1930.

COMMONWEALTH OF AUSTRALIA.

FOURTH ANNUAL REPORT

OF

THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

FOR THE

Year ended 30th June, 1930.

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Council for Scientific and Industrial Research.

FOURTH ANNUAL REPORT FOR YEAR ENDED 30TH JUNE, 1930.

I.—GENERAL.

1. *Summarized Statement of Results Achieved.*—The year 1929–30 is the fourth year during which the Council for Scientific and Industrial Research has been in existence. The Council has created, at any rate in regard to certain of the major branches of its investigations, a strong and effective organization, capable of dealing efficiently with many of our pressing national scientific problems. It is satisfactory to record that valuable progress has been made in the Council's investigations and that important results of economic value have already been obtained. The work of the Council is being pushed forward as fast as practicable in full recognition of the fact that the establishment of primary production on a more profitable basis is a vital factor in the present economic and financial situation of the Commonwealth and in the restoration of prosperous conditions. Whilst Governments and the nation as a whole have their own role to play in the reduction of costs of production and in increasing efficiency, science can take an equally important part. Since, from the point of view of a general report, the question of the results obtained is the matter which is perhaps of greatest public interest, a brief summary of what has so far been achieved is furnished in the following paragraphs.

(i) *Plant Industry.*—The Government Biologist of New South Wales has recently stated that plant diseases cause economic losses in Australia amounting to £12,000,000 annually. In common with the State Departments of Agriculture and other institutions the Council is at work in this field through its Division of Plant Industry. Already its co-operative investigations on bunchy-top of bananas have re-established the industry on hundreds of abandoned plantations in New South Wales and Queensland. The investigations on bitter-pit in apples have been successful and have pointed the way to a clear saving of £100,000 per annum to Australian producers. Spotted wilt of tomatoes is another disease which is frequently responsible for the total destruction of plantings. The transmission of the disease has been traced to the bite of a thrips and thus a large step taken towards the ultimate goal of economic control. Water-blister of pineapples, a disease which causes losses up to £12,000 per annum, has been shown to be controllable by simple washing with salicylic acid. A study of the dread blue-mould disease of tobacco plants has traced the condition to an infection of the seed. Another important activity of the Division of Plant Industry is the testing, after introduction from abroad, of new varieties of plants likely to be of value, particularly in the drier and drought-affected areas of the continent. Several hundred varieties have been imported to date. Valuable progress has been made in the investigations on varieties of wheat resistant to flag-smut which causes an average annual loss of 3 per cent. In certain localities 10 per cent. losses in yield are common and losses of up to 50 per cent. have been known. An important section of the Division's work is concerned with the mode of inheritance and variation of plant characteristics of economic value, in order that the production of improved types may be facilitated, and with the production of new varieties of crop plants which will give increased yield of better quality for every unit of water and food material consumed. In view of the fact that the grass and forage plant crop is the most important in Australia, a beginning has been made with investigations for the purpose of arriving at definite facts regarding the condition of pastures and their improvement.

(ii) *Economic Entomology.*—In the Council's Division of Economic Entomology very definite success has attended the investigations on the control of St. John's wort by insect enemies. This weed pest covers some 400,000 acres, mainly in Victoria and New South Wales, and has recently spread at an alarming rate. The Council's investigators in Europe have discovered certain species of insects (*Chrysomela*) which are extremely destructive to that weed. After most exhaustive tests to ascertain beyond dispute that these insects will not feed on any plants

of economic value, supplies of them have been successfully introduced into Australia, initially under quarantine control. They have been acclimatized to Australian conditions, and supplies of them have been bred free from hyper-parasites and have been distributed in areas infested by St. John's wort in New South Wales and Victoria. Again, with respect to ragwort, a weed which covers many thousands of acres in the southern States, a destructive insect has been introduced and supplies are being bred for early distribution. Other insects have been found to be effective against the seed pods of Noogoora burr, which already covers thousands of acres in Queensland, and which is spreading at an alarming rate. There seems every reason to believe that when adequate supplies of all these insects are bred, the clearing of large areas of weed-infested localities in Australia will be rendered possible at a nominal cost, and that the total increase in value of the land then being made reproductive will amount to millions of pounds.

The extraordinary valuable and spectacular results achieved in the destruction of prickly pear by insect enemies is well-known. The scientific work has been carried out by the Commonwealth Prickly Pear Board, which was created by the former Advisory Council of Science and Industry, and which has been continued as an important activity of the Council. The large-scale distribution of the insects is being effected by the State authorities in New South Wales and Queensland, and the Commonwealth Board is working in the closest co-operation with these authorities. The most surprising achievement has come from *Cactoblastis cactorum*, which has already destroyed the pear over very large areas. Over 2,000,000,000 eggs of *Cactoblastis* have been distributed. They were all obtained from the single consignment of 2,750 eggs of the insect introduced into Australia by the Board in 1925 from the Argentine. Biological control has eradicted dense prickly pear which it was impossible to clear by other methods. Large areas of land have been freed from the pest and have been brought to a state at which productivity is practicable. The Queensland Government has decided to introduce a bill to facilitate the settlement of some of these areas. It is anticipated that the area available for settlement will be vastly increased within the next six or twelve months, by which time the insects distributed during the last two or three years will have completed the work of destroying the original heavy—and in many cases impenetrable—growth of prickly pear. The monetary value of this work runs into millions of pounds.

Turning to insect pests, the full extent of the menace to the cattle and dairying industry of Queensland and New South Wales that is caused by the rapidly increasing and spreading buffalo-fly of northern Australia is realized by few. Nevertheless, the fly is following the path travelled several decades earlier by the cattle tick, and most serious economic losses are in the balance. If it should extend to the cattle areas of Queensland and New South Wales, it is estimated that the damage it will cause will run to no less than £1,500,000 annually. The Council is concentrating on the problem of entomological control by the introduction of parasites which destroy the fly in some stage of its life-history. Already as a result of the Council's investigations in the Dutch East Indies, from which country the fly was originally brought to Australia, no less than twelve varieties of insects have been discovered which apparently control it and prevent it from becoming a serious pest.

Probably no single problem is regarded by Australian primary producers as of equal importance, and no single source of loss as great, as that caused by blowfly attack in sheep. Whilst the quest for a means of effecting an adequate control of the blowfly is by no means hopeless, it is admittedly an exceedingly difficult matter. It involves slow and laborious investigations and, where so many able workers have failed in the past, it cannot be expected that early spectacular results will follow the investigations which the Council is conducting. Although, therefore, progress must inevitably be slow, already very definite advances have been made in the Council's fundamental work on the problem. For example, accurate knowledge has now been obtained of the habits of the various species of blowfly which attack sheep and to the determination in the first place of those species which are " primary ", i.e., which first attack uninjured sheep and which are therefore responsible for the damage, and, in the second place, of those which will only " strike " the sheep after the way has been prepared for them by the presence of " primary " species. It has been established that there is a very definite series of flies which arrive at successive stages in the process of decomposition. While the results of this branch of the work are not of any immediate economic importance, they are of very great significance, since they show that in order to control the pest, attention must be concentrated on those species which are responsible for the first attack. If these species can be controlled, the problem will be largely solved. The Council has also actively continued its investigations on parasites which destroy the blowfly in other countries at some stage of its life-history.

(iii) *Animal Nutrition.*—The Council's Division of Animal Nutrition has concentrated its work almost entirely on a fundamental study of the sheep. Despite the fact that the work has been in progress only for a comparatively short period, results of great value are already

beginning to be obtained. It has been found, for example, that in some localities, the feeding of certain supplementary proteins results in an average increase in the weight of fleeces of no less than 30 per cent. Further work is necessary before the method can be made generally applicable, but the potentialities are most promising and a very considerable lowering of the cost of wool production is in sight. The question of phosphorus deficiency is a very serious matter in many pastoral areas of Australia. Already very substantial progress has been made in the investigations of which the object is to determine the form of phosphorus with which most economically to combat the deficiency. Similarly a great deal of the fundamental information necessary for the determination of the most economic methods of supplementary feeding in times of drought has now been obtained, and as soon as the results of the investigations have been confirmed by semi-large scale experiments, it will be practicable to give definite advice to pastoralists on this very important matter.

(iv) *Animal Health.*—The outstanding achievement of the Council's Division of Animal Health is the discovery and practical application of an effective vaccine against black-disease of sheep, a disease which is responsible for an annual loss of £1,000,000 in New South Wales alone, and corresponding losses in Victoria and Tasmania. The Division has assisted largely in the successful Australian work on the control of liver fluke, which previously caused losses amounting to well over £1,000,000 per annum. The means whereby caseous lymphadenitis of sheep, a disease which causes most serious losses to the mutton export trade, is spread, have been determined. As a result of a co-ordinated scheme of work which the Council and certain of the State Agricultural Departments and other bodies are conducting, a pamphlet has been issued indicating means by which it is confidently expected that the prevalence of the disease will be substantially decreased. In its early stages, it is impossible to diagnose the disease by ordinary clinical methods, but one test has been devised whereby obscure cases may be determined. Further, a vaccine has been prepared which has proved to be efficacious in laboratory tests and which is now being applied experimentally in the field. Very satisfactory progress has also been made in the study of a sheep-disease in Western Australia, simulating, but distinct from, black-disease in the Eastern States and known as braxy-like or Beverley disease. The cause of that disease has now been determined and a vaccine produced, which—judging by laboratory tests—gives a definite indication of proving of value in the control of the disease. Already this view is supported by the results of vaccination applied in a few flocks. Important progress has also been made in the Council's investigations on internal parasites of sheep (stomach worms, lungworms, &c.), and a leading Queensland pastoralist, himself owning 100,000 sheep, has stated that, as a result, sheep-rearing in his district has been completely revolutionized.

Turning to cattle, the value of the "B.C.G." vaccine for tuberculosis has been demonstrated, and much information regarding red-water in cattle has been obtained. A test for the determination of pleuro-pneumonia in cattle has been evolved, and, as a result, the Javan authorities have lifted their previous embargo against the importation of Australian cattle.

(v) *Soils and Irrigation Settlement Research.*—The work of the Division of Soils Research has been confined almost entirely to a study of the soil types of our irrigation settlements with a view to determining the most suitable cultural practices to follow and the best methods of irrigation to adopt without ruining the blocks by salting. Surveys of areas totalling between one and two hundred thousand acres have been completed. The losses incurred in the settlements, due to lack of soil surveys in the past, amount to very large sums of money, and the results of the work already carried out indicate not only that most of these losses could have been avoided, but also that future developments in irrigation settlement can be undertaken with a full knowledge, so far as suitability of soils is concerned, of the conditions essential for successful production.

Since the establishment of the Council's Viticultural Research Station at Merbein, the yield of dried fruit per acre in that area has been doubled. Further, this increase has been accompanied by a considerable improvement in the quality of the product. Largely as a result of the Station's activities, the extensive damage caused by the dried-fruit grub has been eliminated. The work on irrigation has resulted in a 25 per cent. reduction in the period of each irrigation, with its accompanying decrease in water costs per acre, amounting to about £9,000 per annum, in the Mildura district alone. The more recently established Citricultural Research Station at Griffith is now beginning to produce results, and already has obtained information of considerable value to the whole of the settlers in that area.

(vi) *Forest Products.*—In the field of forest products research, the work on paper pulp—initiated by the former Advisory Council of Science and Industry—has been of outstanding success. Despite the definite advice of paper experts from abroad that Australia's hardwoods were quite unsuited for paper pulp, the investigators have been able to develop a method of manufacture that gives a satisfactory product. The work has also been extended to the production

of brown wrapping-papers from *Pinus radiata* (*insignis*), large areas of which have been planted in Australia. The operations of the paper companies interested in Tasmanian forest areas are based entirely on the original work of the Council, and if these companies are able to give effect to their plans for the establishment of an industry capitalized at several million pounds and for the employment of a large number of workers, the development will be due primarily to the successful results of the scientific work. Like its paper work, the Council's investigations on the preparation of tannin extracts from certain Western Australian gums have been successful, and are now being actively followed up by commercial interests which propose to establish the industry on a large scale. The recently formed Division of Forests Products is now concentrating, among other matters, on the development of more efficient methods of seasoning Australian timbers to enable them more effectively to compete with the foreign material. The Division has also recently commenced a programme of timber-preservation experiments aimed at reducing Australia's annual bill for timber replacements, the cost of which in Government structures and railway sleepers alone, amounts to well over £1,000,000 per annum. The Division initially directed its main efforts to a campaign of education in certain of the timber-using industries. It was realized that the application of existing knowledge would be of greater and more immediate benefit to the industry than the results to be obtained from researches initiated by the Division. The results of the educational campaign have been most satisfactory, and many timber organizations and individual firms have expressed their high appreciation of the valuable practical assistance thus rendered. As an example, one timber miller has reported an increase of 25 per cent. in his yield of merchantable timber since the adoption of advice given to him by the Division with regard to kiln-seasoning methods.

(vii) *Miscellaneous.*—In connexion with its investigations on the cold-storage and preservation of foodstuffs, the Council has demonstrated that Australian beef, provided it is young and of suitable quality, can be frozen and exported to London without suffering anything like the deterioration by " drip " that for many years has operated to the detriment of exporters. It has shown that losses in banana ripening can be overcome by the use of small quantities of coal gas in the ripening chambers. Its work on citrus fruit has demonstrated the way in which oranges may be satisfactorily stored over long periods.

Throughout the course of a year the Council receives many hundreds of requests for scientific information on matters concerning the primary and secondary industries of the Commonwealth. There is no doubt that in this field too, it has met a definite want and has indirectly been responsible for many improvements in industrial practices.

To sum up, it is obvious that despite its comparatively recent formation, the Council has already been responsible for large national savings many times greater than its annual cost, and that its possibilities in the not far distant future are even greater. That various commercial and other interests concerned are fully aware of this position is indicated by the numerous grants in money and in kind, and the assistance in the way of gratuitous services rendered to the Council. The total monetary value of these grants and assistance is over £200,000. Sufficient has been stated in this brief summary to indicate not only that scientific research is a most potent instrument in the efficient development of our industries and in the financial and economic rehabilitation of the Commonwealth, but also that it is capable of paying higher dividends in the form of practical results than any other type of national activity or enterprise.

2. *Organization of Work of Council and Formation of Divisions.*—In regard to the major sections of work on which the Council is concentrating, it has adopted the policy of establishing " Divisions ", each under the control of an eminent authority in the sciences concerned, to direct the work in the capacity of Chief of the Division. Up to the present, six Divisions have been formed, viz. :—

(1) The Division of Plant Industry—Dr. B. T. Dickson, Ph.D., &c. (Chief).
(2) The Division of Economic Entomology—Dr. R. J. Tillyard, F.R.S., D.Sc., &c. (Chief).
(3) The Division of Animal Nutrition—Mr. H. R. Marston (Acting Chief).
(4) The Division of Animal Health—Dr. J. A. Gilruth, D.V.Sc. (Acting Chief).
(5) The Division of Soils Research—Professor J. A. Prescott, M.Sc. (Chief).
(6) The Division of Forest Products—Mr. I. H. Boas, M.Sc. (Chief).

The Council suffered a very grave loss by the death in January, 1930, of Professor T. Brailsford Robertson, D.Sc., Ph.D., who was Chief of the Council's Division of Animal Nutrition since its inception in February, 1927, and whose biological studies had made his name famous throughout the scientific world. In co-operation with leading pastoralists and his staff, he laid down a programme of work which has been actively pursued since his death.

In this report, general information is furnished regarding the various investigations in progress and the results obtained. It will be seen that in addition to the work of the six Divisions already established, a number of other investigations are either in progress or have already been completed. Details of the scientific work are not discussed at length, since information of that nature is furnished in the various publications of the Council, namely, its bulletins, pamphlets and quarterly journal.

3. *The Council.*—Since the previous report was made, two meetings of the full Council have been held, one in September, 1929, and the other in February, 1930. Unless special circumstances arise, two meetings will be held each year, of which the first will be sufficiently early to allow of consideration of draft estimates of expenditure for the following financial year. The Council meetings that have been held to date have each extended over three days. The present constitution of the Council is given elsewhere in this report. (*See* Appendix.)

4. *Executive Committee.*—Under the Act constituting the Council, in between full meetings of the latter, all its powers and functions are vested in the Executive Committee. During the period under review 37 meetings of the Executive Committee, allowing one meeting per day, have been held. The 163rd meeting of the Committee was held on 30th June, 1930.

5. *State Committees.*—The constitution of the State Committees of the Council, whose main functions are to advise regarding the general business of the Council, and regarding any particular matter of investigation and research, provides for representatives of the scientific sections of State Departments and of different branches of science and industry. Provision for the co-option of additional members enables each Committee to be so constituted that all the major industrial and scientific activities in each individual State may be given a voice on the local body.

In practice, it has proved that the State Committees have provided the Council with a facile and rapid means of obtaining complete information on different aspects of particular problems. They have also ensured that any important information obtained from State sources is a well-balanced statement of the position, viewed from all aspects. The State Committees, especially those far distant from head-quarters of the Council, have also served on occasions to draw attention to problems previously little known or whose importance and potentialities had not been fully realized.

6. *Co-operation with State Organizations.*—One of the duties of the Council is to co-operate with State organizations with a view to the utilization of facilities and staffs available in the States, and the prevention of unnecessary overlapping. Further attention to the matter has been given during the period under review. The more important investigations in which this co-operation has been established are stated below. Details are given in the sections relating to each particular research. In addition to this co-operation in major investigations, mutual help has been given on numerous occasions in connexion with many minor matters.

(i) *Co-operation with State Departments.*—In Western Australia, co-operation has been continued with the State Department of Agriculture in investigations concerning bitter-pit in apples, Kimberley horse disease and a braxy-like disease in sheep, and with the State Department of Forests in work on tannin extracts. The authorities of the Pathological Laboratory of the Adelaide Hospital are affording valuable facilities in connexion with work on hæmaturia in cattle and on caseous lymphadenitis in sheep. In Victoria, the State Department of Agriculture and the Department of Railways are co-operating in investigations on the storage, preservation and transport of citrus fruit. The former is also helping in the work on the freezing of meat. The State Rivers and Water Supply Commission has made valuable facilities available from time to time in connexion with the Research Station at Merbein. In New South Wales, co-operation has been continued with the Department of Agriculture in investigations on poison plants, on the blowfly problem and on the flying-fox problem. The Water Conservation and Irrigation Commission is closely associated with the work on the production of citrus fruit being carried out at the Council's Research Station, Griffith. In Queensland, the Department of Agriculture is co-operating in the work on the flying-fox problem, in cattle tick-dips investigations and, through the Committee of Direction of Fruit Marketing, in the investigations on the storage, maturation and transport of bananas. The co-operative work of the Commonwealth Prickly Pear Board is mentioned in greater detail later. The Mines Departments in all the States co-operated with the Council in the work of the Imperial Geophysical Experimental Survey.

(ii) *Co-operation with Universities.*—In Western Australia, the University has afforded valuable co-operation in the work on tannin extracts. The University of Adelaide is associated with the Council in several important investigations. It has made available the land on which the Laboratory of the Division of Animal Nutrition has been erected. Very close links have been made with the Waite Agricultural Research Institute of the University. In co-operation with the Council and the Empire Marketing Board, the Waite Institute is carrying out extensive

investigations of the mineral deficiencies of animal pastures. The Institute is the centre of the soils work of the Council, and co-operative investigations on virus and soil-borne fungous diseases of plants, notably tomato wilt, are also carried out there. The University has passed over to the Council its work on the regeneration, in eaten-out pastoral areas, of native vegetation, and is continuing to afford facilities for the investigation. It has also made available to the Council, for the purpose of soils investigations, the laboratory building erected at the Waite Institute mainly from a generous gift of £10,000 by Mr. Harold Darling, on behalf of the Darling family. In Victoria, the University of Melbourne is co-operating with the Council in the investigations of pleuro-pneumona in cattle, tuberculosis in cattle, braxy disease in sheep, on the transport, maturation and storage of bananas, and on the freezing of beef. It is also one of the active parties in the operations of the Radio Research Board, and rendered valuable assistance in the work of the Imperial Geophysical Experimental Survey. The University of Sydney is co-operating with the Council in the investigation of poison plants, of parasitological pests of sheep and stock, braxy disease and caseous lymphadenitis in sheep, and in the activities of the Radio Research Board. It also assisted in the work of the Imperial Geophysical Experimental Survey. The University of Queensland has joined with the Council in the investigations on the storage, maturation and transport of bananas.

