the high humidities and temperatures of tropical places. Tests were performed in a specially-constructed temperature- and humidity-controlled cabinet. In addition, advice was given as to the best method of servicing and maintaining the complete equipment in its most efficient condition.

(*j*) *The Application of Radio-active Luminous Paint for Luminizing Equipment.*—In co-operation with the luminizing section, the physical laboratory has designed and had constructed equipment for (i) comparing the luminous intensity of luminous paint on the dials of meters (to be incorporated in radio equipment) with green light of standardized intensity, and (ii) measuring the luminous intensity of radio-active materials used in luminous paint. The former is used as a check to maintain the luminosity of the dials between known safe limits of intensity and to observe the falling-off of the intensity with time, while the latter equipment measures the variation of intensity and the decay with time of the luminosity of the powders used.

(*k*) *Hard-rubber Coil-formers.*—The Radio Controller's office, Ministry of Supply, forwarded a number of hard-ruber coil-formers used in field radio equipment which tended to expand under working temperatures and overstretch the wire wound round them. Samples of various mixes of compounded rubber were obtained from the manufacturers, expansivity measurements made, and advice given as to the most suitable "mixes." The firm was thus able to produce a rubber compound which had a sufficiently low coefficient of expansion.

(*l*) *Soft Vulcanized-rubber Mountings for Whip-cord Aerials.*—Accelerated ageing tests were performed on soft vulcanized-rubber mountings used for the bases on which whipcord aerials are mounted on Army vehicles. Recommendations were made as to the comparative values of two types of mounting supplied.

(*m*) *Sound Measurement in Aeroplane Engine Test-houses.*—Measurements and recommendations were supplied to Air Department for reducing noise and vibration of test benches.

(*n*) *Repairs, Tests, Calibrations.*—Over nine hundred items have passed through the physical and electrical laboratories during the past twelve months in the nature of repairs, calibrations, tests, &c. Many of these, such as dial thermometer repairs, may take up to three or four days, cloth tests one day per sample, down to pressure-gauge calibrations, which may require fifteen minutes if no cleaning or overhaul is required. In the majority of calibrations, previous overhaul or repair was required.

(*o*) *General:*—

(i) Sound measurements on wallboards for the Director of Scientific Developments:
(ii) A portable experimental vulcanizer was developed, and six were constructed for the Linen Flax Section of the Department of Industries and Commerce for the repair of scutcher belts:
(iii) A bomb-filler was designed for safe filling of practice bombs with chlor-sulphonic acid:
(iv) Ground-vibration measurements were made for the Public Works Department in connection with a railway problem:
(v) Comprehensive life tests made on accumulator boxes for M.G. carriers and tanks:
(vi) Insulation measurements of plastics and wax-impregnated insulated wires for Radio Controller:
(vii) Moisture-meter investigation for determination of moisture in seeds by electrical equipment:
(viii) Investigational work performed on dark adaptometer for Air Department:
(ix) Set of colour cards constructed and reflection factors measured for camouflage paints on ships:
(x) Bimetallic thermometer being developed for Department of Island Territories for use with coconut-desiccator ovens.

Metrology Laboratory

The metrology laboratory is now equipped to make linear measurements from less than 1 in. up to 3 ft. to an accuracy of 0·0001 standard inch. Throughout the year the routine checking of gauges for the Munitions Controller and the Chief Inspector of Munitions (Army) has proceeded satisfactorily. In this period over 12,500 gauges of all types have been certified. The work is performed entirely by a female staff under the supervision of two engineers. This laboratory is the central authority in New Zealand for the certification of munitions gauges made by all tool-rooms throughout the Dominion; it functions quite independently of the Dominion Physical Laboratory tool-room, which makes an inspection of its own work (just as the industrial tool-rooms do) before forwarding gauges to the metrology laboratory for certification. The decreasing number of rejected gauges during the past twelve months reflects partly the improving skill in New Zealand tool-rooms and partly their improved facilities and equipment. Opportunity is taken here to record the spirit of co-operation existing between the industrial tool-rooms, the Munitions Controller's Department, and the Dominion Physical Laboratory, which has enabled such rapid progress to be made in the field of precision tool and gauge manufacture.