7. *Co-operation with Commonwealth Bodies.*—Very close relations have been established with all the scientific organizations of the Commonwealth. The Department of Defence and the Postmaster-General's Department are intimately associated with the Radio Research Board, and the former also with the Committee on the Maintenance of Standards. An agreement has been reached with the Inspector-General of Forests and the authorities of the proposed Federal Forestry Bureau whereby the Council will undertake researches connected with the utilization of forest products, and the Bureau will assume responsibility for researches in problems relating to the growing tree. Both bodies will co-operate in other forestry researches that may prove necessary and that may involve such sciences as entomology, plant pathology, &c., a staff experienced in which the Council has already obtained for other purposes. Close connexion has been established between the Development Branch of the Prime Minister's Department and the Council. In particular, the two bodies are associated in the work of the Imperial Geophysical Experimental Survey and the Australian Tobacco Investigation.

8. *Imperial Co-operation in Research Work.*—An important function of the Council is that of acting as a means of liaison between the Commonwealth and other countries in matters of scientific research. Co-operative arrangements have been completed with several institutions in Great Britain, and satisfactory relations, particularly for the interchange of information and publications, have been established with a large number of scientific bodies throughout the world. The Council attaches great importance to the carrying out of investigations in certain fields of work on an Imperial basis.

In Great Britain, scientific research on national problems falls into two main classes, namely, that connected with the agricultural industry and that connected with the secondary industries. Research work in the former category is subsidized on an extensive scale by the Development Commissioners, the actual work being carried out by independent organizations, such as the Rothamsted Experiment Station for soils work and the growth of plants, the Rowett Research Institute for animal nutrition, the East Malling Research Station for horticulture, &c., each institute specializing in a particular aspect of agricultural problems. Close touch has been maintained with those organizations, which have been particularly ready to afford the Council their help, both in the direction of furnishing advice on particular problems and in making the results of their own research work freely available. In addition, in several instances, arrangements have been made for the British organization to house an Australian investigator for a period sufficient to enable him to obtain full information as to the methods of research adopted, and experience in details of technique, &c. There is no doubt whatever that this help has been of considerable value.

The Empire Marketing Board is another body with which most fruitful relations have been established. The constitution and aims of this body were outlined in the first report of the Council. It has been most generous in contributing towards the cost of Australian investigations. Details of the various co-operative arrangements entered into by the Board are mentioned in the appropriate sections that follow. In addition to the organizations in Great Britain, close relations have been established with bodies corresponding to the Council in the other parts of the Empire.

9. *The Science and Industry Investigation Fund.*—In the previous reports of the Council, mention was made of the creation of this fund. By the Act constituting the Council in 1926, an amount of £250,000 was appropriated from revenue to form the fund. In 1928 an additional

amount of £250,000 was appropriated for the same purpose. The total contributions to the fund therefore amount to £500,000. Up to 30th June, 1929, the sum of £202,781 was spent from the fund, the expenditure during the year 1929–30 being £99,867. This gives a total expenditure from the fund of £302,648, leaving a balance on the 30th June, 1930, of £204,994, after allowing for sundry receipts amounting to £7,642. Particulars of expenditure during 1929–30 on the various investigations, &c., are given in Part XIII. of this Report.

10. *Visit Abroad of Chief Executive Officer.*—In March, 1930, Dr. A. C. D. Rivett, the Chief Executive Officer of the Council, left Australia on an official visit to England. The principal objects of his visit are to consult with the Empire Marketing Board on present and future projects in regard to which the Council is obtaining, or may obtain, grants from the Board ; to establish closer relations with the British Department of Scientific and Industrial Research and other scientific institutions ; to make arrangements for the development of co-operative investigations on an Imperial basis on problems connected with food preservation, cold storage and transport ; to inquire into the work and organization of Research Associations in the United Kingdom and the relation of these Associations to Australian industries ; to arrange for closer co-operation in wool research ; to make inquiries into the present position regarding fuel research, particularly low temperature carbonization and the commercial production of liquid fuels from coal ; to establish closer co-operative relations with the Imperial Agricultural Bureaux and the Imperial Bureaux of Mycology and Entomology ; to inquire into the commercial possibilities of the production of power-alcohol from sugar-cane and other materials ; and to attend a number of Imperial and International scientific conferences and congresses. Substantial benefits have already been derived from Dr. Rivett's visit abroad and from the contacts he has established. It is expected that he will return to Australia early in January, 1931.

11. *Appointment of Sir David Masson as Member of Executive Committee.*—During Dr. Rivett's absence from Australia, Sir David O. Masson, K.B.E., M.A., D.Sc., LL.D., F.R.S., Chairman of the Victorian State Committee of the Council, has been appointed to act as a member of the Executive Committee of the Council.

II.—AGRICULTURAL RESEARCH IN GENERAL.

1. *Imperial Agricultural Research Bureaux.*—As a result of recommendations made by the first Imperial Agricultural Research Conference, which met in London in 1927, arrangements were made for the organization of eight Imperial Agricultural Research Bureaux whose principal function will be to act as effective clearing houses for the interchange of information of value to research workers in agricultural science throughout the various parts of the Empire. An account of the scheme of organization and work of the Bureaux was published in the Council's quarterly Journal, Vol. 2, No. 2. The eight Bureaux which have been established are as follows :—

IMPERIAL AGRICULTURAL RESEARCH BUREAUX.

Bureau.	Location.	Direction.	Australian Correspondent.
Animal Nutrition ..	Rowett Research Institute, Aberdeen	Dr. J. B. Orr ..	(Vacant)
Animal Genetics ..	Animal Breeding Research Department, Edinburgh University	Professor F. E. Crew	Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne
Fruit Production ..	East Malling Research Station, Kent	Mr. R. G. Hatton ..	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra*
Soil Science ..	Rothamsted Experimental Station, Herts	Sir John Russell ..	Professor J. A. Prescott, Chief of Division of Soils Research (C.S.I.R.), Adelaide
Plant Genetics (Herbage Plants)	Welsh Plant Breeding Station, Aberystwyth	Professor R. G. Stapledon	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra
Plant Genetics (Plants other than Herbage)	Plant Breeding Institute, Cambridge	Sir Rowland Biffen ..	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Sydney.
Agricultural Parasitology	Institute of Agricultural Parasitology, St. Albans	Professor R. T. Leiper	Dr. I. Clunies Ross, Parasitologist, Division of Animal Health (C.S.I.R.), Sydney
Animal Health ..	Veterinary Research Laboratory, Weybridge	Dr. W. H. Andrews ..	Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne

* Deputy Correspondent, Mr. W. M. Carne, Senior Plant Pathologist, Division of Plant Industry (C.S.I.R.), Perth.

2. *Imperial Agricultural Research Conference, Australia,* 1932.—In accordance with an invitation given in 1927 by the then Prime Minister of Australia (the Right Honorable S. M. Bruce, P.C., &c.), it has been decided that the next Imperial Agricultural Research Conference shall be held in Australia, in 1932. An Organizing Committee consisting of the permanent heads of the six State Departments of Agriculture and the members of the Executive Committee of the Council, with power to add to their number, has been appointed, and has already held two meetings. An Organizing Sub-Committee has also been appointed in England. A draft agenda-paper for the Conference and a preliminary statement regarding the arrangements for the meeting are being prepared, and copies of them will be sent out in October, 1931, for the information and observation of the Governments of the different parts of the Empire.*

3. *Standing Committee on Agriculture.*—The Council's Standing Committee on Agriculture was appointed in 1927, and consists of the permanent heads of the six State Departments of Agriculture and of representatives of the Council. The principal objects of creating the Committee were to ensure that there should be intimate collaboration between the Council and the State Departments of Agriculture, and to obviate undesirable duplication of effort in research work on problems concerning the agricultural and pastoral industries. It has been found that two meetings of the Committee per annum will normally suffice, one of them being held concurrently with the meeting of the State Ministers of Agriculture, and the other some six months later. Owing to the fact that the meeting in 1930 of the State Ministers of Agriculture was postponed, only one meeting of the Standing Committee was held in the year under review, viz., at Melbourne in November, 1929. Some of the more important matters considered at that meeting were the plans for the development of the Council's Division of Soils Research; the conditions governing the importation of insect and plant parasites; the development of investigations on problems affecting the export of apples and pears; the work of the Commonwealth Dairying Investigation Committee and the intensification of agricultural production.

As regards the last matter, the Standing Committee was of the opinion that the work of the Council for Scientific and Industrial Research will have a profound influence in accelerating the stimulation of primary production, which had previously depended solely on the efforts of State Governments. It considered that agricultural extension and demonstration work in Australia is a State function, and that the entry of the Council into the field of extension and propaganda work would seriously interfere with the progress of its attack on pressing research problems. It pointed out that it was clear from the experience of the State representatives on the Committee that the limitations of State finance are such that provision for expansion of State activities in extension and propaganda work to an adequate extent will be increasingly difficult to obtain.

4. *Register of Agricultural Research.*—The compilation of a Register containing details of agricultural research work in progress throughout the Commonwealth was completed in 1928.

Copies of the Register were forwarded to the principal organizations and institutes concerned with agriculture and agricultural research, both in Australia and in other parts of the Empire. In this way the collection of information desired by such bodies has been facilitated, and so far as Australia is concerned, undesirable overlapping will be prevented. In accordance with a recommendation of the Standing Committee on Agriculture, supplementary sheets of the Register bringing it up to date were compiled and issued in 1929.

III.—PLANT PROBLEMS.

1. *General.*—In 1927 the Council established a Division of Economic Botany and in February, 1928, Dr. B. T. Dickson, B.A., Ph.D., took charge of the work. Plans for the erection of laboratories at Canberra were prepared. It was proposed to include an administrative block, with Museum and Library, to be shared with the Division of Economic Entomology, but owing to the financial situation, the erection of this block has been postponed. Approval for the erection of the Laboratory was given in September, 1929, and it is expected that the building will be ready for occupation towards the end of 1930. In the meantime, the Division has continued in temporary quarters, at the University of Sydney until December, 1929, and afterwards at the Council's Entomological Laboratory at Canberra. Whilst the fact that the Division has as yet no properly equipped laboratory building of its own has inevitably handicapped the Division in the prosecution of its programme, valuable progress has been made in several branches of work.

It appeared at first that, owing to the financial position, a most serious handicap would be inevitable inasmuch as it would be impossible to build and equip the glasshouses which are essential for the proper carrying out of the Division's work. Fortunately a sum of money,

* Since this report was originally drafted it has been decided to postpone this Conference.

sufficient to erect a part of the glasshouse accommodation necessary, was made available partly by the Directors of the Commonwealth Bank from the Rural Credits Endowment Fund, partly from the funds of the Australian Tobacco Investigation Committee, and partly from other sources. The preparation of the plans for the glasshouse is nearing completion and it is anticipated that the work of construction will be commenced at an early date. An area of 7 acres of land near the Laboratory site at Canberra and suitable experimental plots has been cleared, fenced, and put under green manure crops. In addition, an area of 21 acres has been enclosed and will be developed gradually as a special Botanic Garden and Arboretum. The question of securing an area of at least 150 acres to serve the needs of the Division in a locality where extension in the future will be practicable has been under consideration, but has not yet been finalized. In order more adequately to describe the scope and functions of the Division, its title has been changed to that of the Division of Plant Industry.

2. *Plant Diseases.*—In the last Annual Report of the Council, attention was directed to the very large losses incurred in Australia as a result of plant diseases and to the fact that it is estimated that the annual toll levied averages about 10 per cent. of the value of all crops.

(i) *Plant Disease Survey.*—For the purposes of the work of the Division it is very important to ascertain the dates and conditions of incidence, severity, localities affected and success of control measures, &c., for the most important diseases of the principal crops. To explore the records, and to collate and organize the facts available is a heavy task. Mr. C. C. Brittlebank has concentrated on this work with the result that there are now some 1861 records of diseases, 5,814 records of organisms and 26,000 references, in the survey files. In this way it will be practicable to estimate annual losses throughout the Commonwealth concerning which scattered facts only now appear.

A large amount of work is still to be covered in the Plant Disease Survey and it is gratifying to note that the Council's Standing Committee on Agriculture promised the assistance of Departments in affecting and maintaining this compilation. Reference to the survey was made in the Council's quarterly Journal, Vol. 2, No. 2, page 97.

(ii) *Apple Diseases.*—The investigations on bitter pit and related diseases of apples have been continued by Mr. W. M. Carne, Senior Plant Pathologist, of the Division of Plant Industry, and Messrs. Pittman and Elliott, of the Western Australian Department of Agriculture.

Further proof of the relation between picking maturity and the incidence of bitter-pit has been obtained, and in order to give practical application to the findings, a colour chart, by which the ground colour of the skin may be compared with a standard colour, has been printed for test in a number of commercial orchards. The chart is being tried by the State Departments of Agriculture as a result of a Conference held on 3rd December, 1929. That the usual annual loss of about £100,000 from bitter pit in Australian export apples may now be reduced to negligible proportions is a reasonable assumption, but there are other problems still to be solved which affect the apple export industry. Such water deficiency diseases as "cork" and "glassiness" and the various "breakdowns" are being studied. Another outstanding problem under consideration is that of remedying the large annual fluctuations in the exportable surplus resulting mainly from the biennial bearing characteristic of apple varieties. If diseases can be controlled and the annual yield maintained at a steady level, then care in picking, satisfactory standardized grading, a good attractive pack, correct transport conditions, and unified control of marketing will enable the industry to maintain a satisfactory standing in world markets, which is not the case at present.

(iii) *Tobacco Diseases.*—Blue-mould disease again occupied major attention. Field investigations, in order to ascertain the factors involved in the incidence and spread of the disease were undertaken at Tumut, New South Wales, and Myrtleford, Victoria. Experiments for the purpose of ascertaining whether the disease-producing organism over-winters in the soil have given negative results. Seed beds were prepared by Messrs. Marks and Hill of the Australian Tobacco Investigation Committee, and they were maintained in a state to give the best conditions for infection. The seed used was disease-free. In both districts, Dr. H. R. Angell, Senior Plant Pathologist to the Division, found that blue-mould was widespread for two or three weeks before it reached the test beds, and that those nearest to diseased seedlings contracted the disease first while those farther away remained free for a longer period.

A new important fact was determined as a result of these tests, viz., that the disease may be spread by moths of the split worm *Phthoromea operculella L.* An account of this has been published in the May, 1930, issue of the Council's quarterly Journal.

Virus diseases of tobacco are important in tobacco-growing countries and it is necessary to watch the incidence and severity of similar diseases in Australia. Miss P. Jarrett, M.Sc., Assistant Plant Pathologist to the Division, surveyed the Tumut and Myrtleford areas during the growing season and found that tobacco mosaic was uniformly present in the Myrtleford area and a disease characterized by " ring-spotting " was present throughout both districts. This disease was particularly prevalent on farms where solanaceous weeds such as *Datura sp.*, *Solanum nigrum*, &c., were allowed to infest the fields and adjacent areas. Actually, virus diseases were not so serious this season because of the dry conditions prevailing during the growing period.

(iv) *Wheat Diseases.* (*a*) *Flag Smut.*—This disease takes its annual toll throughout the wheat-growing areas of Australia. The average annual loss from flag-smut has been estimated conservatively at 3 per cent., but in certain localities 10 per cent., reductions in yield are common and up to 50 per cent. has been known. This total effect is the sum of (1) the complete loss of young, heavily infected plants which do not reach maturity, and (2) the reduced yield of grain from the poorly developed culms of partly infected plants. In any locality where the disease is present, the degree of infection is chiefly dependent on the variety of wheat cultivated.

The aim of the Division's work is the study of varietal susceptibility or resistance and the application of these results to the development of smut-resistant varieties. To this end the development of a method by which varieties can be tested accurately was the first step. The work has been seriously handicapped by the absence of the essential glasshouse equipment, but a method has been evolved whereby complete infection can be obtained with susceptible varieties, and varieties showing various degrees of resistance are now being tested. Since the number of culms produced by a plant is an important factor in determining its yield, the effect of flag-smut on culm production must be studied and experiments verified under field conditions.

(*b*) *Take-all and Foot-rots.*—The term " foot-rot " is somewhat wide, as it may be applied to the disease caused by any one of a number of fungi. The disease is characterized by a rotting at the base of the culm, causing reduced stand, and shrivelled grain. The foot rot disease caused by *Ophiobolus graminis* is known as " take-all " and this disease may affect seedlings so as to kill them, or cause the plants to produce prematurely " white-heads ", which contain no grain. Other fungi proved to have caused foot-rot in Australia are *Helminthesporium sativum* and *Wojnowicia graminis*.

It is quite possible that, in addition to the above-mentioned parasites, there are others not yet reported, and it is partly the object of this investigation to elucidate this point. Work is being carried out to determine the causative organisms of diseased wheats of different varieties from different districts, with the ultimate object of co-operating with the geneticists in an attempt to breed wheat varieties resistant to the foot-rot organisms. Figures for the loss by foot-rots and take-all are difficult to obtain, but it is estimated that the annual loss is approximately equal to that caused by flag-smut.

(v) *Spotted-wilt of Tomatoes.*—The investigations on this disease were continued at the Waite Agricultural Research Institute by Mr. G. Samuel, M.Sc., of the Institute and Mr. J. G. Bald, B.Agr.Sc., of the Division, and the latter co-operated with Mr. D. B. Adam of the Victorian Department of Agriculture in studies in Victoria. A bulletin has been published giving a detailed picture of symptoms and of the disease transmission tests with the thrips *Frankliniella insularis*. Further work has demonstrated a reliable mechanical method of inoculation so that practically 100 per cent. infection may be obtained. Another important finding is that only larval thrips or adult thrips which have fed on diseased plants during their larval life can transmit the disease. A number of other solanaceous plants have been artificially infected with spotted wilt, and the Iceland poppy and zinnia have been found naturally infected in suburban gardens. *Frankliniella insularis* is found only rarely in the Melbourne area, but infection was obtained with thrips larvae different from *F. insularis* and as yet unidentified.

(vi) *Pineapple Diseases.*—In co-operation with Mr. J. H. Simmonds of the Queensland Department of Agriculture, Dr. Dickson continued the investigation on water-blister of pineapple with a view to controlling the losses. Experimental consignments were arranged for by the Queensland Committee of Direction of Fruit Marketing, during the months of February, March and April, 1930. Satisfactory control of butt infection in such consignments between Palmwoods, Queensland, and Canberra, F. C. T., were obtained by basal treatments with salicylic acid, benzoic acid and to a lesser extent with tannic acid. Tests were also made with alum, aluminium sulphate, and ammoniacal copper carbonate, but without success. A full account of the work is in course of preparation.

(vii) *Coconut Diseases.*—As a result of negotiations between the Commonwealth Government and the Papuan Administration, the Division of Plant Industry was asked to investigate a disease of coconuts which had assumed economic proportions. Dr. Angell spent August and September, 1929, in Papua and is now paying a second visit in connexion therewith. On one estate, the disease was present over half the area, affecting 30 per cent. of the trees and causing a loss of £1,000 per annum. Other estates were more or less affected. Leaf break and subsequent death of the leaves is an obvious symptom of the disease which, however, appears to originate in the stem, although stem symptoms are not so apparent externally. Suggestions as to remedial and control measures were made and reports indicate that these have been satisfactory considering the short duration of the tests, as one third of the trees have recovered and another third show signs of definite improvement. During Dr. Angell's second visit he will look into diseases affecting coffee, rubber, &c. as well as coconuts.