Metallurgy Laboratory

The following major investigations have been made during the year:—

(*a*) *Manufacture of Screw-ring Gauges.*—In the manufacture of hardened screw rings two interdependent problems are encountered, the prevention of distortion in heat treatment and the final lapping to correct form. In an effort to hold pitch and diameter of rings to 1/10,000 in. in hardening, all types of commercial tool steels were investigated, and overseas rings were examined to determine materials and technique used. A satisfactory combination of hardening and lapping with materials available has now been evolved.

(*b*) *Determination of Magnetic Change Points of Steel.*—An investigation was undertaken to determine the applicability of the magnetic test as a means of determining correct hardening temperatures. This simple test is widely used in industry, but gives satisfactory results with only a limited class of steels. All commonly-used tool steels were accordingly investigated, and the relation between the magnetic change points and upper and lower critical points determined. These results will shortly be circularized to tool-rooms.

(*c*) *Linear Changes in Refractories at High Temperature.*—Apparatus has been constructed for the determination of linear expansion of refractories up to 1,000° C. A series of eight types of refractory brick has been investigated for a cement company, and results compare very favourably with published figures. The work will be extended to cover all types of locally-available bricks as time permits.

(*d*) *Thermal Insulation Values of Refractories at High Temperature.*—Equipment for the determination of thermal insulation of refractories up to 1,100° C., designed along the lines of the A.S.T.M. apparatus, will be completed shortly. Bricks used in the construction of rotary kilns will be first investigated, and subsequently all other refractories available.

(*e*) *Optimum Annealing-conditions for Steel used in drawing Bomb Casings.*—In an effort to improve tool life and quality of finished product, an investigation into the correct interstage annealing procedure for mortar-bomb drawn casings has been carried out. Machinability, physical properties, life of dies, and difficulty of final pickling all have to be considered together in this problem.

(*f*) *Optimum Annealing-conditions for Fuze Brass.*—The change over from Australian forgings to English forgings in the manufacture of fuze bodies has given rise to a serious machining problem. Laboratory work directed at overcoming this difficulty has been completed, and large-scale tests are now being carried out.

(*g*) *Casting of Alnico Magnets.*—The difficult problem of remelting and treating Alnico magnet alloy has been overcome by a very rapid melting technique employing an indirect arc furnace. The laboratory is now in a position to supply limited quantities of castings up to 10 lb. in weight.

(*h*) *Determination of Stresses in Welded Girders.*—The adoption of welded joints for the main girders of the new Whirokino Bridge has given rise to the question of best welding procedure to minimize residual stresses. A very sensitive strain-gauge has been constructed for the investigation, and two full-scale test welds are now being prepared.

(*i*) *Uniform Hard Chrome-plating of Steel Balls.*—The application of barrel plating methods to hard chrome-plating has been successfully undertaken, and spherical drifts for use on mortar-bomb tail units are now being processed.

(*j*) *Electroplating of Bearing Surfaces with Lead.*—At the request of the Air Department, a small pilot plant was instituted for the lead-plating of radial engine master-rod bearings. After the technique had been established, Air Force personnel were instructed and details of full-scale equipment supplied to the Department. The process is now being worked very satisfactorily.

(*k*) *Investigation of the Cause of Failure of Rocker-boxes on Aircraft Engines.*—A detailed investigation of the failure of rocker-boxes on certain aircraft-engines has been completed. This entailed metallographic examination combined with destructive tests on cylinder heads and an investigation of the actual running conditions of the engine.

(*l*) *Manufacture of Suitable Alloys for Fusible Links to prevent the Overheating of Salt Bath Furnaces.*—The whole question of fusible alloys for furnace protection at various temperatures has been investigated. Several different types have been supplied and are operating satisfactorily. For operating-conditions in which fusible links are unsuitable a differential expansion-type relay has been designed and is now being constructed.