3. *Genetics and Plant Breeding:* (i) *Wheat.*—This section is concerned with the mode of inheritance and variation of plant characteristics of economic value in order that the production of improved types may be facilitated, and with the production of new varieties of crop plants which will give increased yield of better quality for every unit of water and food material consumed. In view of the facts that wheat is the most important widely cultivated crop for export purposes and that our average yields are relatively low, it was decided to concentrate on wheat problems with the object of ultimately improving the quality and yield per acre of this cereal. The investigations will include the effects of environmental factors and studies of the plant as to morphology and physiology, determination of the factors involved in drought resistance and in disease resistance. With these problems in mind, 1,635 varieties and strains of wheat have been collected from various sources in Australia and an additional 214 have been made available by Dr. A. McTaggart, Senior Plant Introduction Officer to the Division. The land available for experimental studies is of very poor quality and seeding was delayed until after the rain of the first week of June, 1929. Mature seed was, however, obtained from practically all varieties planted. Individual plant selections were made and these, together with hybrids and introductions were planted in April and May, 1930, in approximately 4,000 plots. No glasshouses were available whereby a season could be saved by growing a second crop in each year, but an attempt was made to grow two crops in the field. Germination of the second crop was good, but grasshoppers attacked the plants. Hessian screens were erected and the remaining plants grew well and produced good ears but birds then took their toll. Glasshouse accommodation, netting against birds, suitable barn and storage space, and a much larger area of land are essential to the proper prosecution of this work.

(ii) *Maize.*—By arrangement, Mr. J. R. McMillan is continuing maize-breeding work at Gatton College, Queensland, which was initiated there in 1925–26. Besides visiting Gatton to supervise the work there, some 372 strains of maize were used in the experiment plots in Canberra to make 1,800 pollinations for inbreeding and crossbreeding. As a result of this work there is evidence that another method of selection can be adopted which will give quicker and better results than those used in the past. Further testing of this on an extensive scale is planned for the next season.

(iii) *Other Crops.*—With a view to the development of work with other crops, as staff and facilities become available, efforts are made to obtain and maintain pure lines of such crop plants. For this purpose 170 plots of oats, 256 plots of barley, 37 of rye and 10 of tomatoes have been established.

4. *Plant Introduction.*—(i) *General.*—As noted in the first report on the work of the Division, Dr. Dickson had paved the way by correspondence for the initiation of exchanges of seeds, &c., but the work of the section may be regarded as actually commencing with Dr. A. McTaggart's visit to the Bureau of Plant Industry at Washington in 1929. There useful arrangements were made with the Office of Foreign Plant Introduction for general exchange, and with the offices of cereal crops and diseases, forage crops, alkali and drought resistant crops, botany, crop physiology and breeding, sugar plants and horticulture for particular information and exchanges. Particularly was this the case with respect to cereals and forage crops. This section of the Division's work also suffered from lack of glasshouse accommodation and suitable land for testing and multiplication purposes. Yet despite handicaps and the fact that work has been in progress but a few months, the Division had on 30th June, 1930, gathered from outside Australia 270 cereal varieties and strains, 85 varieties and strains of grasses, over 50 leguminous forage plants and a number of miscellaneous crop plants.

Detailed records of each introduction are kept as to country of origin, dates of testing, conditions and results, &c. Eventually, for the proper and adequate conduct of this work, plant introduction gardens will be required in suitable climatic zones, as obviously no one place can possibly represent the various climatic types to be found in agricultural Australia.

(ii) *Plant Introduction Record.*—Inasmuch as most of the crops grown in Australia have been introduced at one time or another, it may well happen that a given plant has already been tested and rejected or lost or multiplied and put out for field trial, &c. Further, several investigators may and do introduce for test, and inadvertently, overlapping may occur. It was, therefore, proposed by Dr. Dickson that an inventory should be made of all introductions to date with brief notes regarding source, date introduced and tested, success or failure of the introductions and reasons for failure if available and any other pertinent information. The Council's Standing Committee on Agriculture in November, 1929, approved the proposal promised that State Departmental officers should supply the necessary information and suggested that the records go back twenty-five years. Such a record will take a long time to prepare and will involve much searching of records, but when completed will constitute an extremely valuable record of achievement.

5. *Noxious Weeds*—(i) *Noogoora Burr.*—The survey of the present distribution of this weed pest was completed for Queensland by Dr. J. White-Haney in September, 1929, and an abbreviated account has been published in the 1930 issue of the Council's Journal. More detailed statements are in course of preparation for the use of Departments and interested graziers. It must be recalled that the actual area covered by this weed varies from season to season, but on the whole it requires at least a 24-inch rainfall and is found mainly along watercourses and on flood plains. The possibility of entomological control is being considered by the Council's Division of Economic Entomology. Botanically Noogoora burr has been determined as *Xanthium pungens*, but the possibility of the presence of variants is being borne in mind.

(ii) *St. John's Wort.*—Mr. J. Calvert, in company with Mr. G. A. Currie of the Council's Division of Economic Entomology, recently inspected areas in New South Wales and Victoria where St. John's wort constitutes a problem. The weed is encroaching up the hills and along valley slopes and developing a pure stand even at the expense of bracken. The prostrate winter type of growth is particularly well adapted to smothering any other herbage. It is a very prolific seeder, the seed being enclosed in a somewhat sticky resinous capsule. Rabbits are in all probability the chief agency in seed distribution by the adherence of seed capsules to their coats. A survey to determine what species of *Hypericum* are present is in progress, but so far the specimens from Australia represent *Hypericum perforatum* var. *augustifolium.*

6. *Agrostology.*—There can be no doubt that the grass and forage plant crop is the most important in Australia and that its importance justifies very extensive and intensive studies of the areas where most sheep and cattle are depastured, with a view to arriving at definite facts regarding the present condition of pastures and their ultimate improvement. Unfortunately, personnel for this work is not easy to obtain, and consequently this Section of the Division's programme has not been adequately established. Certain phases of the work of the Plant Introduction Section touch on pasture problems and Dr. McTaggart has this in mind in his programme.

(i) *Regeneration of Pastures—Koonamore, South Australia.*—The work concerning regeneration of perennial pasture plants in an area of low rainfall has been continued by Professor T. G. B. Osborn at Koonamore, and in spite of drought, valuable data of regeneration have been obtained. Another phase of the work involves a study of the reaction of saltbush to grazing and results tend to show that under the drought conditions obtaining, a stand of saltbush is improved in vigour by grazing when compared with ungrazed areas. The benefit is proportional (within limits) to the intensity of stocking provided that the stocking is not continued at a heavy rate too long. It would appear that smaller paddocks, more frequent watering places, and rotational grazing are the practical applications of this work.

(ii) *Ecological Investigation—Glen Elgin, New South Wales.*—It is the opinion of some graziers in the New England district that on the Eastern slopes where sheep were depastured on areas hitherto used for cattle only, a pronounced improvement in quantity and quality of wool was noticed at first. This improvement was not maintained, however, after the first clip. The late Professor T. B. Robertson suggested that sheep depastured on these areas for the first time might select and eat out certain forage plants in the first year which would thus account for the drop in wool yield and quality. With a view to ascertaining the facts a field station was established at Glen Elgin by the courtesy and co-operation of Mr. E. D. Ogilvie of Ilparran, Glen Innes. Dr. J. White-Haney took charge of the work and an area of 320 acres has been surveyed botanically so that all herbage plants are noted. The area will be ring-barked and sheep depastured thereon in late 1931, when a second careful survey will be made to determine the preferences, if any, of the sheep in the pasture.

(iii) *Grasses of the Federal Capital Territory.*—A commencement has been made of a survey of the grasses of the Federal Capital Territory, and some 40 grasses collected and placed in the herbarium for reference. This work will be continued during the coming summer.

7. *Herbarium.*—A small, but satisfactory, commencement has been made with respect to the accumulation of specimens for a national reference herbarium. Such a collection will have a definite economic bias. At present there are over 1,000 specimens duly labelled and recorded.

8. *Poison Plants.*—The Division of Plant Industry is co-operating in the work of the Poison Plants Committee, which was established in 1927, as a joint undertaking by the University of Sydney, the New South Wales Department of Agriculture, and the Council. It was established by the Council primarily to assist the pastoral and farming industries by co-ordinating and amplifying work already being done, particularly at Glenfield, New South Wales, in the investigation of the known and reputedly poisonous plants, which sometimes cause serious losses of stock by poisoning. Feeding tests are carried out at the Glenfield Veterinary Research Station near Sydney, botanical identification at the Botanic Gardens, Sydney, and chemical and physiological tests at the University of Sydney. The Committee has already carried out a number of valuable investigations, the results of which have been disseminated through the State Departments of Agriculture. General information regarding the Committee's work was published in the Council's Journal, Vol. 2, No. 1. The results of its examinations of several poisonous plants are also published from time to time in that Journal.

IV.—IRRIGATION SETTLEMENT PROBLEMS.

1. *General.*—In view on the one hand of the many millions of pounds sterling that the Governments concerned have expended in the Murray River irrigation settlements for the construction of the necessary dams, channels, pumping stations, &c.; and on the other hand of the many thousands of settlers that have been placed on the areas, any research work aimed at the improvement of methods of production in these districts is obviously of no little importance. The main production of the settlements in question consists of dried vine fruits and citrus fruits. Investigations in regard to these industries have been undertaken by the Council and its predecessors for some time. In addition, the Council is carrying out an investigation of the soils of the areas, but an account of this work is given in the next section.

2. *Viticultural Problems.*—Work on the production problems of vine fruits is being carried out at the Commonwealth Research Station, Merbein, under the direction of a Committee of Control (*see* Appendix). Mr. A. V. Lyon, M.Agr.Sc., is the officer in charge of the Station.

Further progress has been made in the viticultural studies, comprising records of seasonal growth and development of the sultana vine, the fruiting habit of the sultana and the Zante currant, the development of the fruit, the reactions to pruning modifications, and yield variability. Among other things, the results have indicated that there is little correlation between yield and weight of prunings when the vines are pruned to a constant quantity of bearing wood. An experiment to ascertain whether dis-budding barren shoots affect the remaining shoots showed no increase in yield. It has been found, too, that trellising canes results in higher yields than does tying. Studies of the seasonal development of roots, with special reference to the reaction of the feeding rootlets to the methods of cultivation and periodic irrigation of the settlement, indicate that both beneficial and deleterious operations are at present practised by settlers in the district. As regards buds, the records and distributions of these in the sultana have been continued. It has been found that the fruit buds are formed during the November of the year preceding that in which they bear fruit. Preliminary studies with a view to ascertaining the factors controlling fruit bud formation have been commenced and the correlation of data already obtained is in progress.

The Station is also carrying out investigations concerning the serious salting of irrigation blocks, which has already brought disaster to a number of blocks throughout the various settlements. A salt and botanical survey of a virgin area of 20 acres belonging to the Station has been made. It is proposed to plant this with vines and to irrigate it in the usual way, and to study the effects of the irrigations on the distribution of salt after the lapse of some time. It is hoped by this means to obtain sufficient information of the precise way in which salting is usually brought about. Subsequently it is hoped to develop methods of avoiding the trouble or of considerably mitigating its effects.

A number of miscellaneous investigations are also being carried out at the Station. These relate to the " duty " of irrigation water, the dried fruit grub pest, the dipping of dried fruits, the sulphuring of apricots, and certain vine diseases.

The application of recommendations based on the work of the Station is steadily increasing throughout the Murray Valley, e.g., the average yield of the vines in the Mildura district has been doubled since the establishment of the Station, methods of processing have been altered and more closely meet the requirements of the overseas market, the control of dried fruit insect pests is

much more effective and complaints from overseas have been rare for the past two years, and finally recommendations in respect to periodicity and method of irrigation are being adopted, resulting in the saving of an estimated amount of £9,000 per annum in the Mildura and Redcliffs districts alone.

3. *Citricultural Investigations.*—Work on citricultural problems is being carried out at the Commonwealth Research Station, Griffith. The investigations are being financed jointly by the Council and the Water Conservation and Irrigation Commission of New South Wales. The latter body contributes £1,500 per annum, and also supplies all water free of charge.

The main investigations of the Station concern—

(*a*) The effect of different soil treatments on the structure, yielding capacity and other properties of the soil.
(*b*) The most profitable fertilizer treatment for citrus fruit under local conditions.
(*c*) The effect on soil and citrus trees of various methods of green manuring.

An area of 25 acres was planted some five or six years ago and is now coming into production. The first crop, estimated to be about 500 to 600 bushels, will be harvested shortly after the close of the period under review.

Valuable results are beginning to be obtained. In regard to green manures, for instance, measuring the effects of different treatments by the mean diameter of the butts of the trees receiving those treatments, the following results have been obtained :—Trees manured with a winter green crop (tick beans), mean diameter of butt 70.6 cms. ; with a biennial green crop (Bokhara clover) 64.4 ; with continuous clean cultivation 64.3 ; with a summer green crop (cowpeas) 64.3 ; with a perennial crop (lucerne) 54.7. With mineral fertilizers (superphosphates, &c.), no differences are as yet observable between trees receiving different treatments, either in the general appearance of the trees or in their butt measurements.

A considerable amount of attention is being given by the Station to matters concerning the soils and the effects of irrigating them. Originally the average water table of the Station area was on the high side, being 4 ft. 6 in. from the surface. On the plots on which clover and lucerne are growing, however, the table is now down to 10 or 12 feet. This is a very hopeful indication, the water table throughout the whole Griffith area being rather high and needing lowering.

Arising out of the studies of soil and the moisture content, much information is being obtained in regard to the different amounts or irrigation water to apply at different times and without increasing the height of the water table. A column of soil 1 metre in diameter and 20 feet deep has been isolated *in situ* and surrounded with a water-tight jacket. A water table is being maintained in this column with a view to ascertaining whether it is possible to produce salt accumulation with a high-water table, but with no lateral movement.

Some investigations on the effects of mulching have been completed and the results published in the Council's Journal (Vol. 3, No. 2). Briefly they indicate that the effect on the water content of a soil that mulching causes is much less than commonly believed. The results of a study of methods of protecting young citrus trees from frost have also been published in the Journal (Vol. 3, No. 1).

4. *The Sulphuring of Dried Fruits.*—At the present time, British Health Regulations do not permit the importation into Great Britain of dried apricots, peaches, pears, &c., containing more than 14 grams of sulphur dioxide per lb. It has been found, however, that some samples of such Australian material contain more than this amount. A committee formed of representatives of the Council and the Departments of Agriculture in New South Wales, Victoria, and South Australia, has now almost completed its investigations and inquiries into the matter. As a result it has formulated a procedure of sulphuring which results both in an improved product, and one which conforms to the above regulations. This procedure is now being submitted to the dried fruit associations concerned. The results of some of the experimental work on which it is based and relating to such matters as the duration of exposure to the sulphur fumes, the quantity of sulphur to use, the best type and sizes of sulphur chambers, and the maturity of the fruit, have been published in the Council's Journal (Vol. 3, No. 3).

5. *Proposed Imperial Irrigation Research Station.*—In the previous report, it was stated that an Irrigation Research Sub-committee of the Committee of Civil Research (Great Britain) had been constituted to investigate, *inter alia*, a proposal that an Imperial Irrigation Research Station should be established in some suitable locality within the Empire ; and that until a decision had been made as to that locality, and as to the lines of work the Station should undertake, the Council considered it undesirable to make definite arrangement for any enlargement of its own programme of irrigation research.

The report of the Sub-committee (now a Committee of the Economic Advisory Council) has recently become available in Australia. It does not recommend the appointment of a central station, largely on the grounds that the problems of the Empire are divergent and would not warrant study in one locality. It contains, however, a recommendation to the effect that central irrigation boards should be formed in the various parts of the Empire and also that a central irrigation committee should be set up in London and charged with the duty of disseminating information to the various investigators concerned.

V.—SOIL PROBLEMS.

1. *General.*—In 1927 the Council entered into a co-operative agreement with the University of Adelaide for investigations to be carried out at the Waite Agricultural Research Institute on soil problems, particularly in the Murray River Valley Irrigation Settlements. The investigations were placed under the control of Professor J. A. Prescott, who was appointed as adviser to the Council on soil problems. This action was taken as a result of the realization of the importance of greater co-ordination in the investigation of soil problems throughout the Commonwealth, and of the urgent necessity for a more complete understanding of the soil problems associated with the development and subsequent practical difficulties in the irrigation settlements in the Murray Valley. In April, 1929, a laboratory for soils investigation was opened at the Council's Research Station on the Murrumbidgee Irrigation Area at Griffith, New South Wales. At the Waite Institute, the Melrose Laboratory was completed from funds made available by Sir John Melrose for the building of a chemical laboratory, and the head-quarters of the Council's soils investigations have up to the present been located at that Laboratory. The generous gift of £10,000 by Mr. Harold Darling, on behalf of the family of the late Mr. John Darling, has enabled the necessary extensions to the laboratories to be undertaken, and these extensions will be ready for occupation in September, 1930. The University of Adelaide agreed that the new laboratories should be utilized by the Council for the establishment of a Division of Soils Research and Professor J. A. Prescott was appointed Chief of the Division in September, 1929.

The main objects of the Council's soils investigations are twofold :—

(*a*) To advise individual settlers as to the treatments required in order to make their blocks more productive and to minimize the serious troubles with which many of them are faced at the present time, and

(*b*) To make soil surveys of virgin areas for future settlement and development and thus to render possible an avoidance of similar costly mistakes to those which have been made in the past.

2. *Investigations in Irrigation Areas.*—The work of the Division has been directed primarily to investigations of the more closely settled and more valuable lands, namely, irrigation settlements, the work of survey having been divided into convenient units, each involving about six months' work for a surveyor with twelve months' associated laboratory work for a chemist. The first unit, the survey of Block E and the Ral Ral Division of Chaffey, both at Renmark, has been completed by Mr. J. K. Taylor, Senior Soil Survey Officer, and the results have been published in the Council's Bulletin No. 42. In 1929–30 the soil survey of the Renmark area was continued so as to include the older established areas under the control of the Renmark Irrigation Trust. It is expected that this work will be completed in 1930. Both the field work and the laboratory work of the second unit, the Woorinen Settlement in the Swan Hill irrigation area, have been completed and the results of the investigation will be published as one of the Council's Bulletins. The third unit comprises the swamp soils of the Lower Murray, for which the field work has been completed, as well as a considerable part of the associated laboratory work. The survey has been followed up by investigations into the nature of the infertility problems associated with certain burnt out sections of these swamps, and as a result, it is hoped that practical recommendations regarding methods of reclamation will be found possible. These swamp areas as a whole present a further special problem in so far as they have been used in the past more successfully for the growing of lucerne. These is reason to believe that the development of permanent pasture by approved modern methods offers an alternative more in character with the soil type. The results of these investigations are in course of preparation for publication.

Closely associated with the investigation has been the survey of the bed of Lake Albert at the mouth of the Murray. The survey has been completed and presented unusual features. The work was carried out from a motor launch, and special sampling tools were developed for this purpose, which would enable samples to be withdrawn without contamination from a depth of 14 feet of mud below 4 feet of water.

The developmental drainage project in the south-east of South Australia has necessitated preliminary soil surveys of considerable extent and beyond the immediate capacity of the Division. By a co-operative arrangement, however, the work is being carried out by an officer of the Department of Agriculture working in close consultation with officers of the Division.

As part of the soil survey work, an aerial photographic survey of the whole of the Renmark Settlement has been carried out by officers of the Royal Australian Air Force, with a view to ascertaining whether the known differences of soil types could be identified from the air. These photographic surveys have proved to be of very considerable value and have formed the basis of the ground work. The country surveyed from the air showed a very close correlation between soil types and the major vegetation associations. The Council is indebted to the Air Board for its valuable co-operation in this work and it is hoped that it will be practicable to arrange for similar aerial photographic surveys to be made of other settlements.

In the Murrumbidgee Irrigation Area, the survey of the rice soils has been continued by Mr. H. N. England, B.Sc., Assistant Soil Survey Chemist. The area involved is considerable, and progress is necessarily slow. Close association with the work of the Council's Research Stations at Griffith and Merbein has been maintained and in the past year two important pieces of soil investigation have been carried out by Messrs. E. S. West, M.Sc., Officer in Charge of the Griffith Station, and J. E. Thomas, B.Sc., &c., Agricultural Officer at the Merbein Station, respectively. Mr. West's paper on the effect of a soil mulch in the conservation of soil moisture has been published in the Council's Journal, Vol. 3, No. 2, while Mr. Thomas has completed in some detail a salinity survey to a considerable depth of an area of virgin mallee soil. The distribution of salt in such a soil shows remarkable variations in amount, both horizontally and vertically, and accounts to a considerable extent for the characteristic appearance of salinity troubles in newly established vineyards.

3. *Survey Work in Tasmania.*—Arrangements have been made with the Tasmanian Department of Agriculture and the University of Tasmania for investigation into certain important Tasmanian soil types. So far this work has been restricted to characteristic orchard soils in the Huon Valley. A certain amount of systematic field work has been carried out in this connexion, and it is hoped to organize the work on more systematic lines in the near future.

4. *Relations with State Departments of Agriculture and Developmental Committees.*—During the year, at the request of the State authorities concerned, Professor J. A. Prescott, the Chief of the Division, has been afforded the opportunity of assessing the character of the soil problems in Queensland and in Western Australia. In Queensland, the problems of agricultural development on the basis of rainfall and climatic conditions are very considerable, and the opportunity was afforded of visiting the Atherton Tableland, the coastal sugar cane areas, the pastoral areas of the Darling Downs and Peak Downs and the Upper Burnett and Callide Districts. Subsequently, Mr. J. K. Taylor, M.Sc., the Senior Soil Survey Officer, visited the Mackay District, the Dawson Valley area and the Western Darling Downs. A soil survey of the area being reclaimed from prickly pear in this latter zone is considered by the Queensland authorities to be of great immediate importance, and advice has been sought as to the method of carrying out this work and the training of the required personnel.

In Western Australia, the problems associated with the development of the 3,500 farms scheme were accentuated by the confirmation by Dr. L. J. H. Teakle of an important soil salinity factor in the most important area concerned, that between Salmon Gums and Southern Cross. As a result of a request from the Premier of the State the Chief of the Division visited Western Australia and was afforded the opportunity of seeing a considerable section of the agricultural and forest zones. Valuable information was secured, throwing light on the character of the soils in this portion of Australia. The most important problems are those associated with the soils of the " sand-plain " type and with the occurrence of salt in the projected wheat areas.

As a result of these visits and further correspondence with officers of the Lands Departments it has proved possible to prepare a tentative soil map of Australia, which recognizes the existence of important international groups of soils in the Commonwealth. This map has been published in the Council's Journal (Vol. 3, No. 2.).

Apart from the close association with the Department of Agriculture of South Australia, the Division has also been of assistance to the New South Wales Department of Agriculture in assessing the character of the Mallee soils in the Lachlan District, and is in consultation with the Tasmanian authorities with regard to the soils of King Island, and of the North-Eastern Districts.

5. *Laboratory Technique and Soil Fertility Investigations.*—This section of the activities of the Division has been developed principally by officers of the University of Adelaide and post-graduate students. The methods for the examination of soils have been further developed by Messrs. C. S. Piper and H. C. Poole, with regard to technical analysis, and by Mr. R. J. Best

in relation to soil salinity determinations. Mr. Piper has, in association with Mr. G. Samuel, published an important contribution in relation to the grey speck manganese deficiency of oats in South Australia, and is continuing the investigations with special reference to conditions affecting the availability of manganese in the soil. During the year, extensive series of investigations on the nitrate fluctuations in the soil of the Waite Institute were completed by the Chief of the Division in association with the late Mr. G. R. Piper, B.Sc.

VI.—ANIMAL HEALTH PROBLEMS.

1. *Formation of Division of Animal Health.*—During the year, the various investigations that had been initiated previously were organized into a Division. In taking this action the Council merely followed its usual policy of placing its major and related activities under the direction of an eminent authority in the particular science involved. This newly created Division of Animal Health has been placed in charge of Dr. J. A. Gilruth, D.V.Sc., M.R.C.V.S., F.R.S.E., F.R.S.I., who was for many years the Chief Government Veterinary Officer and Government Bacteriologist for New Zealand, and subsequently Professor of Veterinary Pathology in the University of Melbourne. He took over control of the Division in January, 1930.

2. *Erection of the F. D. McMaster Animal Health Laboratory.*—In the previous report, mention was made of the generous gift of £20,000 by Mr. F. D. McMaster of " Dalkeith," Cassilis, New South Wales, for the erection and equipment of an animal health laboratory to be erected in New South Wales. This laboratory is now in course of erection in a portion of the grounds of the University of Sydney, and it is expected that it will be ready for occupation in about April, 1931. The building will be one of two stories and of a design that will harmonize with the other buildings in the University grounds. It is confidently expected that as a result of Mr. McMaster's public spirited action, material advancement in the elucidation of many problems affecting animal health and husbandry in Australia will result.

3. *Black Disease of Sheep* (*Infectious Necrotic Hepatitis*).—In the previous report this condition was referred to as a braxy-like disease. It has been fully demonstrated, however, that the disease is not the true braxy of European countries. It will be referred to from now on as black disease.

The investigation of this condition has been actively pursued and the work has now practically been brought to a most successful conclusion. A very full and comprehensive report of the experiments has been prepared and will shortly be published as one of the Council's Bulletins. It is gratifying to know that this report, together with some papers on his earlier researches, having been submitted by the investigator—Mr. Turner—to the University of Melbourne as a thesis for the degree of Doctor of Veterinary Science, has been accepted by the examiners, who in their covering memorandum to the Council of the University eulogize the work.

During the past year, 25,000 sheep in Victoria and 7,000 in Tasmania have been treated with the vaccine prepared by Mr. Turner at the Veterinary School of the Melbourne University. In every case the animals have been vaccinated at the request of the owner, who had either had personal experience of the beneficial results accuring from the previous year's treatment or had been advised by owners of such results. Mr. Murnane, together with State Veterinary Officers, conducted the vaccinations in Victoria, while in Tasmania the work was carried out by the official veterinarians of that State.

The disease has definitely been shown to be caused by an infection by *Bacillus oedematiens* following injury to the liver by young fluke. Thus active measures against fluke, together with the use of the vaccine, which has been fully demonstrated to exert a valuable protective action, would seem to constitute an adequate safeguard against the losses of £1,000,000 which have been annually caused by black disease in Australia during recent years.

4. *Braxy-like Disease of Sheep in Western Australia.*—The investigation of this disease is being carried out in co-operation with the Western Australian Department of Agriculture, which is providing a number of facilities for the purpose.

The tentative opinion previously held by Mr. H. W. Bennetts (State Veterinary Pathologist, seconded to the Council for the special investigation of this disease), that it is a toxaemia produced by the *Bacillus welchii* has been confirmed by further studies.

It is considered that several factors may favour the growth of *B. welchii* in the bowel contents. The effect of local bowel irritation is seen in sheep feeding on *Inula graveolens* (stinkwort). Certain pasture and soil factors not yet completely known also operate. These are being investigated in the hope of finding some means of prevention other than inoculation.

Further research is being directed towards the study of factors predisposing to the disease. The Avondale State Farm has been made available for this purpose and, approximately, 1,000 experimental sheep are being run in lots of 200 on different types of pasture representative of those which are normally used for depasturing sheep in the affected districts (oats, rape and oats, top-dressed and not top-dressed stubble paddocks).

A field laboratory has been erected by the State Government at Avondale to house the work. In addition local residents of the district have provided £200 for officers' quarters.

5. *Haematuria* (*Redwater*) *in Cattle.*—The laboratory investigation of this condition is being carried out at the Government Laboratory of Bacteriology and Pathology of the Adelaide Hospital. Field conditions are being studied in the Mt. Gambier district, where the disease is probably more prevalent than in any other part of Australia. There is reason to believe, however, that it is not unknown in certain parts of New South Wales, while recently it has been proved to exist in at least one district in Victoria. The same condition has been recognized for many years in Europe and in America. So far all investigations have failed to determine the cause of the pathological changes in the bladder, which result in the appearance of blood in the urine. Some of the observations made by the Council's investigators suggest that the elucidation of the problem will throw new light on the subject of the nutritional requirements of the dairy cow, and indeed even on the cause of cancer.

Very definite advances have been made in the investigation and it is believed that the investigators now have a means of measuring qualitatively, if not quantitatively, a distinct departure from the normal, which appears to be definitely associated with the spontaneous production of the disease. The results obtained during the year appear to have definitely excluded oxalic acid as being the irritant responsible for the production of lesions in the bladder.

6. *Parasitological Problems.*—The Veterinary Parasitologist of the Council, Dr. I. Clunies Ross, last year visited Japan where he underwent a special training in post-graduate research at the Japanese Institute of Infectious Disease, Tokio, under Professor Miyagawa. While there he was the recipient of much kindness and hospitality. On his return journey various research institutions in China and Java were visited. It is realized by the Council that the experience gained in Japan by Dr. Ross and the personal contact he has established with eminent parasitologists and others there, and in the Far East generally, will prove of great value to him and to his future work in Australia.

Since Dr. Ross's return, he has outlined his research proposals for the coming year. These will mainly be concerned with investigations into certain phases of the life history of the lungworm and stomach worm parasites, which cause serious losses in sheep annually, as well as improvements in methods of treatment, both preventive and curative. Provided sufficient funds are available, field stations will be established in several States on properties, the owners of which have expressed their willingness to co-operate with the Council in the elucidation of these important problems.

7. *Caseous Lymphadenitis in Sheep.*—No little progress has been made with the co-operative investigation of this condition, which is such a serious menace to the whole Australian frozen lamb and mutton export trade. The amount of assistance the Council has received from outside and independent veterinarians in this particular work has been most helpful and is freely acknowledged.

In his studies of serological methods of diagnosis, Mr. H. R. Carne of the Veterinary Department, University of Sydney, has made considerable progress. At least one definite method of diagnosis has been evolved, but it is as yet only applicable under laboratory conditions, being too complicated for general field work. It is hoped, however, that such a method may ultimately be determined.

Dr. Bull of the Adelaide Hospital Laboratory, has succeeded in preparing a vaccine which gives satisfactory results with laboratory animals. At present this vaccine is being tested out on 300 lambs made available at Dookie College, through the kindness of the Victorian Council of Agricultural Education, but it will be some time before definite conclusions can be reached regarding its general efficacy. It is not anticipated that vaccination against this disease, which has been found to affect a considerable percentage of animals in the majority of flocks throughout the Commonwealth, can become a general procedure, but it is reasonable to hope that with stud flocks it may prove a means of hastening eradication, while for the small flock-owner it may also prove useful. In Dr. Bull's studies he has encountered many difficulties of a technical nature. He reports—"Sufficient has been shown to demonstrate that it is possible to increase the resistance against Preisz-Nocard infections in guinea pigs at least, and there is good reason to believe that sheep will be found to give equally good, if not better, results."

Observations have also been made by Dr. Bull and by Mr. Carne on the means whereby the causal organism gains exit from the body other than by discharges from superficial lesions. Mr. Carne has been able to demonstrate that the bacillus under certain conditions, which evidently depend on the nature of the food supply, may be cultivated on sterilized sheep manure. This line of investigation, when completed, may elucidate certain factors in regard to the spread of the disease that at present are somewhat obscure.

Careful examination has been made of many live sheep on many different properties in New South Wales by veterinary officers of the State Department of Agriculture, and in Victoria by Mr. Murnane, the Council's Field Veterinary Research Officer. Much valuable information on the incidence of the disease in various parts of the Commonwealth has been afforded by the officers of the Veterinary Inspection Division of the Markets Department. The data, experimental and clinical, secured point very definitely to the shearing-shed and surroundings, together with the operations of shearing, as by far the principal factors in the spread of the disease from infected to non-infected sheep.

Recently a conference of all investigators engaged in the study of this disease was held in Sydney. As a result, a joint report appeared in the August, 1930, issue of the Council's Journal. It has now been distributed throughout the Commonwealth by the State Departments of Agriculture and Stock as a special pamphlet. This document discusses the whole question fully in as plain language as possible, and indicates in detail the measures recommended for prevention.

8. *Tuberculosis in Cattle.*—Professor Woodruff and Mr. Gregory have continued their investigations in connexion with the B.C.G. (*Bacillus Calmette-Guerin*) vaccine. In two dairying districts of Victoria, the calves on a number of farms were inoculated, but it will be some time before it will be possible to secure any definite data regarding the result. Such evidence as is available, however, warrants the extension of such vaccinations and gives promise of a definite degree of success in the prevention of the disease. The innocuity of the vaccine has been further demonstrated by these field inoculations. Arrangements have been made whereby Professor Woodruff and Mr. Gregory will prepare the requisite supply of vaccine and the inoculations will be conducted by Mr. Shew, B.V.Sc., of the State Veterinary Service.

Arrangements are also being made in conjunction with the Department of Home Affairs to have an extensive test made on an isolated herd in Northern Australia known to be badly affected with tuberculosis.

9. *Other Investigations.*—As was anticipated, the formation of a special Division of Animal Health was followed by an increased demand on the part of Pastoral Associations and others in various parts of the Commonwealth for investigations to be made into the cause of troubles affecting their animals. It is obviously impossible for the Council, even were it desirable, to undertake general work of this nature. Its policy must be to confine itself to problems with a general significance, leaving investigations into matters of purely a local aspect to the State authorities. But, even so, it is limited by its staff no less than its finances. Nevertheless it has been possible to arrange certain preliminary work without any increase of staff or material increase of expenditure. Dr. Gilruth, during his visit to Western Australia, was consulted by the officers of the Department of Agriculture engaged in the investigation of an obscure disease affecting cattle in the Denmark District. As a result, certain lines of investigation were planned, and in these so far as possible the Council's staff will assist. The indications are that this complaint is due to some deficiency, probably in the mineral content of the pasture. Another disease affecting lambs, foals and calves, which is known locally as " rickets " or " Gin Gin disease " from the locality, was also inquired into. Again, there is evidence of deficiency in some element. Arrangements were made for certain preliminary work to be undertaken by the Council's officers. It is realized that the elucidation of such diseases, though apparently only of local concern, will probably have an important bearing on the study of disease in live-stock generally as it becomes more and more apparent that nutrition, not necessarily under-nutrition, is intimately associated, as a predisposing factor at least, in the production of most of the ills that affect Australian live-stock.

10. *Further Developments.*—Towards the end of the period under review, consideration was given to two further developments in regard to animal health work.

(i) *Co-operation with Pastoralists Research Fund.*—At a conference between the Australian Wool Growers Council and the National Council of Wool Selling Brokers of Australia, held in Adelaide in June, 1927, it was unanimously decided to make a voluntary appeal for the payment of 2s. per bale on the then coming wool clip of Australia. The objective at the time was to establish a capital fund of £200,000, the income of which could be utilized in pastoral research. At the present time some £44,000 has been subscribed and the Australian Pastoral Research Trust Limited has been formed to administer the income obtained from the Fund.

The Trustees of the Fund have indicated their willingness to co-operate with the Council in a programme of investigations relating to the health of sheep, and to allocate a sum of £2,000 per annum for five years for that purpose. The Empire Marketing Board has also agreed to contribute towards the cost of the work on a pound for pound basis with the Trust up to a maximum of £3,000 per annum for a period of five years.

The investigations will accordingly be put in hand at an early date. They will probably relate to the drought feeding of sheep, certain aspects of the phosphorous deficiency problem, foot rot in sheep, certain aspects of black disease, urinary disease, infertility, and caseous lymphadenitis.

(ii) *Beef Cattle Problems.*—Queensland and the north of Australia generally are responsible for practically the whole of the Australian export of beef and for many of the store cattle which are fattened in southern districts. Many pastoralists of the north have urged the Council to undertake research work into conditions which militate against the success of their operations. Dr. Gilruth, who is cognizant of many of these difficulties, visited Queensland last summer at the instance of the Council and furnished a comprehensive report with definite recommendations, which in essence met with the approval of the Council.

Amongst the particular problems that are concerned the following might be mentioned :— Breeding experiments with a view to the development—probably by crossing with Zebu breeds —of a special breed of cattle much more suitable for the northern coastal areas of Australia than existing breeds ; pleuro-pneumonia of cattle ; nutritional diseases generally ; cattle tick and redwater prevention ; internal parasites of cattle ; the so-called " peg leg " disease and several other unspecified and unstudied diseases which occur throughout Northern Australia and which cause losses from time to time.

Dr. Gilruth's recommendations imply the co-operation of the Queensland Government, pastoralists and others, and the necessary negotiations to obtain that co-operation are now in progress. There is every reason to believe that the Empire Marketing Board will agree to the transfer to the scheme of its original offer of very considerable contributions towards an Australian Tropical Agricultural Research Station.

VII. ANIMAL NUTRITION INVESTIGATIONS.

1. *Division of Animal Nutrition.*—On 18th January, 1930, Professor T. Brailsford Robertson, Ph.D., D.Sc., who as its first Chief organized the Division of Animal Nutrition and planned the investigations in progress, died of pneumonia supervening on influenza. The highest possible tribute is due to him. He was a man of great intellectual attainment and world-wide reputation, who inspired confidence in all who came into contact with him, and gained the love and respect of his staff and associates. With his passing, Australia lost one of its greatest intellects and finest characters. It was upon his high ideals and breadth of vision that the extensive programme of nutrition investigations rested, and so great was his capacity for organizing, and such was the confidence he placed in his staff, that the investigations that he had undertaken have proceeded practically unhampered since his death, his staff continuing along the lines he had indicated, inspired by the ideals and happy memory of their late chief.

The ultimate aim of the Division's work, which is being carried out in co-operation with the University of Adelaide, is to obtain information whereby sheep reared in various localities and climates of Australia may be so fed as to yield the best economic results.

During the past year, the scientific investigations of problems associated with the economic possibilities of increasing the wool clip by supplementary feeding with cystine-rich materials have been extended. The prediction that the availability of the amino-acid cystine from the fodder plants would form the first limiting factor in certain types of pastoral country was justified and demonstrated at the Division's field-station at " Meteor Downs " in Central Queensland.

The pastures of this area were supplemented with sterilized blood-meal—a slaughter-house by-product—which was offered freely as a lick to a small flock of 100 experimental lambs over a period of the first twelve months of their lives. The results were observed in comparison with a similar group of 100 control lambs which were given the same treatment as the experimental flock with the single exception that the latter received blood-meal whereas the control group did not. It was found that the supplement was taken by the experimental sheep only when the pastures depreciated over the dry winter months, and was left practically untouched during those periods when the fresh young shoots of the perennial grasses were abundant. At the leanest period of the year the intake rose to approximately 6 oz of blood-meal per head per week. Throughout the whole period, the lambs which were offered blood-meal

grew better, and at shearing the wool clip from the treated animals was raised some 30 per cent. above that taken from the control group. The estimated cost of the treatment is of the order of 10d. per head and the mean increase of wool was approximately 31 oz. The full scientific details of the progress in supplementary feeding will probably be published in bulletin form in the near future.

The wide economic possibilities implied by this field-experiment have been recognized, and many of the major investigations at present being carried out by the Division are associated with similar problems. It is perhaps too early to predict with any degree of certainty, but the information already gained indicates the possibility that large quantities of other materials for supplementary feeding may become available to the pastoralists at prices which compare more than favorably with blood-meal. An active search for such materials is now in progress.

There is the further possibility that the production of cystine by the pasture may be limited by the availability of sulphur in the soils, and, in consequence, attempts are being made by the Division to influence favorably the chemical and botanical composition of the pasture for the growing of wool, by top-dressing with manures containing high quantities of sulphur. This work is in progress on the Division's field-stations at " Wambanumba", New South Wales, and at " Niawanda " in Victoria.

The sheep undoubtedly selects those fodder plants which are most suited to supply the needs of its bodily economy, and, in consequence, the animal represents a strong selective agent in pastures which may become perceptibly changed in carrying capacity through overstocking. The nature of the plants selected, and the influence of the change in botanical composition of the grazed land on the wool clip and growth of the sheep is being studied at " Glen Elgin ", New South Wales. In these studies, the Division is co-operating with the Division of Plant Industry in the agrostological investigations which this work implies.

Another branch of work which the Division hopes shortly to investigate with some degree of thoroughness relates to drought feeding. Fundamental data necessary for the scientific compounding of mixtures which may be used with economic success for hand-feeding during the nutritional stress met with during drought are being collected, and in connexion with this problem a detailed investigation is in progress to determine the nature and extent of the energy changes which occur in resting sheep at different ages and on different planes of nutrition. The first publication on the basal metabolic rate of the merino sheep is ready for the press.

Further investigations in connexion with the possibility of iodine deficiency in Australian pastoral country have yielded information which indicates that little or no deficiency of this element is noticeable in Australia and that the use of iodized licks cannot be recommended on any of the pastoral areas studied. This work is being continued and the effects of iodine added to the licks on the yield of wool and well-being of the sheep are receiving especial attention at the Division's field-station, " Keytah ", situated at Moree, New South Wales.