The above investigational work is additional to the routine testing and examination of metals, the calibration and inspection of works' pyrometers for outside industry, the determination of heat treatment procedures for outside industry, the X-ray examination of castings, and the hard chrome-plating of dies, tools, and gauges. Over one hundred separate items of work have been dealt with under these various headings. In addition, this laboratory has exercised technical control over all heat treatment of steel tools and gauges carried out in the Dominion Physical Laboratory furnace-room for the Laboratory's tool-room and for industry.

Design Section and Instrument Workshop (including Glass-blowing, Glass-grinding, and Electrical-instruments Workshop)

The design, manufacture, and repair of instruments and equipment has been done on a large scale this year. In round figures, over 250 items of construction, 500 items of repair, 1,500 items of glass construction, and 150 items of electrical-instrument repair and construction have been despatched. This work has been confined as far as possible to that requiring specialist attention such as the combined laboratory and workshop facilities and the scientific and technical staff of the Dominion Physical Laboratory are now capable of. The work has all been directly or indirectly related to the war effort. The United States Marine Corps made full use of the facilities available for the overhaul of optical and other equipment requiring laboratory supervision.

An appreciation of the variety and type of work accomplished can be gained from the following list of special apparatus which has passed through the hands of the Dominion Physical Laboratory this year: Gun telescopes, range-finders, binoculars, theodolites, surface-aluminized mirrors, casettes, aerial and other cameras, microscopes, projectors, bomb-sights, gun-sights, lenses, photometers, chronometers, stop-watches, barometers, barographs, aneroids,

tachometers, frequency meters, special electric motors, X-ray tubes, mercury contactors, thermostats, pyrometers, thermometers, special electric switches, voltage-regulators, railway-track recorders, moisture-meters, thermocouples, microtomes, seismographs, hygrometers, balances, gas-pressure recorders, magnetic compasses, pressure and vacuum gauges, plotting-tables, dial gauges, micrometers, smoke-density meters.

Tool-room

The tool-room has been fully engaged throughout the year on the manufacture of precision steel gauges, dies, tools, and special equipment requiring accurate machining and grinding. Over 6,190 gauges and 2,545 tools were made during the past twelve months. This work has been performed strictly to priorities submitted weekly to the Dominion Physical Laboratory by the Munitions Controller. The shortage of skilled toolmakers has necessitated the employment of the minimum ratio of skilled to unskilled operators. Several female machinists trained under the Emergency Training Scheme at the Wellington Technical College have proved very satisfactory. The work is subdivided into (*a*) machining of steel before hardening; (*b*) hardening by salt-bath furnace-heat treatment; (*c*) grinding within the final tolerance; (*d*) check measurement. These four processes are conducted in separate rooms. A thorough system of routing the work has been instituted, since one of the major difficulties in any workshop dealing with a large number of differing items is to avoid losing sight of any one piece of machined metal.

Although the main output of the tool-room to date has been gauges, there has been a considerable increase in the amount of small precision-tool work, and this can be expected to increase still further as the facilities at the Dominion Physical Laboratory tool-room become more widely known.

GEOLOGICAL SURVEY

Director: Dr. J. Henderson

During the year ended 31st March, 1944, the Director visited Whangarei, Wellsford, Kaukapakapa, Greymouth, Hokitika, Clarendon, Elliotvale, and Glenorchy to inspect deposits of economic value. He prepared reports on fireclays and ganisters, on feldspar, on quartz crystal, and on earthquake risk in New Zealand, and in addition a number of reports by other officers of the Geological Survey were edited.

Field officers were largely engaged in examining, sampling, and estimating quantities of coal and other deposits of possible economic value, the only regional mapping being that necessary to further this work. Many bore-sites to test for subsurface water were selected, several municipal water-supplies were examined, hot-water supplies at Rotorua were reported on, and the geology of sites suggested for dams, bridges, and buildings was investigated. Geophysical work was carried out in several localities, the magneto-meter being found especially useful in the prospecting of the small bodies of serpentine occurring in North Auckland.

Coal Survey

All parts of the Grey Coalfield have now been mapped sufficiently to allow the preparation of the report. Mr. W. E. Hall is working on the historical and operational sections in Wellington, and Mr. M. Gage on the sequence and structural sections in Greymouth.

The Westport Coalfield has been photographed from the air, ground control stations have been fixed, and as soon as the detailed map now in hand is ready, Mr. H. E. Fyfe will begin the detailed examination. Aerial mapping and the much simpler sequence of coal-measures should greatly shorten the time of investigation as compared with that of the Grey Coalfield.

Dr. A. R. Lillie, who, since the beginning of 1944, has been assisted by Mr. M. T. Te Punga, is now well forward with the mapping of the Nightcaps-Ohai Coalfield. The topography is easier and the outcrops fewer than on the Grey Coalfield, so that data are less abundant and the conclusions will be less precise.

Mr. Fyfe visited Greymouth, Manapehi, Ohura, and Huntly, the two latter in order to advise on areas of shallow coal that it is proposed to strip and mine opencast. Mr. J. Healy furnished a report on the proposed prospecting at Kawakawa, North Auckland, and Messrs. H. W. Wellman and R. W. Willett another on a coal-bearing area at Elliotvale, a few miles south of Milton.

Palæontological Work

Dr. J. Marwick examined many collections of molluscan fossils from the West Coast and from Wairoa (Hawke's Bay) and Moeraki districts. Mr. C. A. Fleming completed his identifications of faunas from the Dannevirke Subdivision. Both officers prepared descriptions of new forms found during their work.

Dr. H. J. Finlay identified foraminifera from a great many samples forwarded by oil companies and field officers. The more important groups of samples were from North Auckland, the West Coast, and Moeraki.

Petrological Work

Dr. C. O. Hutton made many mineral determinations for the Dominion Laboratory, Railways, and other Departments, as well as for commercial firms, &c. He identified minerals in numerous samples of heavy residues from the Manawatu-Wanganui district and North Westland. This work was to aid oil companies in mapping formations. He examined also a series of concentrates from dredges, visited New Plymouth in connection with the igneous rock penetrated in the Devon bore, and visited North Auckland to advise on the probable behaviour of the small bodies of serpentine likely to be required by the fertilizer industry.

Geophysical Work

Mr. N. Modriniak made magnetic and seismological observations in the Whakatane district in an investigation of the possibility of obtaining volcanic heat near the sea. He also visited Whale Island. Mr. E. O. Macpherson prepared reconnaissance geological maps of the Whakatane district and Whale Island. Mr. Modriniak extended the magnetometer work already undertaken at Rotorua.

Mr. Modriniak continued the investigation of possible dam-sites on the Waikato River upstream from Arapuni Lake. Only magnetometer work was possible.

At Huntly an attempt is being made to ascertain the shape and structure of the coal-basin concealed by the sands and silts of the Waikato north of the present mines.

The geophysical drill has been found most useful in boring for serpentine and water in North Auckland and for coal at Huntly.

Special Examinations

Phosphates.—The prospecting of the Clarendon deposit of phosphatic rock continued throughout the year, Mr. R. W. Willett taking samples and advising as the work progressed. Mr. E. O. Macpherson, in a report, discusses the origin of the rock, and suggests that similar deposits may occur in other parts of the South Island.

Serpentine.—Mr. J. Healy and Mr. C. A. Fleming investigated the known bodies of serpentine in the Kaukapakapa district and some of those in the Wellsford district with the magnetometer, post-hole digging and boring with a power-drill. The rock-bodies were found to be disappointingly small, but a quantity of at least 100,000 tons of reasonably-accessible serpentine was proved.

Limestone.—Mr. R. W. Willett continued the estimation and sampling of the limestone deposits of Southland within easy reach of transport. Mr. M. Ongley was in Masterton on two occasions, once to report on and sample a limestone deposit proposed for crushing as agricultural lime, and again to report on a new sink-hole in gravel probably overlying limestone.

Chalk.—Mr. H. W. Wellman reported on the deposit of chalk at Oxford, North Canterbury.

Diatomite.—Mr. C. A. Fleming mapped and bored a small deposit of diatomite at Morningside, Auckland.