Phosphate deficiency in the soil provides the first limiting factor of a large proportion of the pastoral country in Australia. The extensive studies both in the Division's central laboratory and on its field-station at Mount Gambier, South Australia, are in progress and will provide scientific data which will allow the most economic means of combating this deficiency to be predicted.

Physiological and physico-chemical studies have indicated that the phosphorus deficiency which is evidenced by the animals grazing over certain types of country is caused, in the first instance, by the high calcium content rather than the actual low percentage of phosphorus in the fodder plants. The laboratory findings are now being put to practical test in the field.

2. *Mineral Deficiencies of Pastures.*—Work on this problem is being carried out as a co-operative enterprise by the Empire Marketing Board, the University of Adelaide, and the Council. The investigations are centred in the Melrose Laboratory of the Waite Agricultural Research Institute and are there carried out under the direction of Professor A. E. V. Richardson. As practically the entire sheep and cattle population of the Commonwealth is maintained on the indigenous pastures, and as in consequence grass must be regarded as Australia's most important crop and her outstanding source of wealth, the importance of this mineral deficiency work is obvious.

The general object of the work is to investigate the mineral content of pastures with a view to determining the grassland areas in which deficiencies exist and the most economical methods of alleviating their effects. The natural grassland associations found in any locality or on any given area are a reflex of the environment—expressed in terms of climate, soil composition, and pasture management—under which the pasture type is grown. These grassland associations in any given climatic region may be profoundly altered in botanical and chemical composition and in nutrient value, by the use of fertilizers, by the introduction of new pasture

plants into the sward, and by varying the character of the pasture management. Hence an important phase of the study of mineral content of pastures is the classification of the more important grassland associations, and the demonstration of the relationship between the composition of the pasture and the soil on which it is found. Indeed, the classification of grasslands according to the natural pasture associations is fundamental to work bearing on grassland improvement. Moreover, the individual species constituting the principal pasture types must be known thoroughly from the physiological and chemical aspects, and the biological phenomena causing change or successional development in grassland associations must be thoroughly understood if grassland improvement is to rest on a scientific basis. Information on these fundamental aspects of the problem is gradually accumulating.

Laboratory studies are in progress concerning the factors affecting the mineral content of pastures such as the stage of growth, the effect of phosphates, the soil type, the rate of growth and the soil moisture content. The survey of the composition of pasture plants from mineral deficient areas from the point of view of the detailed mineral content is also being continued. Work on the effect of phosphates has demonstrated that a substantial increase in the phosphorus content of pasture plants quickly follows the application of a soluble phosphate, and that this increase is accompanied by a marked reduction in the transpiration ratio, in one case—with *Erodium botrys*—amounting to as high as 30 per cent. These results are of considerable economic significance in connexion with pasture management in regions of light rainfall.

By means of field investigations, information is being collected on the effects of varying intensities of grazing on the yield, and the botanical and chemical composition of the pastures. Studies are also being made in the field in regard to the effects of applying soluble phosphates and various forms of phosphatic fertilizers, on the productivity and grazing value of the grasses; of applying soluble phosphates with lime; and of rotational grazing and intensive manuring with phosphates and nitrogen in a grassland region of heavy rainfall.

A progress report of the results already obtained has been published as the Council's Pamphlet No. 17.

VIII. ENTOMOLOGICAL INVESTIGATIONS.

1. *Laboratory Buildings and Staff.*—The new Entomological Laboratory buildings at Canberra were completed and occupied in November last, and were officially opened by the Prime Minister (the Right Honorable J. H. Scullin, P.C., M.P.), on 12th March. A brief description of the buildings was published in the Council's Journal, Vol. 2, No. 3. A commencement has been made with the erection of a Blowfly Unit, which will consist of a special insectary provided with facilities for studying the striking of sheep under controlled conditions.

Controlled temperature and humidity chambers have been provided in the basement of the Laboratory, and a small refrigerator has also been installed.

In January, 1930, Dr. A. J. Nicholson, Lecturer in Entomology at the University of Sydney, joined the staff of the Division as Deputy Chief, and shortly afterwards proceeded to England among other things to represent Australia at the Imperial Entomological Conference in London. As was the case in previous years, the Division has been considerably hampered by the difficulty of obtaining entomologists with the necessary training for its special investigations. The work on the blowfly problem in particular has suffered for this reason.

2. *Noxious Weeds.*—Mr. G. A. Currie has been appointed senior in charge of this section. Mr. S. Garthside has continued his work at Farnham Royal, and Mr. S. G. Kelly at Manhattan, Kansas.

(i) *St. John's Wort* (*Hypericum perforatum**).—Consignments of three species of *Chrysomela* (*C. varians*, *C. hyperici* and *C. didymata*) have been received from Mr. Garthside during the year. All three have been acclimatized in Quarantine Insectary No. 1, and have been fully tested out on a long series of examples of all groups of plants of economic importance. The results prove that these beetles are harmless to all plants except St. John's Wort. All three species, however, exercise a powerful defoliating effect on that weed and should certainly produce a crisis in the pest when liberated. Unless an unexpected onslaught of a bacillus or a virus reduces the beetle population, there is good reason to expect that the work will be successful and that much of the 400,000 or so acres of land now infested will be economically cleared. A permit is now being sought to liberate these beetles in selected areas of infestation.

(ii) *Bathurst and Noogoora Burrs* (*Xanthium spp.*).—The serious nature of the Noogoora burr problem and its rapid increase have been mentioned elsewhere in this report (*see* Section III.). Mr. S. G. Kelly has selected the seed-fly *Euaresta aequalis* as the most promising of the natural enemies of *Xanthium* found in Kansas, and has forwarded consignments of the pupae in seed-capsules to Canberra. Flies bred out from these and placed on the Noogoora burr plot in No. 2

* var. *augustifolium*.

Quarantine Insectary have been observed to pair and oviposit in developing capsules. The resulting larvae have also been observed to feed on the seeds within the capsules. This insect thus appears to be a promising one and it will be tested out during the coming year. Further work on the problem is being developed in co-operation with the Prickly Pear Board in Queensland and Mexico.

(iii) *Ragwort* (*Senecio jacobaeae*).—Small consignments of the cinnabar moth (*Tyria jacobaeae*) were received from New Zealand in September, 1929. Larvae obtained from these were used in additional tests on economic plants, including eucalypts and acacias. These tests proving satisfactory, permission was sought for a permit to liberate, and this has now been granted by the Federal Department of Health. Some rather encouraging results have been obtained with *Tyria* in New Zealand, where ragwort is a troublesome pest in some parts.

(iv) *Lantana* (*Lantana camara and L. sanguinea*).—A request was received from the Department of Agriculture in Queensland that the Council should undertake some work on this weed. The lantana seed-fly (*Agromyza lantanae*) is apparently powerless to prevent the abundant seeding of this weed, which is spreading widely in the coastal areas having a moderately high rainfall. Dr. Tillyard has examined the position during a recent visit to Queensland, and has recommended that a complete survey be made of lantana insects in Mexico, in co-operation with the officers of the Prickly Pear Board.

3. *The Buffalo-fly Pest.*—At the present time, this fly constitutes a most serious menace to cattle and dairying industries of Queensland and Northern New South Wales, and unless it can be controlled at an early date extensive economic losses that have been estimated at £1,500,000 per annum are in the balance. The only possible method of control appears to be along the biological lines being followed by the Division.

Dr. I. M. Mackerras, Senior Officer in charge of this Section, completed an extensive tour of the Dutch East Indies and Northern Australia in October, 1929, during which he laid the foundations of a comprehensive research scheme aimed at a determination of the reason why buffalo-fly is not a pest in Java although it occurs there. Thanks to the generosity of Mr. L. McGhie, Manager of the Wyndham Meatworks, excellent facilities have been provided for Mr. T. G. Campbell at that place, while Dr. Bubberman has kindly provided equally good facilities for Mr. Windred at the Veterinary Institute at Buitenzorg, Java. Professor E. Handschin of the University of Basle, Switzerland, has accepted an appointment to work on this problem in Java for two years, and will shortly leave Europe for that purpose.

As a result of the work carried out by the officers in Northern Australia and in Java, a considerable amount of information regarding the habits of the fly and the prevalance of parasites has been obtained. It has been found that while a concentration of about 1,000 flies per beast may be considered as the danger-point, the fly population per beast in Northern Australia often rises to 2,000 or more. As to parasites, so far twelve species have been recorded in Java, but only two in Australia. It has also been found that certain localities in Java suffer sporadic outbreaks of buffalo-fly of great intensity. A special study of such outbreaks will be made by the Council's investigators, and if they can discover a correlation between the course of one of them and the incidence of any particular parasite, a great step forward will have been made in the solution of the Australian problem.

4. *The Sheep Blowfly Pest.*—Dr. Mackerras is the Senior in charge of this Section, with Miss M. Fuller in charge of the experimental work and Mr. Alan Wade as a junior student. Dr. Holdaway is working at the University of Toulouse, France, with Mr. A. C. Evans as his assistant.

As the result of the year's work, the very complex problem of blowfly attack has been definitely simplified. The problem of the succession of insects attracted to carrion has been studied along two different lines in Canberra and in France, but both yield closely similar results. In Europe, and very probably in Australia also, the most important primary sheep blowfly is found to be *Lucilia sericata* (greenbottle fly), while *Chrysomyia rufifacies* (hairy maggot fly) in Australia is probably purely secondary in attack and is dependent on previous attack by some other species. In France, the place of *Chrysomyia* on carrion is taken by the flesh flies (*Sarcophaga*) which help to control *Lucilia* by the severity of their competition for the available food. While the results of the work indicate the value of introducing another competitor that would be in itself innocuous, they do not hold out much hope of success with European parasites. *Alysia manducator* is very abundant in the autumn in France, but it is by no means certain that it is a major control factor, and, in Canberra, the dry autumn weather militates badly against its activities. Other parasites of blowflies are also being studied.

In addition, mechanical methods of control, e.g., traps, are being investigated. Preliminary studies of repellents have been undertaken, and will be extended when the new blowfly unit is completed. The officers of the Section have also co-operated with the Federal Capital Commission in a campaign to minimize the blowfly nuisance in Canberra.

5. *Orchard and Fruit Pests.*—During the year, Mr. J. W. Evans continued his researches on *Trichogramma* as a control of codlin moth. Unfortunately, it has been found that the insect is an unsatisfactory one with which to deal owing to its very frequent failure to recognize the very variety of eggs, namely those of the codlin moth, which it is necessary for it to parasitize if it is to reproduce its species. Similar results have now been obtained from an investigation of the peculiarities of *Trichogramma* carried out in America. It has therefore been considered wise not to proceed further with this line of research in Australia.

6. *Field Crop and Pasture Pests.*—Mr. Hill has continued his work on *Oncopera* (the underground grass grub) by studying the life history of the Gippsland species, *O. fasciculata.* Unfortunately no signs of parasitism have as yet been found in any species of *Oncopera* in Australia. Arrangements have been made whereby entomologists in other parts of the world have kindly arranged to watch for the occurrence of parasites of *Oncopera* within the regions with which they are concerned.

Mr. H. Womersley has been appointed to co-operate with the Department of Agriculture in Western Australia on the problem of the red-legged earth mite (*Halotydaeus destructor*), and is at present studying this mite in its native home, South Africa, as a most promising place to discover parasites likely to be of value in controlling the pest in Australia. The mite is responsible for serious damage to pastures in the West and its spread to the Eastern States would be followed by even heavier losses.

The invasion of Tasmania by clover springtail or lucerne flea (*Sminthurus viridis*) is a very serious problem. Dr. Tillyard has been co-operating with the State Department of Agriculture, and the recommendations which he made in a report as a result of a visit to Tasmania in October last are being put into operation.

7. *Termite (White Ant) Problem.*—Mr. G. F. Hill is in charge of this work, with Mr. H. J. Willings as assistant. The work is being carried out in close co-operation with the Division of Forest Products. The two Divisions are also working together on the general problem of timber preservation. A large number of tests are being carried out on wood preservation processes, on treatments by *Callitris* extracts, on various so-called white-ant specifics and white-ant resisting materials, and on various types of stump-caps. Mr. Hill is also undertaking an intensive study of the biology and systematics of Australian termites, as it is realized that this is the only sound basis for a successful result in the economic sphere. A large field testing plot has been successfully established, and a good method of maintaining small colonies of termites in the laboratory has also been worked out. It will thus be possible readily to obtain information as to the effect of different treatments on timber placed in nests of different species of the insect.

8. *Section of Systematic Entomology.*—The original Museum scheme for the Division has been reorganized into a Section of Systematic Entomology in charge of Mr. A. L. Tonnoir, who joined the staff in September, 1929. Working under him are Miss W. Kent Hughes (Coleopterist), Miss L. Graham (Hymenopterist), and Miss H. Barnes (Junior Assistant). The aim of this Section is to build up an Australian collection that will be of the greatest value in all phases of economic research, and at the same time to increase our rather scanty knowledge of those orders of insects of most economic importance. Mr. Tonnoir is working on the Diptera, particularly on the sand-flies or Simuliidae which are suspected as carriers of worm-nodule in cattle. Miss Kent Hughes has just completed a course of work on Coleoptera under Mr. A. M. Lea at the South Australian Museum, and Miss Graham is engaged on the study of parasitic Hymenoptera.

IX.—DIVISION OF FOREST PRODUCTS.

1. *Laboratories.*—The absence of central laboratories for this recently formed Division has seriously hindered the proper development of its work.

In the early part of the year, a considerable amount of attention was given to the most favorable site for such laboratories, and finally a location in New South Wales was chosen. Preliminary plans had been prepared, but the final arrangements in regard to the site had not been completed when financial difficulties prevented the scheme going any further. Attention was then turned to the old coach houses at the head-quarters of the Council at East Melbourne, where for a very moderate outlay, temporary laboratories were completed during the closing month of the period under review. These, though small, are well equipped and will at any rate enable all the staff to be collected at the one spot. The advantages of this arrangement cannot be overstressed, as the work of the various sections of the Division is so closely interwoven that the individual members of the staff must have the closest contact with one another if maximum efficiency is to be obtained.

The Council's tannin extract plant in Western Australia was closed down in June, 1930, and the staff and plant transferred to Melbourne. Similarly, the chemical work at Canberra was transferred at about the same time. At the present time, the only section still away from head-quarters is that of technology, which remains at Canberra. The officer in charge of this work is a member of the staff of the Forestry School, and the project is a co-operative one between the Division and the School.

2. *Co-operation with other Bodies.*—Very close co-operation has been maintained between the Division and the other forest products laboratories abroad, and with the Commonwealth and State Forestry Services. The Division has also in the past year established very satisfactory contacts with the timber trade both in sawmilling and in utilization. During the year, 278 visits were paid by members of the staff to 74 firms in every State of the Commonwealth. In addition, 80 specific inquiries were made by 46 firms into problems mainly connected with seasoning or special utilization, and 17 firms have asked for plans and specifications for seasoning plants. In all cases, efforts have been made to provide the information desired and many letters of thanks have been received which speak highly of the value of the assistance rendered. Another way in which the Division maintains close touch with problems of the timber industry is by the attendance of its officers at meetings of Sawmillers' Associations, timber merchants, &c.

3. *Utilization.*—In the course of visits to each State, officers of the Division inspect as many industries as possible and inquire into their timber requirements. In addition, all the State forest services refer to the Division questions on the utilization of special timbers or on the use of definite timber for some particular industry. In several cases, this has resulted in tests of Australian timbers to replace an imported article. For instance, tests are now being carried out in England on behalf of the Division by the Princes Risborough laboratories in regard to the possible use of *Eucalyptus maculata* for axe and hammer handles.

In the above way, a fund of information is gradually being built up which as years go on will enable more and more definite advice to be given. In time, it is hoped to develop a separate section for this valuable work.

4. *Wood Technology.*—One of the disabilities under which the Australian timber industry operates is the present difficulty in making a precise determination of the variety of timber by an examination of the sawn plank only. Work on the microscopical examination of timbers for the purpose of developing an identification test has proceeded at the Federal Forestry School, Canberra, under a co-operative arrangement with the controlling authorities of that organization. The Inspector-General of Forests, under whose direction this work began and who has continued to control it, has been of the greatest assistance to the related work on chemical methods of identification which is being carried out in Melbourne.

So far, 1,175 samples have been received from various State Forest Services; 850 have been sectioned and mounted for examination and 50 have been partly or completely examined.

Although identification is the first object of this work, it will gradually extend into an investigation of the relation between microscopical structure and the properties of timbers. A further extension will be to co-operate with the sections of seasoning, preservation, and mechanics in an investigation into the physical cause of behaviour of timbers in experimental operations. The chemists' work on identification has proved to be of great assistance to that of the microscopist, and indeed seems to offer the best chance of still further classifying the eucalypt groups into which the microscope seems able to divide the genus.

5. *Seasoning.*—By far the greatest call from the industry is for help in this direction, and recognition of the fact that faulty seasoning has been the cause of much of the prejudice which undoubtedly exists against Australian hardwoods is now fairly general.

In this connexion the following extract from the report of the Tariff Board on the question of duties on timber is very interesting :—

> Comment has already been made in this report on the importance of the proper seasoning of Australian timber. There is no doubt that lack of attention in this direction has definitely militated against the greater use of hardwoods. It is gratifying to learn that the Council for Scientific and Industrial Research is assisting the sawmilling industry with expert advice in regard to the seasoning by the kiln drying method . . . . . The Tariff Board considers that kiln drying is essential, and if adopted in accordance with methods proved by experiment to be the most satisfactory will enable the sawmilling industry to market its products under conditions as to quality that will make them more attractive and inspire more confidence in their use. If impetus is to be given to the Australian sawmilling industry by the imposition of increased duties, the Board considers it an urgent necessity for the Forest Division of the Council for Scientific and Industrial Research to be placed in a position to proceed without delay with the necessary experiments.

The Division has carried out a considerable amount of advisory work in regard to seasoning, but it is handicapped in this regard owing to the existing paucity of information as to the behaviour of Australian timbers in seasoning kilns. A small experimental kiln is accordingly being erected at the central laboratories of the Division, and funds have been set aside for the erection of a larger kiln at a later stage.

The year's work has consisted of :—

(*a*) A study of existing practices ;
(*b*) educating the trade in the need for better methods, and
(*c*) the solution of problems which arise in existing installations.

The annual report of the senior seasoning officer shows in detail the work done in each of the States. It indicates that contacts have been made with all the kiln drying installations in Australia, and much useful assistance rendered. Letters have been received expressing the gratitude of many of the firms for the valuable help given.

The general position disclosed is very unsatisfactory. Very few drying plants are in existence, compared with the number essential to the proper development of the timber industry, and of these only a minority are satisfactory. The most heartening feature is the general recognition of the need for proper methods which the efforts of the Division have largely helped to create. The present unfavorable state of the trade has militated against the introduction of proper plant and methods, and it is confidently believed that as soon as trade revives there will be a marked improvement in this respect.

6. *Preservation.*—The work in this Section has been largely confined to field work in co-operative projects with the Western Australian Forest Service, the Postmaster-General's Department and the New South Wales Department of Works. In addition, two new processes for preservation have been investigated. One of them proved to be of little value and the second is still under test. Many inquiries from Government Departments and private firms have been received, and in some cases help has been given in dealing with attacks of borers.

Relations have been established with railway services and other bodies suffering from the depredations of fungi, white ants, and borers. A large amount of information has been collected as to the extent of the attack of these various destructive agents. It has been ascertained, for instance, that the various public utilities of Australia are faced with an annual bill of more than £1,000,000 owing to necessary replacements of railway sleepers, telegraph poles, bridge timbers, &c. One of the objects of the preservation work is to endeavour to reduce this expenditure by the very material amounts which seem possible.

Plans for the erection of a 4-foot experimental pressure cylinder have been completed and the plant should be erected early in the coming year.

The chemical side of the investigation of timber preservation that has been carried out has mainly consisted in work on cypress pine and will be mentioned in greater detail later. Very interesting results have been obtained, and the section is planning work on several quite new types of preservatives which have been suggested by the work so far done. There are reasons to believe that there are promising possibilities in this direction.

7. *Tannin Extracts.*—The two main problems attacked in the tannin extract plant at Crawley in Western Australia were the preparation of a tannin extract of good quality at a suitable price, and the preparation of a decolorized extract from redgum kino. The karri work resulted in a very satisfactory extract being prepared, and tanners who tried it have given favorable reports. At the present time sufficient bark is burned at the mills or left in the bush to allow of the manufacture of 1,500 tons of extract per year. A careful survey of the cost of collecting and treating the bark indicated that a good margin of profit is possible, and it is encouraging to be able to report that a commercial firm is now following up the matter still further. A report describing the work in greater detail was published in the Council's Journal (Vol. 2, No. 3, August, 1929).

As regards redgum kino, it was found possible to avoid the colour trouble by not attempting to solubilize all the tanning material present. A good yield of extract can be obtained at much lower temperatures than any previously used and without the use of autoclaves. In addition to many laboratory experiments, one large scale trial was carried out with results that satisfactorily demonstrated the commercial possibilities of the process.

It is considered that the tannin extract work has now been brought to a satisfactory conclusion and the plant has now been dismantled.

8. *Wood Chemistry.*—The work in this Section is directed to a study of the fundamental chemistry of Australian timbers. This involves the collection of an enormous amount of data from many samples of each of the hundreds of species that occur. The programme of work

set down will thus naturally take many years to complete. Meanwhile, the special application of chemical methods to problems of timber identification is being studied. In this direction, two objectives are kept in mind, firstly, the establishment of definite chemical tests that will enable the certain identification of many species of timber which are readily mistaken for others and which often cannot be differentiated by the microscope, and secondly, the development of simple qualitative tests of identification that can readily be applied in the field. The work already completed has resulted in the development of a method of rapidly differentiating between pieces of karri and jarrah ; and between tallowwood and blackbutt.

Another main line of chemical work has been the investigation of the extracts obtainable from cypress pine which is well known to be resistant to white ants. The object of these investigations is to determine the preservative properties of the various constituents of the pine with a view to applying them on similar materials to the preservation of varieties of more common but non-resistant timbers.

9. *Standards.*—A section of the co-operative work undertaken by the Division is in connexion with standards for timber. The Standards Association of Australia has appointed a Timber Committee of which the Chief of the Division is Chairman, and two of its staff (Messrs. Clarke and Cummins) Joint Secretaries. Though the task is difficult, the Division welcomes the opportunity to do work of such great value. Among other results it will serve to show the gaps in existing knowledge of our timbers.

10. *General.*—This record of the year's work indicates that a very large portion of the work of the Division is, and must for some considerable time continue to be, more in the direction of collecting existing information and getting it put into use rather than the search for new knowledge. Nevertheless, the need for much more fundamental work is not being overlooked, for while calls for help can be partly met by existing knowledge, the need for further information is continually made apparent. The present laboratories, though quite insufficient for the Division's full needs, will serve for the time being at least to enable an attack to be made on some of the more pressing problems that are only too obvious.

X.—COLD STORAGE PROBLEMS.

1. *General Organization.*—The various investigations in the field of the preservation, storage, and transport of foods, which the Council is carrying out, have not yet been organized into a Division. The Council is, however, furnished from time to time with valuable advice by its adviser on cold storage problems—Associate Professor W. J. Young of the Biochemistry Department, University of Melbourne—and by various Committees that have been set up in connexion with particular investigations.

2. *Co-operation with British Food Investigation Board—Expedition re Meat Transport.*—The authorities of the British Food Investigation Board and others have recently decided to carry out some investigations with a view to the possible improvement of the condition—particularly the bloom—in which frozen lamb and mutton arrives on the London market. The proposed work was suggested by New Zealand interests. It has been stated that frozen lamb is frequently landed on the London market with defective bloom, leading to a decrease in its market value, sometimes by as much as ½d. per lb.

As an essential preliminary to the investigations, a survey was made during the last year of the actual conditions under which lamb and mutton is exported from New Zealand from the earliest stage on the farm to the final market in England.

Two Australian investigators were attached to the expedition making the survey. The results of the work will naturally be of considerable benefit to Australia. In addition, the investigation will serve as a means of training at least two Australians in the methods of cold storage research work. The services of these two investigators will subsequently be of value in connexion with the export from Australia not only of meat but of other perishable food products as well.

3. *Problems in Preservation of Citrus Fruit.*—Progress has been made during the past year in the work on research into methods for the preservation of citrus fruit, and a report on the experiments to date was published in the Council's Journal, Vol. 3, No. 2.

A particularly interesting result was obtained in regard to storage temperatures, it being found that the optimum temperature of storage for Washington Navels was from 42 degrees to 45 degrees Fahr., whereas Valencias appear to keep better at the lower temperature of 38 degrees Fahr.

The Citrus Preservation Committee, which is responsible for the planning and carrying out of the experiments, has very clearly demonstrated that in order to be able to store Navels in perfect condition for two to three months and Valencias for an even longer period, it is necessary to handle the fruit with much greater care than is the usual practice in Australia.

As the causes of wastage have varied somewhat in each of the experiments so far undertaken and as seasonal variations have to be taken into consideration, it has been thought necessary to repeat the experiments over a greater number of seasons before recommending the adoption of definite methods. In the meantime, it is of interest to note that recent small but commercial shipments of citrus fruits from Australia to Canada have followed the methods indicated by the Committee as most likely to yield the best results.

4. *Banana Investigations.*—The investigations into the maturation of the Cavendish banana have been continued in Brisbane and Melbourne. The first object was to work out a standard procedure of ripening which would give satisfactory and rapid results. The fact that much more rapid ripening was found possible in a small commercial ripening chamber in Brisbane than could be done in the rooms at the two Universities, even with fruit picked at the same time in the same plantation, was found to be due to an accidental leak of coal gas in this commercial chamber, and this led to the use of coal gas as an accelerator for the ripening. The effect was traced to the ethylene in the gas, and no other constituent has been found to have a similar action.

Experiments have shown that it is almost impossible to obtain satisfactory ripening by heat and humidity alone, ripening being always very slow and uneven, but that if a small quantity of coal gas or ethylene be added to the atmosphere, the fruit ripens very much more quickly, more evenly, and has a better flavour.

The early experiments were largely taken up with the determination of the optimum quantity of gas, and an interim report published in the Council's Journal for November, 1929, gave a tentative method of procedure with gas. Later experiments have had for their object the determination of the modifications required at different seasons of the year, and with different types of fruit; and the correlation of ripening conditions with those of transport and growth. These experiments have shown that modified conditions such as time of applying heat and humidity, time of ventilation, &c., are necessary with fruit at different seasons and of different types, and the exact conditions are being determined.

The transport conditions to Southern markets were studied in conjunction with the New South Wales railways, and a number of possible means of improving conditions were investigated. These tests, in conjunction with laboratory observations in Brisbane and Melbourne, have shown that the temperature of the fruit during carriage is very largely determined by the temperature when loaded, and point to the importance of conditioning the fruit before it leaves Queensland.

An interesting aspect of the whole banana work is that the investigators are experiencing an increasing number of requests from commercial ripeners for assistance and advice.

5. *Meat Problem.*—The investigations in this field are under the charge of the Meat Preservation Committee, which itself is a joint Committee of the Council and of the Australian National Research Council. The annual report of this Committee containing a survey of work done for the year ending 30th June, 1930, has been published in the Journal of the Council (Vol. 3, No. 3).

Results of an experimental consignment to England of frozen carcasses from prime two-year-old Australian bullocks have also been published in full in the Council's Journal (Vol. 3, No. 1). The conclusions arrived at confirmed the Committee's previous observations that frozen and chilled portions of prime young beef were indistinguishable in regard to palatability, and also demonstrated that prime young Australian frozen beef compared favorably in palatability with that of prime Scotch fresh beef and prime Argentine chilled beef, while ordinary average quality Australian frozen beef was considerably inferior. Suggestions have been made for the improvement of the standard of Australian beef for export by means of the introduction of new blood of the desired types from early maturing breeds, and the "topping off" of cattle, where possible, by means of artificial feed to supplement the natural pastures.

Investigations have been continued on the freezing of beef and mutton, particularly concerning the problem of "drip". Factors such as age, time after death, rigor mortis, hydrogen-ion and salt concentrations have been studied and experiments in the separation of the proteins of muscle, muscle juices and drip are now in progress.

XI.—OTHER INVESTIGATIONS.

1. *Commonwealth Prickly Pear Board.*—In 1899 Mr. H. Tryon, Government Entomologist, Queensland, advocated that steps should be taken to investigate the possibility of the control of prickly pear by biological means. In 1911, the Queensland Government appointed a Board of Advice on Prickly Pear Destruction. The two principal recommendations of this Board were:—(*a*) that an officer should be appointed to conduct experiments mainly on the chemical control of prickly pear at an experimental station, and (*b*) that a scientist should be sent abroad to inquire into the possibility of importing parasites to control the pest.

In 1912, the Queensland Government appointed Professor T. Harvey Johnston and Mr. H. Tryon as a Prickly Pear Travelling Commission. They returned in 1914 and recommended that certain parasites should be imported. In the same year, the Queensland Government established an experimental station at Dulacca under the charge of Dr. Jean White, now Dr. Jean White-Haney, who carried out exhaustive tests with hundreds of chemical compounds. This work was completed in 1916, when it was definitely proved that arsenic pentoxide was the most efficient specific. This chemical is now the main constituent of all poisons which are effective against prickly pear, but which, owing to the cost of application, are not in general use except for clearing scattered infestations. Dr. White-Haney also carried out successfully the work of breeding cochineal insects (*Coccus indicus*) of which a consignment had been received from the Travelling Commission in 1913. These insects live in Queensland solely on *Opuntia monacantha*, found mainly in Central and Northern Queensland. The insects were distributed from Dulacca and practically exterminated *Opuntia monacantha*.

Soon after the creation in 1916 of the former Commonwealth Advisory Council of Science and Industry, the question of biological control of the prickly pear pest again received consideration. In 1919, as a result of recommendations made by the Advisory Council, the New South Wales and Queensland State Governments agreed to co-operate with the Commonwealth Government in an investigation of the problem of biological control, and in the following year a Commonwealth Prickly Pear Board was created for the purpose of supervising generally the work. The biological investigations were continued during the year 1929–30, and the results of the work of the Board were published in a bulletin issued in October, 1929. The scientific work of the Board is under the charge of Mr. Alan P. Dodd.

As a result of the work of the Board, several species of insects which attack the pear in different ways have been introduced, acclimatized and distributed in large numbers. These include *Chelinidea tabulata*, a plant-sucking bug; the small red spider *Tetranychus opuntiae*; several species of cochineal, *Dactylopius*; and *Cactoblastis cactorum* which belongs to a group of gregarious tunnelling caterpillars. The first-mentioned insects are proving effective though somewhat slow, considering the enormous area covered by prickly pear, which area amounts to about 50 million acres in New South Wales and Queensland. The most surprising achievement has come from *Cactoblastis cactorum* which is now rapidly destroying the pear over very large areas. Over 2,000,000,000 eggs of *Cactoblastis* have been distributed. They were all obtained from the single consignment of 2,750 eggs of the insect which were introduced into Australia in 1925 from the Argentine. The work of the Commonwealth Prickly Pear Board ceases with the establishment of the various introduced insects and with the demonstration that they can be safely and profitably used to destroy the pear. The large scale distribution of the insects does not therefore, come within the Board's functions, but is a matter for State action. The Board has accordingly entered into very close co-operative arrangements with the responsible State authorities, viz., the Queensland Prickly Pear Land Commission and the New South Wales Department of Agriculture. The Board is also carrying out investigations on the destruction of the pear by fungous and bacterial diseases. Mr. H. K. Lewcock, M.Sc., has made a survey of fungous diseases and bacterial rots attacking the pear in America, and on his return to Queensland in 1929 he brought with him a large number of cultures of organisms isolated from diseased prickly pear. These cultures are being maintained by the Council's Division of Plant Industry at Canberra for the purpose of the comparative study of organisms which occur in Australia. Mr. Lewcock is carrying out a survey of prickly pear diseases in Australia and is particularly inquiring into certain diseases which follow the partial destruction of the pear by *Cactoblastis cactorum*.

There is no doubt that the introduction of *Cactoblastis* has completely changed the outlook for prickly pear eradication. The Board and its scientific advisers, although satisfied with the success of the other established insects, were of the opinion that the control and eradication of the pest would prove a very slow undertaking. However, the advent of *Cactoblastis* and the demonstration of its remarkable destructive powers have given rise to considerable optimism.

Reports received during 1929–30 indicated definitely that as a result of the work of the Commonwealth Prickly Pear Board and of the State bodies which are co-operating in the distribution of the insects, not only is the pear being kept in check, but vast areas of infested lands are now being reclaimed. The spectacular results already achieved have aroused the greatest interest among the land-owners who have expressed the highest appreciation of the rapidity and completeness of the destruction effected by *Cactoblastis*. Although good work has resulted from pear poisoning activities by chemical methods, practically all the eradication is now being carried out by biological agencies. The latter are of course much more inexpensive, as the insects, once established, require little or no attention.

The Queensland Government has decided to introduce a Bill to facilitate the settlement of large areas of land which have either already been reclaimed from prickly pear or are in an advanced process of reclamation. It has been estimated that already about a million acres are involved. It appears that the land with which the proposed legislation will deal consists of large areas suitable for mixed farming settlement.

Whilst it appears that very large additional areas of prickly pear infested lands will be reclaimed during the next few years, it would be dangerous at present to prognosticate definitely the end of the prickly pear pest. Whilst the progress made is very satisfactory and the outlook exceedingly favorable, the problem cannot yet be regarded as solved, since at any time *Cactoblastis* itself may become subject to control by disease or parasitic agencies, and its destructive value may thus be largely nullified. Moreover, the problem of the destruction of the re-growth of the pear requires the closest attention. It is therefore recognized that the scientific work of the Board must be continued. Now that *Cactoblastis* has been distributed more or less thickly over practically the whole of the pear-infested lands in New South Wales and Queensland, and as large tracts of country in the areas where they were first distributed have already been denuded of pear, the promise of ultimate success is very hopeful, but even under the most favorable circumstances complete control of the pest cannot be effected for several years.

2. *Geophysical Prospecting.*—Mention of the Imperial Geophysical Experimental Survey might appropriately be made in view of the fact that the Council was largely responsible for the administrative work of the Survey, although that portion of the Survey's funds that was contributed by the Commonwealth was drawn from funds other than those of the Council. The other portion (one half) of the necessary funds was contributed by the Empire Marketing Board.

The field work of the Survey was completed in January, 1930, and its agreed-upon two years' programme of work came to an end in the middle of February. By that time, the four field parties that were established had completed geophysical surveys in the following localities :— *Electrical Sections.*—Anembo and Captain's Flat, near Lake George, New South Wales ; Leadville, New South Wales ; Woods Point, Victoria ; Renison Bell, Tasmania ; Copper-Nickel, near Zeehan, Tasmania ; the Mallee, Victoria ; Moonta, South Australia ; Port Lincoln, South Australia ; Northampton, Western Australia ; and Chillagoe, Queensland. *Gravimetric Section.*—Gelliondale, Victoria ; Lakes Entrance, Victoria ; and Gulgong, New South Wales. *Seismic Section.*—Gulgong, New South Wales, and Tallong, New South Wales.

In many cases, definite indications of ore bodies were obtained. It was subsequently arranged with the various State Departments of Mines concerned to test these indications by bores, and most of this work has now been completed with successful results in a number of instances. The co-operation of the Departments in this boring work and in other ways has been most valuable to the Survey, and has enabled it to cover much more ground than would otherwise have been possible.

The final report of the Survey has now been completed, and the printed copies will be available at an early date. The report will include an account of the field work carried out in Australia and the results of the confirmatory bores and shafts subsequently put down. In addition, it will include detailed accounts of the various methods of prospecting by geophysical means and the theories on which they are based. These detailed accounts have been written in consultation with eminent authorities in Great Britain to whom the draft report of the Survey was submitted through the Geophysical Prospecting Committee of the British Department of Scientific and Industrial Research. The report will accordingly serve somewhat as a text book on the whole subject of geophysical prospecting and thus fulfil one of the objects of the Survey, which was to throw further light on the individual methods that had been developed but concerning which much secrecy prevailed.

3. *Dairy Research.*—The Council has experienced considerable difficulty in initiating a programme of research on dairying problems. It is aware of the great importance of the dairying industry to the national welfare, and realizes that the application of scientific knowledge to the industry must inevitably lead to a material increase in production. One of the difficulties met with, however, has been the reconciliation of conflicting views hitherto held as to the part which the Council might take in any organized scheme of dairy research.

At a meeting of the Standing Committee on Agriculture held in March, 1928, it was resolved :—

> " That this Committee is in accord with the suggestion that the Council for Scientific and Industrial Research should undertake research on problems affecting the dairying industry. It is considered that not more than one bacteriologist and one chemist would be required in the immediate future."

The Council accordingly invited applications for the positions of dairy bacteriologist and dairy chemist. In view, however, of subsequent developments and also of the further conflicting opinions which the Council received regarding the whole question of dairy research in Australia, it was decided not to make any appointments for the present.

In the report of the British Economic Mission which visited Australia in 1928 and 1929, attention was directed, in referring to the work of the late Development and Migration Commission and of the Council for Scientific and Industrial Research, to the importance of the more intensive use of, and increased productivity in, the already partially developed resources of Australia. The Mission stated that it had been struck by what had been seen and heard of the comparatively small degree to which intensive use is made of the land already in occupation in Australia. The more intensive use of land already settled or partially settled, might, at least cost, be productive of a greater increase in wealth and population than extensive schemes involving the construction of new railways, roads and other developmental works. The Mission suggested that the scope of the £34,000,000 Agreement should be enlarged to permit of the funds available under it being used in other ways and, in particular, to assist the work of scientific research through subsidies to appropriate institutions, by facilitating large scale experiments and the like.

The Commonwealth Government resolved to pursue inquiries in the directions recommended by the Economic Mission, and decided that the dairy industry should be the first branch to be investigated. An economical and technical survey of the dairy industry has accordingly been undertaken jointly by the Development Branch of the Prime Minister's Department and the Council for Scientific and Industrial Research, and is under the control of a Committee of which Professor A. E. V. Richardson is chairman. As soon as the report of that Committee is available the Council will give further consideration to the formulation of definite plans for research on dairy problems.

4. *Fuel Problems.*—No change has been made in the policy of the Council towards research work relating to the important national problem of liquid fuels. It has, therefore, continued to watch the course of developments in other countries. Research in connexion with the production of liquid fuels from coal, either by low temperature distillation or by hydrogenation, &c., involves the provision of complicated plant and is, therefore, costly. Moreover, large sums have been spent on such researches by private and public interests in various European and American countries. The British Fuel Research Board is in close touch with all the developments that have arisen in regard to such matters, and, as is well known, it itself has been engaged for many years on an extensive programme of liquid fuel research. As a result of the close liaison that exists between the British Department of Scientific and Industrial Research and the Council and also the further development of team spirit in bodies interested in research throughout the Empire, Australia is in the fortunate position of knowing that information concerning any important developments in the field of liquid fuel research will be made available to her. During the year 1929–30 one of the Council's officers (Mr. L. J. Rogers) who had previously been a research student under the *Science and Industry Endowment Act* 1926, continued to work at the Research Station at Greenwich of the British Fuel Research Board. The other officer (Mr. J. R. Duggan) was taken over by an industrial company in Australia in August, 1929.

5. *Australian Radio Research Board.*—The second annual report of the Board (for the year ended 30th June, 1930) was published in the Council's Journal (Vol. 3, No. 3, August, 1930).

The four additional investigators mentioned in the previous report have now joined the staff of the Board and have been at work some months. By reason of the British Department of Scientific and Industrial Research freely offering its co-operation, it was possible to arrange for all of these investigators to obtain a month's experience of the investigations and methods adopted by the Department's Radio Research Board, and particularly the work in progress at that Board's research station at Slough. Two of the investigators were, in fact, members of the staff of the British Board prior to their coming to Australia. In addition much of the apparatus necessary for the Australian work has been obtained through the kind offices of the British Board. Thus not only are the investigators now at work in Australia working along similar lines to those followed in Great Britain, but the apparatus they are using is of a similar type to that employed in the English investigations. The results they will obtain should accordingly be all the more valuable from both the Australian and the Imperial point of view.