Flint.—Mr. H. W. Wellman examined the deposits of flint near the mouth of Clarence River, Marlborough.

Mica. Messrs. H. W. Wellman and R. W. Willett visited Henry Pass between George Sound and the middle arm of Lake Te Anau where a lenticular dyke of pegmatite was mined for mica many years ago. The body of rock seems to have been worked out and no other was found during a hurried reconnaissance of the neighbourhood. Some miles from the sea, however, a dyke of feldspar was noted on the south side of George Sound.

Clay.—Clay deposits in widely-separated districts were mapped and sampled. A number of students, under Mr. Healy's supervision, mapped and sampled with post-hole diggers a volcanic dome of partly-decomposed dacite at McLeod Bay, Whangarei Harbour. The same party, assisted by Mr. C. A. Fleming, worked on clay deposits in the Bay of Islands district and near Kaikohe.

Mr. H. W. Wellman sampled and mapped clay deposits at Waimangaroa and Charleston on the West Coast, and at Mount Somers at Kakahu in Canterbury.

Fuller's Earth.—Mr. R. W. Willett directed the locating, prospecting by trenching and post-hole digging, and sampling of deposits of Fuller's earth in the Gore-Mataura district. Some regional mapping was necessary in this geologically little-known region.

Water-supply.—Mr. M. Ongley discussed the Hutt artesian basin and the Gisborne town supply with waterworks engineers.

Mr. J. Healy was consulted on subsurface water-supplies by the military and county authorities, municipalities, State Departments, commercial firms, drillers, farmers, and others. He selected many well-sites with good success, chiefly in North Auckland and about Auckland City, but went as far afield as Tairua, Rotorua, Morrinsville, and Raglan on this business.

There are substantial areas of low relief in North Auckland suitable for close settlement, except for shortage of water for stock during continued dry weather. At a few points good underground water has been tapped, but in general such supplies have not been found even by fairly-deep drilling. At Mr. Healy's suggestion several bores were drilled in the Silverdale - Dairy Flat district. These had to be abandoned, owing to caving, without striking water; the deepest was 715 ft.

Hot Water.—Messrs. Macpherson, Healy, and Modriniak at different times visited Rotorua to report on how the extensive drilling for hot water by the municipality, hotels, and others was likely to affect the supply for public baths. The last-mentioned officer located the position of many of the wells on a map and collected some data on their depth, discharge, and temperature. A large part of the ground water under Rotorua is heated by magmatic gases, and no worth-while opinion as to the effects of the bores on the discharge of the springs can be given without systematic observations over a number of years.

Mr. Modriniak also reported on the lowering of the hot pools at Whakarewarewa feeding the Spout and Blue baths, and suggested means to maintain the supply.

MAGNETIC OBSERVATORY, CHRISTCHURCH

Director: Mr. H. F. Baird

The programme of work in terrestrial magnetism, seismology, cosmic radiation, atmospheric electricity, and meteorology has been generally maintained during the year as in former years. Magnetic resurvey field-work was also continued, new stations being established in suitable locations throughout the country.

Terrestrial Magnetism.—The work of recording and tabulating the mean hourly values of the magnetic declination, horizontal force, and vertical force has been continued as usual, and absolute observations of the earth's magnetic field were obtained regularly. From the mean hourly values for all days the following mean figures for 1943 are derived:—

		Change since 1942
Magnetic declination	18° 48′·4	+ 5′·9
Magnetic horizontal force	22,222·0γ	−10·7γ
Magnetic vertical force	−55,203·3γ	+ 4·5γ
Magnetic inclination	68° 04′·37	− 0′·47
N.	21,035·6γ	−22·5γ
E.	7,163·9γ	+32·9γ
T.	59,508·2γ	− 8·1γ

Also given in the above table are the changes in each element since 1942. The secular change in declination, although less than last year, still remains high; that in H shows a tendency to return to the normal figure.