Investigations of various aspects of the fading problem are in progress at both Sydney and Melbourne, the officers concerned being accommodated at the local Universities. Much of this work is being carried out on the lines adopted by Appleton and his co-workers. Although the experiments that have been carried out have not as yet been sufficiently numerous to justify the drawing of definite conclusions, it would appear that conditions regarding the Heaviside layer in Australia are vastly different from those in England, probably because the more intense power of the sum affects the degree of ionization in the lower levels of the absorbing part of the layer.

In addition to the above investigations on fading, a programme of studies of atmospherics has been prepared and is now being actively followed. In this work, an investigator in the Federal Capital Territory (Mt. Stromlo) and another in Victoria (Laverton, near Melbourne) will co-operate and each will observe the same atmospherics as the other. The apparatus that will be used will consist of an atmospherics recorder and two cathode ray direction finders of the same type as those used by the British Radio Research Board. The recorder will be used to determine the periods when vigorous atmospherics are prevalent. During such periods, observations on individual atmospherics will be made by means of the two finders. Judging from indications that have already been obtained both in Great Britain and in Australia, investigations of this nature will be of value in connexion with somewhat long range weather forecasting, apart altogether from their value in relation to radio communication and broadcasting.

The atmospherics recorder which has been in operation for some time at the Watheroo Magnetic Observatory, Western Australia, is now being converted into a new type instrument After conversion, it will be returned to Watheroo and observations with it continued.

6. *Maintenance of Standards.*—It was stated in the last Annual Report of the Council that the question of Commonwealth control of weights and measures had been brought before the Council and the former Institute of Science and Industry on several occasions. In 1926 the Council convened a representative Conference in order to obtain advice as to the action it should take in the matter. The Conference advised that the progress of Australia, its efficiency in industry, and the effectiveness of its defence system would be handicapped if some of the facilities which other countries possess in the way of national physical laboratories were not provided in Australia. The Council accordingly appointed a Committee under the Chairmanship of Professor J. P. Madsen, University of Sydney, to go thoroughly into the whole question of the provision and maintenance of legal physical standards on a uniform basis throughout the Commonwealth.

The report and recommendations of the Committee were published in the Council's quarterly Journal, Vol. 2, No. 3. The Committee recommended that as a first step the Commonwealth Government should pass a Weights and Measures Act defining standards for the whole of Australia and adopting those standards which are legalized or recognized in Great Britain. It also recommended that the work should be carried out by the Council for Scientific and Industrial Research under the direct control of a Standards Board, and that it should be sub-divided under the following headings :—(i) metrology, (ii) physics, (iii) electricity and wireless, and (iv) electric technics and photometry. It considered that suitable arrangements could be made for the work to be carried out at the Universities of Sydney and Melbourne and at the laboratories of the Munitions Supply Board of the Defence Department.

The report and recommendations of the Committee were approved by the Council and were transmitted to the Commonwealth Government, which decided that in view of the present financial position of the Commonwealth no action is to be taken to deal with the recommendations at present. The Commonwealth Attorney-General has given his opinion that the Commonwealth Parliament has full power to legislate on the subject of weights and measures on the lines indicated in the Committee's report.

7. *Standards Association of Australia.*—In its report, the British Economic Mission suggested that it would be greatly to the advantage of commerce and manufacture in Australia, if there were added to the present activities of the Council for Scientific and Industrial Research, the sphere of work which deals with the standardization and simplification of manufacturing processes. As a result of this suggestion, the Australian Engineering Standards Association and the Australian Association for Simplified Practice have been re-organized and combined under the title of the Standards Association of Australia, and the Commonwealth Government has decided that the Council shall be the means of liaison between the new Association and the Government. The Chairman of the Council (Sir George Julius) is also Chairman of the Standards Association.

8. *Flying Fox Problem.*—In view of the serious menace confronting fruit-growers in New South Wales and Queensland through the depredations of flying foxes and of the failure of such suggested methods of control as poisoning, shooting, &c., the Council decided to approach the problem from a fundamental basis and to collect full information regarding the life-history and habits of the animal. The Council and the New South Wales and Queensland Departments of Agriculture accordingly agreed to contribute £500 each towards the cost of an investigation over a period of two years. Applications were invited for the position of investigator, and Mr. F. N. Ratcliffe was appointed to the post in March, 1929. He is carrying out a systematic biological study of the various species of flying fox and has collected quantitative evidence of the losses caused in various districts to the fruit industries in New South Wales and Queensland, and of the

distribution of the different species of flying foxes. There are four species in Australia, the commonest being *Pteropus poliocephalus*. The investigations will be concentrated mainly on that species, as it is responsible for by far the greater part of the loss suffered by fruit-growers. Arrangements are being made to carry out tests with various poisons and deterrents. Specimens of the skins of the animals have been obtained, and after dressing them it has been ascertained that they are of no commercial value. A progress report on the work has been published in the Council's Journal, Vol. 3, No. 1.

9 *Tobacco Investigations.*—The Australian Tobacco Investigation was initiated in July, 1927, as a result of a co-operative agreement between the Commonwealth Government, the five mainland State Governments and the British-Australasian Tobacco Company Pty. Ltd. The Development and Migration Commission (now the Development Branch of the Prime Minister's Department) and the Council for Scientific and Industrial Research were responsible for the organization of the Investigation. An Executive Committee has been appointed to control the finance and general policy of the Investigation and an Advisory Committee, composed of the permanent heads of the five mainland State Departments of Agriculture, is consulted from time to time. Later a Research Committee was also created, the objects being to relieve the Executive Committee of the necessity of deciding technical details and to facilitate more effective supervision of the work. A staff of workers has been secured and an organized scheme of procedure has been planned and put into operation.

In each of the five mainland States the experimental work is being carried out in co-operation with the State Departments of Agriculture.

The preliminary results of such work carried out at an experimental farm at Mareeba, North Queensland, have resulted in the Queensland Government making available twenty-five blocks of land in the vicinity, the intention being to have these blocks thrown open with a view of having an area of each block planted with commercial tobacco during the current season. Co-operative research work on the blue mould disease of tobacco is under way in the Council's Division of Plant Industry, and reference to these investigations has already been made in this report. The aim of the Investigation is the improvement of the tobacco industry, and it is hoped to improve the quality and to increase the quantity of Australian grown tobacco until at least the major part of the cured leaf used in local tobacco factories will be grown in Australia. Exploratory and general agronomical field tests are in progress in each of the five mainland States. Warehouse and factory tests have been made in Melbourne, Sydney and Perth.

10. *Mineragraphic Investigations.*—Of recent years the Australian mining industry has suffered a serious decline largely as the result of the working out of many of the richer deposits of metalliferous ores. The rehabilitation of the industry will thus involve, *inter alia*, the development of the lower grade but extensive deposits which are known to exist in various parts of the continent. This in its turn will involve the utmost efficiency in treatment methods. In the past, a difficulty that has always hampered the development of the best method of ore treatment has been the lack of information regarding the precise mineral content of the deposits. Ordinary assays are not enough. What is of even greater importance is a knowledge of the precise minerals which occur in the ore, the size of their individual crystals, their associations with each other, &c. Once information of this nature is available, it becomes possible to determine the degree of grinding that will render the most economic separation possible, the minerals that can be most economically floated, &c. A knowledge of the relation of the individual minerals to each other is also quite frequently of vital importance to the mining geologist, giving him information as to the genesis of the deposit and thus leading to suggestions for the better underground development of the mine.

In the past, the obtaining of full information regarding mineral associations in an ore has been practically impossible owing to the fact that most minerals are opaque to light and thus cannot be determined by the ordinary and well known petrographic methods. Of recent years, however, the difficulty has been largely overcome by the development of a special technique depending on the use of reflected light. This technique is used by the Council's investigator—Dr. F. Stillwell. During the past year, he has specialized on the telluride gold ores of Kalgoorlie, but in addition has examined a number of ores from Pernatty Lagoon, Bethanga (Victoria), Renison Bell (Tasmania), Cassilis (Victoria), Blue Tier (Tasmania), Stawell (Victoria), Cobar (New South Wales) and Moonta (South Australia).

The investigations have been greatly facilitated by a grant of £400 per annum from the Australasian Institute of Mining and Metallurgy. The University of Melbourne has also assisted by providing Dr. Stillwell with laboratory accommodation in the Geology Department under its control.

11. *Research in the Field of Secondary Industries.*—The Council has adhered to its policy, outlined in its previous report, in regard to investigations in the field of secondary industries. It is of the opinion that, in general, research work in the secondary industries may well be carried out by these industries themselves. They are more favorably placed to investigate their own specific problems than are the primary industries. The latter face many problems which possess a broad national character, and the investigation of them may legitimately be regarded as a function of the Government. Individual farmers, or even groups of them, cannot be expected to undertake the investigation of complex biological problems of continental significance. On the other hand, in the application of science to problems not of so wide a national character, the responsibility for research may well rest mainly with the industries concerned, rather than with the Government. Up to the present, therefore, and also in view of its limited financial resources, the Council has confined its main activities to the primary industries.

As regards the secondary industries, however, it is felt that it may be advisable in time to aim at the establishment of Research Associations of a nature similar to those already in existence in Great Britain. If such associations be formed in Australia, the Council will explore the possibilities of co-operation with the corresponding bodies in Great Britain. It is known that some of the latter would welcome such co-operation and would also welcome Australian firms as members, although in other cases requests to be admitted would not be favorably considered.

As discussed in a later section of this report, a considerable amount of assistance is given to the secondary industries in the form of technical and scientific information made available to them through the medium of the Bureau of Information.

XII.—MISCELLANEOUS.

1. *Publications of the Council.*—The following publications were issued by the Council during the year :—

(i) *Books*—

Catalogue of Scientific and Technical Periodicals in the Libraries of the Commonwealth.

(ii) *Pamphlets*—

No. 14.—The Work of the Division of Economic Botany for the year 1928–29, by Dr. B. T. Dickson.

No. 15.—The Work of the Division of Economic Entomology for the year 1928–29, by Dr. R. J. Tillyard.

No. 16.—The Work of the Division of Animal Nutrition for the year 1928–29, by Professor T. Brailsford Robertson.

No. 17.—The Mineral Content of Pastures—Progress Report on Co-operative Investigations at the Waite Agricultural Research Institute.

(iii) *Special Publication*—

The Dairy Industry of the Commonwealth in relation to possible activities of the Council for Scientific and Industrial Research, by Professor S. M. Wadham.

(iv) *Quarterly Journal*—

Vol. 2, No. 3, August, 1929.
Vo. 2, No. 4, November, 1929.
Vol. 3, No. 1, February, 1930.
Vol. 3, No. 2, May, 1930.

The confidential Monthly Summary is still being issued to members of the Council and of its State Committees, and enables them to keep in closer touch with the manifold activities of the Council than would otherwise be the case. This Summary is also issued to the officers of the Council and to certain research organizations in other parts of the Empire. In the last mentioned direction, it thus serves as one means of keeping these organizations acquainted with the various investigations, and to that extent plays its part in the general movement for the closer co-ordination of research work throughout the Empire as a whole.

2. *Catalogue of Scientific Periodicals.*—The completed catalogue was received from the printers early in April, and its distribution throughout the Commonwealth was immediately proceeded with. To all those engaged in research work, it is proving of inestimable value, enabling them to locate references that they require without trouble. Librarians in charge of libraries which embrace scientific and technical publications have probably benefited most by its appearance. Not only does it assist them very considerably in their cataloguing, but it is especially useful when the question arises as to whether a particular periodical should be purchased or not. Its publication should result both in less duplication of periodicals as between library and library

and in some of the more important periodicals that are at present missing being obtained. Arrangements are in hand for the formation of a Committee to deal with the question of supplements in order that the Catalogue may be brought up to date at regular intervals.

3. *Commonwealth Scientific Publications Committee.*—It was explained in the previous report that this Committee had been set up to advise on the allocation of a special grant that had been available on the estimates of the Prime Minister's Department in order to ensure the publication of memoirs and reports, which, while of great scientific value, might not be acceptable to ordinary commercial publishing houses. This Committee is formed of representatives of the Council, of the Australian National Research Council, and of the Treasury.

During the year, the following books were published under the ægis of the Committee :—

Meteorological Observations of the First Shackleton (Nimrod) Antarctic Expedition 1907–1909, by E. Kidson, O.B.E., D.Sc., &c., formerly of the Commonwealth Meteorological Bureau, now of the New Zealand Department of Scientific and Industrial Research.

Australian Rain Forest Trees, by W. D. Francis, Assistant Government Botanist, Queensland.

The Committee is now devoting some funds towards the cost of publication of a geological map of Australia prepared by Sir Edgeworth David, K.B.E., C.M.G., F.R.S., &c., Emeritus Professor of Geology, University of Sydney.

4. *Council Representation in Great Britain.*—Mr. F. L. McDougall, C.M.G., the Representative of the Council in Great Britain, and his officers have continued to furnish valuable reports on various matters, and constitute a most useful means whereby the Council is readily able to obtain information on recent scientific developments in practically any subject whatever. Mr. McDougall maintains effective liaison between the Council and numerous research organizations and individual workers in Britain. In addition, his services have been of particular value during the negotiations for co-operative investigations between the Empire Marketing Board and the Council. The promised contributions of the Board towards present and future scientific investigations of the Council have been most generous, and their total value is large.

5. *Library.*—The number of volumes added to the library at head-quarters during the past year has been 569, of which 254 are bound volumes of periodicals. The number of bulletins, pamphlets, reports and periodicals to be received has been far greater than hitherto, the total accessions per month averaging 712. The expected transference of some of the agricultural and other literature from head-quarters to the Divisional libraries has now taken place. It was at first thought that this would affect the usefulness of Head-quarters Library, particularly in regard to periodicals, but owing to the generosity of the State Departments of Agriculture, Departments of Agriculture of New Zealand, the Federated Malay States and the United States of America and various other bodies, as well as private individuals, complete duplicate sets of many of the journals have been obtained without any expense being involved. The Commonwealth Department of Health contributed a particularly useful gift when it forwarded many volumes from the duplicate shelves of the Australian Institute of Tropical Medicine.

The section of the library dealing with marine biology and fisheries has been greatly augmented by some valuable gifts. The United States Fisheries Bureau has sent an almost complete set of its publications and the Canadian Department of Marine and Fisheries has also provided many reports. Perhaps of even more value to the section are the publications of the Conseil Permanent International pour l'Exploration de la Mer which have also been received.

Now that the Council is publishing a quarterly journal as well as bulletins and pamphlets on special subjects, it is becoming increasingly easy to establish valuable exchanges. This is particularly the case with agricultural literature, and has assisted materially in building up the Canberra Divisional Library.

The number of inquirers using the library is on the increase. The greater number of these desire all the available references to a particular subject. The extent and variety of the subjects asked for are dealt with in this report in the paragraph on the Bureau of Information. In addition, the officers of other Departments as well as private individuals are finding the library increasingly useful in supplying them with the special references that they require.

6. *General Scientific Advice to the Government.*—The Council continues to act as a source of general scientific advice to the Government both on matters which it is investigating itself and on others as well. Throughout the period under review, the range of subjects which were referred to the Council in this connexion was a very wide one. In addition, the Council was consulted by the Government in relation to Australian representation at a large number of scientific congresses and conferences of an Imperial and international nature.

7. *Bureau of Information.*—The Act constituting the Council provides that one of the Council's functions shall be the establishment of a Bureau of Information for the collection and dissemination of information relating to scientific and technical matters. Although such a

Bureau has not yet been definitely established, its purpose has been largely met by the dissemination of a large amount of such information both amongst outside organizations and the general public. The requests for such information are of a very varied nature, but, with the wealth of scientific resources the Council now has available, it has been possible to meet nearly all of them, and work of no little value continues to be carried out in this direction. A considerable proportion of these requests for information have related to the manufacturing or secondary industries. The following selected list gives an indication of the varied nature of the matters on which advice was given during the period under review :—

Agricultural and Pastoral.—Rabbit control by disease, artificial manure, soya bean cultivation, sheep licks, skeleton weed, dried meat, liquid bait for blowflies, cattle tick, chicory, Angora rabbits, stomach worms in sheep, wheat production in arid areas, carob beans, fibre plants, sea-weed as a stock food, locust destruction, prussic acid in clovers and iodine in poultry diseases.

Horticulture and Fruit By-products.—Protection of orchards from frosts, drying of apricots, bottled grapes, drying of prunes, fumigation with hydrocyanic acid, passion fruit pulp, unfermented grape juice, rose diseases, potato by-products, banana preservation, citrus cultivation, starch content of bananas, juniper berry, utilization of fruit juices, cork cultivation and electro-culture.

Minerals.—Tantalite ore, stannite ore, sulphur, coorongite shales, nickel ores, mica, metallurgy of copper ores, barytes, asbestos.

Fuels.—Power alcohol from surplus sugar cane, low temperature distillation of coal, motor fuels, power alcohol from waste timber and waste fruits, oil shale distillation.

Manufactures.—Coco-nut fibre for bags, wool scouring—recovery of wool grease, reconditioning of lubricating oils, extraction of iodine, vegetable black, corrosion of tin containers, dyes from black currants, banana oil, pollapas, levulose from artichokes, odourless celluloid, glucose, ultramarine, pectin, felt and felting materials, enamel substitutes, sealing materials for containers, dried egg albumen, margarine, artificial leather, dry ice, artificial marble and dry cells.

Miscellaneous.—Perfumes from Australian wild flowers, pearl culture, turtle meat, Posidonia fibre, power from tides, freezing mixtures, composition of honey, watery white in eggs, refrigeration—latest researches, dried meat.

XIII.—FINANCIAL MATTERS AND STAFF.

1. *Finance.*—The statement of expenditure from 1st July, 1929, to 30th June, 1930, is as follows :—

	£	£
1. Salaries and contingencies		14,384*
2. Remuneration of Chairman and Members of Council		3,580†
3. Investigations—		
(i) Animal Problems—		
(*a*) Black disease	2,048	
(*b*) Parasitology	446	
(*c*) Caseous lymphadenitis	1,147	
(*d*) Sheep blow-fly	433	
(*e*) Haematuria in cattle	462	
(*f*) Braxy-like (Beverley) disease (Western Australia)	1,382	
(*g*) Cattle tick dips — £614		
Less contributions from Governments of New South Wales and Queensland towards 1929–30 expenditure — 500		
	114	
(*h*) Flying-fox pest	798	
(*i*) Chief of Division of Animal Health	922	
(*j*) Miscellaneous	320	
		8,072

* The main items of expenditure under this heading are salaries of the Administrative Staff at the Council's Head Office; staff and upkeep of State Committees; staff at Australia House; travelling expenses of head office staff, members of the Council, &c., and printing and general office expenditure. The sum of £14,384 was provided as follows :—

	£
From Consolidated Revenue Fund	5,084
From Science and Industry Investigation Trust Account	9,300
	14,384

† Provided from Consolidated Revenue Fund.

	£	£	£
(ii) Plant Problems—Division of Plant Industry—			
(a) Central Laboratory—			
Salaries, &c.	4,054		
Capital	8,905*		
		13,959	
(b) Tomato wilt		670	
(c) Bitter pit in apples		916	
(d) Arid flora		712	
(e) Poison plants		844	
(f) Genetics		1,518	
(g) Noogoora burr		219	
(h) Agrostology		396	
(i) Miscellaneous		428	
			19,662
(iii) Entomological Problems—Division of Economic Entomology—			
(a) Central Laboratory—			
Salaries, &c.	6,026		
Capital	24,443		
		30,469	
(b) Noxious weeds		927	
(c) Noxious insects		662	
(d) Blow-fly and Buffalo fly		2,695	
(e) Forest Entomology		1,258	
(f) Scouting work abroad (Farnham Royal, &c.)		1,994	
(g) Miscellaneous		88	
			38,093†
(iv) Animal Nutrition—Division of Animal Nutrition—			
(a) Central Laboratory—			
Salaries, &c.	6,578		
Capital	549		
		7,127	
(b) Waite Institute		1,976	
(c) Field Station, Beaufort, Victoria ..		374	
(d) Field Station, Young, New South Wales		514	
(e) Field Station, Moree, New South Wales		264	
(f) Field Station, Springsure, Queensland		321	
(g) Field Station, Mount Gambier South Australia		1,464	
At Waite Institute in co-operation with E.M.B. and Adelaide University—			
(h) Mineral deficiencies in pastures ..		935	
			12,975

* Contribution of £1,500 was received from the Tobacco Investigation Committee towards cost of erection of Plant House.
† Contribution of £29,016 was received from the Empire Marketing Board towards this expenditure.