As usual, the international magnetic character figures for all days have been furnished quarterly to the Secretariat de l'Organisation Meteorologique Internationale, Lausanne, and the Carnegie Institution, Washington. Values of "K," the range index of geomagnetic activity, have also been transmitted to the International Association of Terrestrial Magnetism and Electricity at Washington. Since April last "K" indices have been supplied daily to the Defence Services for use in connection with the forecasting of radio conditions. Tabulated hourly values of D and H for the years 1912, 1915, 1916, and 1917 were supplied to Mineral Resources Survey, Commonwealth of Australia, for use in certain defence projects. It was found that the hourly measurements for these years had never been reduced, and this had to be done before accurate values could be supplied.

Magnetic Resurvey.—Despite delays caused by inclement weather, magnetic observations were made at 63 stations throughout New Zealand. Of these, 34 were new points established in areas which were selected as magnetically undisturbed, after collaboration with members of the Geological Survey. In some cases sites were also tested by making a reconnaissance survey with a Schmidt vertical magnetic balance. The remaining 29 stations were points observed at during the first year of the survey and which were reoccupied for secular-variation purposes and to make other needed checks. These reoccupations confirmed quite well the differing rates of secular variation with change of latitude.

Intercomparisons between the field instruments and the Amberley base station instruments have been frequent and the results are still in close agreement. Complete results of the field observations up to the end of 1943 have been forwarded to the Carnegie Institution of Washington, who are utilizing this information in the preparation of magnetic charts. A map of New Zealand showing the isogonals and lines of equal annual change in declination as at epoch 1943·5 was prepared using the results obtained at 109 of the stations occupied during the resurvey. This has been published for use by the Services.

Electric Potential Gradient.—The Bendorf electrometer has been kept in operation, and the number of hours of recording lost due to spider-webs was greatly reduced by applying a timber-treatment process to the building at regular intervals. For the purpose of obtaining more frequent checks on the constancy of the "zero," a relay was devised for automatically earthing the collecting system at frequent intervals throughout the day. As well as maintaining current measurements, further progress has been made in overcoming arrears of measurement. The Kew method of characterization of days has been adopted and all days 1940–44 grouped according to this scheme. Early this year the method was extended along lines suggested by the International Association of Terrestrial Magnetism and Electricity. The extended method has been used for 1944 values and eventually will be applied to all previous years. A new method of preparing data to be used for correlating the observed variations of potential gradient with local meteorological conditions was also instituted.

Seismological.—The seismological equipment has functioned satisfactorily and has been maintained in critical adjustment by quarterly calibrations. Preliminary measurements have been published each month with those from the Dominion Observatory. In all, some 359 seismic disturbances were recorded during the year. Owing to the failure of the master clock controlling the time-marking mechanism, it was necessary to adapt a chronometer for this purpose until new parts could be obtained from England. Repairs have been effected, and the system is again functioning satisfactorily.

Cosmic-ray Meter.—Delay in the fulfilment of supplies again caused a loss of record for a short period. Measurement of records has been maintained and results forwarded quarterly to the Carnegie Institution, Washington.

Meteorological.—The programme of meteorological observations—thrice daily on most days—was continued for climatological purposes and the results forwarded to the Director of Meteorological Services. Results were also published daily in the local newspapers. As usual, there has been much demand for meteorological data from other Departments and many sections of the community. In order to comply with the increasing number of requests for information regarding humidity and the moisture content of the air, figures derived from the thrice-daily observations for the last forty-two years were tabulated.

Equipment.—A new radio receiving-set was designed and made to improve the reception of time signals at Amberley for the purpose of checking the clocks there.

METEOROLOGICAL BRANCH

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

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

IMPERIAL AGRICULTURAL BUREAUX

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

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

OVERSEAS LIAISON

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

During the year approval was obtained for an increased establishment of overseas scientific liaison officers, and Messrs. N. A. Marris and J. A. D. Nash, of the head office staff, were appointed to United States of America and Australia respectively. Mr. Nash has taken up his duties in Melbourne, and Mr. Marris will leave shortly for Washington, which will be his headquarters in the United States of America.

PUBLICATIONS

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

Apart from the *Journal,* a further departmental bulletin was issued during the year: No. 88, "Fireclay and Ganister in New Zealand," by J. Henderson.

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