(v) Horticultural Problems of the Irrigation Settlements—			
Citricultural—	£	£	£
(*a*) Research Station, Griffith—			
Salaries and incidentals..	3,523		
Capital	1,096		
	4,619		
Contributions by New South Wales W.C. & I.C.	1,500		
		3,119	
Viticultural—			
(*b*) Research Station, Merbein—			
Salaries and incidentals ..	3,823		
Capital	369		
		4,192*	
			7,311
(vi) Soil Problems—			
(*a*) Investigations at Waite Institute and Irrigation Areas—			
Salaries, &c. ..	3,728		
Capital	567		
		4,295	
(*b*) Miscellaneous		150	
			4,445
(vii) Food Preservation and Transport—			
(*a*) Banana Investigations (Queensland University)		557	
(*b*) Banana Investigations (Melbourne University)		362	
(*c*) Cold Storage of Meat and Fish ..		496	
(*d*) Citrus preservation		502	
(*e*) Meat Export Survey 1929–30 ..		778	
(*f*) Adviser on Food Preservation ..		406	
(*g*) Miscellaneous		109	
			3,210
(viii) Dairy Branch—			
(*a*) Professor S. M. Wadham's Investigations ..			30
(ix) Prickly Pear—			
(*a*) Grant for Investigations—			9,099
(x) Forest Products—			
(*a*) Central Laboratory—			
Salaries, &c.	2,035		
Capital	722		
		2,757	
(*b*) Seasoning		1,290	
(*c*) Preservation		680	
(*d*) Wood Technology		1,497	
(*e*) Tannin Extracts		1,665	
(*f*) Essential Oils		323	
(*g*) Miscellaneous		28	
			8,240
(xi) Mining and Metallurgy—			
(*a*) Mineragraphic Investigations			592
(xii) Fuel Investigations			586
(xiii) Radio Research—			
(*a*) Melbourne University		1,799	
(*b*) Sydney University		2,476	
(*c*) Adviser on Radio Research ..		97	
(*d*) Miscellaneous		10	
			4,382†

* £615 was received for sale of produce and credited to Trust Fund receipts.
† Contrbution of £1,950 was received from the Postmaster-General's Department towards this expenditure.

		£
(xiv)	Maintenance of Standards	12
(xv)	Library	1,312
(xvi)	Catalogue of Scientific Periodicals	1,526
(xvii)	Contributions to Imperial Agriculture Bureaux and to British Woollen and Worsted Association	3,125
(xviii)	Miscellaneous	361
		123,033
Less contributions by—	£	
Empire Marketing Board ..	29,016	
Tobacco Investigation Committee	1,500	
Postmaster-General's Department	1,950	
		32,466
Total of Item 3		90,567
Grand Total of Expenditure.		
From Science and Industry Investigation Trust Account		99,867
From Consolidated Revenue		8,664
		108,531

2. *Staff.*—The following is a list of the staff of the Council as at the 30th June, 1930. The list does not include typistes, laboratory assistants and labourers, &c.

1. Head Office Staff.

Chief Executive Officer—A. C. D. Rivett, M.A., D.Sc., F.A.C.I.
Secretary—G. Lightfoot, M.A.
Assistant Secretary—G. A. Cook, M.Sc., B.M.E., A.A.C.I.
Chief Clerk and Accountant—H. P. Breen.

Library—
Librarian and Scientific Assistant—Miss E. Archer, M.Sc.
Assistant Librarian—Miss K. Ramsay.

Accounts, Staff, Stores—
M. G. Grace, L.I.C.A.
J. Derum.
D. J. Bryant.

Orders—
R. W. Constable.

Records—
P. Domec Carre.
H. T. Chadwick.
W. Gillespie.

Clerical Assistant to Chief Executive Officer—Miss A. Slattery, B.A.
Clerical Assistant to Chairman—Mrs. N. Roberts.
Local Secretary, Canberra—R. F. Williams.

2. Secretaries of State Committees.

New South Wales—
Brigadier-General I. G. Mackay—University of Sydney.

Victoria—
G. A. Cook, M.Sc., B.M.E., A.A.C.I., 314 Albert-street, East Melbourne.

Queensland—
Miss H. Todd, corner Ann and Edward Streets, Brisbane.

South Australia—
E. V. Clark, B.Sc., University of Adelaide.

Western Australia—
L. W. Phillips, M.Sc., A.A.C.I., Box K.766, G.P.O., Perth, W.A.

Tasmania—
F. J. Carter, Box U.B., G.P.O., Hobart.

3. Australia House, London.

Representative in Britain—F. L. McDougall, C.M.G. (part-time).
Scientific Assistant—A. S. Fitzpatrick, M.Sc., Ph.D. (part-time).
Clerical Assistant—A. W. Stuart Smith (part-time).

4. Division of Plant Industry.

At Canberra—
Chief—B. T. Dickson, B.Sc. (London), B.A. (Ontario), Ph.D. (Cornell).
Senior Plant Pathologist—H. R. Angell, B.Agr.Sc., Ph.D.
Senior Plant Geneticist—J. R. A. McMillan, B.Agr.Sc., M.Sc.
Senior Plant Introduction Officer—A. McTaggart, B.S.A. (Toronto), M.S.A. (Cornell), Ph.D. (Cornell).
Assistant Plant Pathologist—W. L. Geach, B.Sc. (Bristol).
Junior Plant Introduction Officer—W. Hartley, B.Sc. (Cantab.).
Assistant Plant Geneticist—H. F. Smith, B.Sc. (Edin.), M.S.A. (Cornell).
Assistant Botanist (Weeds)—J. Calvert, M.Sc. (Belfast), F.L.S.
Chemist—E. H. Kipps, B.Sc.
Librarian (part-time)—Mrs. L. M. Willings, B.A.

At Head Office, Melbourne—
Mycologist—C. C. Brittlebank.

At Waite Agricultural Research Institute, South Australia—
Assistant Plant Pathologist—J. G. Bald, B.Agr.Sc.

At Department of Agriculture, Western Australia—
Senior Plant Pathologist—W. M. Carne, F.L.S.

At University of Sydney, under direction of Poison Plants Committee—
Research Officer—Miss M. Holdsworth, B.Sc.

At Koonamore Vegetation Reserve, South Australia (under part-time direction of Professor T. G. B. Osborn)—
Research Officer—T. B. Paltridge, B.Sc.

5. Irrigation Settlement Problems.

Commonwealth Research Station, Griffith—
Liaison Officer—F. K. Watson, M.A., B.Sc., A.M.Inst.C.E. (part-time).
Officer-in-Charge—E. S. West, B.Sc., M.S.
Accountant (part-time)—D. Chalmers.
Orchard Superintendent—B. H. Martin.
Field Assistant—E. F. Mackenzie, D.A.
Clerical Assistant—Miss E. A. E. Smith.

Commonwealth Research Station, Merbein—
Officer-in-Charge—A. V. Lyon, M.Agr.Sc.
Agricultural Officer—J. E. Thomas, B.Sc., B.Agr.Sc., B.V.Sc.
Botanical Assistant—C. Barnard, B.Sc.
General Assistant—J. E. Giles.

6. Soil Problems.

At Waite Agricultural Research Institute—
Soil Adviser—Professor J. A. Prescott, M.Sc., A.A.C.I. (part-time).
Soil Survey Officer—J. K. Taylor, M.Sc., M.Agr.Sc., B.A.
Assistant Field Officer—T. J. Marshall, B.Agr.Sc.
Assistant Chemist—H. G. Poole, M.Sc., A.A.C.I.
Assistant Chemist—J. S. Hosking, B.Sc.
Assistant Field Officer—P. D. Hooper.

At Commonwealth Research Station, Griffith—
Assistant Soil Chemist—H. N. England, B.Sc., A.A.C.I.

At University of Tasmania—
Assistant Soil Chemist—C. G. Stephens, B.Sc.

7. Animal Problems.

At Head Office, Melbourne—
Acting Chief of Division—J. A. Gilruth, D.V.Sc., M.R.C.V.S., &c.

At Melbourne University Veterinary Research Institute–
Veterinary Officer—A. W. Turner, D.V.Sc.
Veterinary Officer—D. Murnane, B.V.Sc.

At Adelaide Hospital Pathological Laboratory—
Veterinary Officer—C. G. Dickinson, B.V.Sc.
Chemist—A. T. Dann, M.Sc.

At Department of Agriculture, Western Australia—
Veterinary Officer—H. W. Bennetts, M.V.Sc. (seconded from Department of Agriculture, Western Australia).
Assistant Veterinary Officer—R. Harley, M.R.C.V.S.
Chemist—F. F. Allsop, B.Sc., A.A.C.I.

At University of Sydney—
Parasitologist—I. Clunies Ross, D.V.Sc.
Bacteriological Technician—E. Parrish.

At Nyngan Experimental Farm, New South Wales—
Veterinary Officer—C. R. Mulhearn, B.V.Sc. (on loan to the New South Wales Department of Agriculture).

Abroad—
Veterinary Officer—W. A. Carr Fraser, B.V.Sc. (in Great Britain engaged in post-graduate work in animal nutrition).

8. Division of Animal Nutrition.

At the University of Adelaide—
Acting Chief—H. R. Marston.
Chief Assistant—J. Ward Walters.
Chemist—R. G. Thomas, B.Sc.
Assistant—J. D. O. Wilson.
Assistant Chemist—J. W. H. Lugg.
Statistical Recorder—G. W. Bussell.
Chemical Assistant—F. C. Farr.
Typiste-Secretary—Mrs. E. V. Wilson.

At the Waite Agricultural Research Institute—
Field Officer—E. W. Lines, B.Sc.
Assistant Field Officer—A. W. Peirce, B.Sc.

At "Buln Gherin" Sheep Station, Beaufort, Victoria.
Field Assistant—A. R. Beggs.

At "Meteor Downs" Sheep Station, Springsure, Queensland—
Field Assistant—C. Brown.

At "Keytah" Sheep Station, Moree, New South Wales—
Field Assistant—O. K. Samuel.

At "Dismal Swamp" Sheep Station, near Mt. Gambier, South Australia—
Field Assistant—K. M. Horwood.

At "Wambanumba" Field Station, Young, New South Wales—
Field Assistant—W. Haddon Cave.

9. Mineral Deficiency of Pastures Investigation.

At the Waite Agricultural Research Institute—
Agronomist—K. M. Fraser, B.Agr.Sc.
Analytical Chemist—R. E. Shapter, A.A.C.I.

10. Division of Economic Entomology.

At Canberra—
Chief—R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.R.S.
Deputy Chief—A. J. Nicholson, D.Sc.
Senior Entomologist—G. F. Hill.
Senior Systematic Entomologist—A. L. Tonnoir.
Senior Entomologist—I. M. Mackerras, M.D.

Senior Entomologist—G. A. Currie, B.Sc., B.Agr.Sc.
Entomologist—J. W. Evans, B.A.
Field Assistant—H. Willings, B.A.
Junior Entomologist—Miss M. Fuller, B.Sc.
Junior Systematic Entomologist—Miss W. P. Kent-Hughes, M.Sc.
Junior Systematic Entomologist—Miss L. F. Graham, B.A.
Junior Museum Assistant—Miss H. M. Barnes, B.Sc.
Librarian—Mrs. L. M. Willings, B.A. (part-time).

At Farnham House Laboratory, England—
Entomologist—F. G. Holdaway, M.Sc., Ph.D.
Entomologist—S. Garthside, M.Sc.

At Buitenzorg, Java—
Junior Entomologist—G. L. Windred, B.Agr.Sc.

In Northern Australia—
Junior Entomologist—T. G. Campbell, B.Sc.

At State College, Manhattan, Kansas, U.S.A.—
Junior Entomologist—S. G. Kelly, M.S. (Agr.).

11. Division of Forest Products.

At Head Office, Melbourne (temporarily)—
Chief—I. H. Boas, M.Sc., A.A.C.I.
Senior Seasoning Officer—S. A. Clarke, B.E., A.M.I.E. (Aust.).
Senior Chemist—W. E. Cohen, B.Sc., A.A.C.I.
Assistant Seasoning Officer—C. S. Elliot, B.Sc.
Preservation Officer—J. E. Cummins, M.Sc., A.A.C.I.
Chemist—H. E. Dadswell, M.Sc.
Assistant Chemist—L. Baldock.
Assistant Chemist—Mrs. I. W. Dadswell, M.Sc.
Assistant Wood Technologist—Miss M. D. Burnell, B.Sc.
Librarian and Records Clerk—Miss I. Hulme.

At Technological Museum, Sydney—
Chemist—A. H. Innes Young.

12. Cold Storage Investigations.

At University of Melbourne—
Adviser and Investigator—Associate Professor W. J. Young, D.Sc. (part-time).
Assistant Biochemist—W. A. Empey, B.V.Sc.
Biological Assistant—E. W. Hicks, B.Sc.

At University of Queensland—
Biological Assistant—F. E. Huelin, B.Sc.

In England—
Investigator—J. R. Vickery, M.Sc., Ph.D.
Assistant Investigator—N. E. Holmes, B.E.E.

13. Radio Research.

At University of Melbourne—
Senior Investigator—G. H. Munro, M.Sc.
Investigator—R. O. Cherry, M.Sc.
Investigator—D. F. Martyn, B.Sc., Ph.D.

At University of Sydney—
Senior Investigator—A. L. Green, M.Sc., A.M.I.R.E.
Investigator—L. G. H. Huxley, M.A., Ph.D.
Investigator—W. G. Baker, B.Sc., B.E.

14. Other Investigations.

Mineragraphic Investigations—
Investigator—F. L. Stillwell, D.Sc.

Flying-fox Investigation—
Investigator—F. N. Ratcliffe, B.Sc.

Fuel Research—
At Fuel Research Station, East Greenwich, England—
Investigator—L. J. Rogers, B.E. (seconded to British Fuel Research Board).

XIV.—ACKNOWLEDGMENTS.

The Council desires to acknowledge the very valuable assistance so freely afforded by many organizations and individuals. It is also desired to make special reference to the various State Departments, particularly those of Agriculture, and to the Universities. The help these bodies have given in affording laboratory accommodation and the use of their other facilities has been invaluable. Other organizations, including Commonwealth Departments and independent bodies, have also been particularly helpful. In addition to those who have been specified in the main part of this report, mention must also be made of many other private individuals who have taken a keen interest in the work of the Council and afforded it much help, both financial and otherwise.

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A. C. D. RIVETT, Deputy Chairman and Chief Executive Officer,
D. O. MASSON, Deputy Member,
A. E. V. RICHARDSON,
} Executive Committee.

G. LIGHTFOOT, Secretary.

APPENDIX.

A.—Personnel of the Council and of its Various Committees.

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Sir George A. Julius, Kt. B.Sc., B.E. (*Chairman*).
A. C. D. Rivett, Esq., M.A., D.Sc. (*Deputy Chairman and Chief Executive Officer*).
Professor A. E. V. Richardson, M.A., D.Sc.
Sir David O. Masson, K.B.E., F.R.S., &c. (*Deputy Member*).

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Professor R. D. Watt, M.A., B.Sc. (New South Wales).
Sir David O. Masson, K.B.E., F.R.S., &c. (Victoria).
Professor H. C. Richards, D.Sc. (Queensland).
W. J. Young, Esq., C.B.E. (South Australia).
B. Perry, Esq. (Western Australia).
P. E. Keam, Esq. (Tasmania).

Co-opted Members.

Professor E. J. Goddard, B.A., D.Sc.
A. E. Leighton, Esq., F.I.C.
Professor H. A. Woodruff, M.R.C.V.S., &c.

STATE COMMITTEES (AS AT 30TH JUNE, 1930).

New South Wales.

Professor R. D. Watt, M.A., B.Sc. (Chairman).
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Professor Sir Henry E. Barraclough, K.B.E., V.D., B.E., M.M.E., M.Inst., C.E., M.I. Mech.E.
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E. D. Ogilvie, Esq., B.A.
Professor T. G. B. Osborn, D.Sc.
Professor J. D. Stewart, M.R.C.V.S., B.V.Sc.
G. D. Ross, Esq.

Victoria.

Emeritus-Professor Sir David O. Masson, K.B.E., M.A., D.Sc., LL.D., F.R.S. (*Chairman*).
Professor W. E. Agar, M.A., D.Sc., F.R.S.
W. Baragwanath, Esq.
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W. F. Cuming, Esq.
Associate-Professor W. N. Kernot, B.C.E., M.Mech.E., M.Inst.C.E.
Emeritus-Professor Sir Thomas R. Lyle, M.A., D.Sc., F.R.S.
H. A. Mullett, Esq., B.Agr.Sc.
F. J. Rae, Esq., B.Agr.Sc., B.Sc.
W. E. Wainwright, Esq., A.S.A.S.M., M.Aust.I.M.M., M.Am.I.M.M.
L. J. Weatherly, Esq., M.A.
Associate-Professor W. J. Young, D.Sc.

South Australia.

W. J. Young, Esq., C.B.E. (*Chairman*).
E. H. Bakewell, Esq.
Professor Kerr Grant, M.Sc., F.Inst.P.
W. A. Hargreaves, Esq., M.A., B.C.E., D.Sc., F.I.C.
W. J. Hill, Esq.
Professor T. H. Johnston, M.A., D.Sc.
Professor A. J. Perkins.
F. T. Perry, Esq.
Professor J. A. Prescott, M.Sc.
L. K. Ward, Esq., B.A., B.E., D.Sc.

QUEENSLAND.

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J. D. Bell, Esq.
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Professor J. K. Murray, B.A., B.Sc.Agr.
Professor T. Parnell, M.A.
Professor B. D. Steele, D.Sc., F.R.S., F.I.C.
W. L. Payne, Esq.

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B. Perry, Esq. (*Chairman*).
F. G. Brinsden Esq., M.I.M.M., M.Aust.I.M.M.
Professor E. de Courcy Clarke, M.A.
J. D. Hammond, Esq.
S. L. Kessell, Esq., M.Sc., Dip. For.
E. H. B. Lefroy, Esq.
Professor G. E. Nicholls, D.Sc., A.R.C.Sc., F.L.S.
Professor A. D. Ross, M.A., D.Sc., F.R.S.E., F.Inst.P.
E. S. Simpson, Esq., D.Sc., B.E.
G. L. Sutton, Esq.
Professor H. E. Whitfield, B.A., B.E., M.I.M.M., M.I.E.Aust.
Professor N. T. M. Wilsmore, D.Sc., F.I.C., M.I. Chem.E.

TASMANIA.

P. E. Keam, Esq. (*Chairman*).
N. P. Booth, Esq., F.I.C.
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A. K. McGaw, Esq.
A. McIntosh Reid, Esq., A.I.M.E.
R. O. Shoobridge, Esq.
F. E. Ward, Esq.

STANDING COMMITTEE ON AGRICULTURE (STATE MEMBERS).

S. S. Cameron, D.V.Sc., M.R.C.V.S., Director, Department of Agriculture, Victoria (*Chairman*).
E. Graham, Esq., Under-Secretary, Department of Agriculture and Stock, Queensland.
Professor A. J. Perkins, Director, Department of Agriculture, South Australia.
G. D. Ross, Esq., Under-Secretary, Department of Agriculture, New South Wales.
G. L. Sutton, Esq., Director, Department of Agriculture, Western Australia.
F. E. Ward, Esq., Director, Department of Agriculture, Tasmania.

COMMONWEALTH RESEARCH STATIONS, MERBEIN AND GRIFFITH—COMMITTEE OF CONTROL.

B. T. Dickson, B.A., Ph.D., Chief, Division of Plant Industry.
Professor T. G. B. Osborn, D.Sc., University of Sydney.
Professor J. A. Prescott, M.Sc., Waite Agricultural Research Institute, University of Adelaide.
F. K. Watson, M.A., B.Sc., (Agr.), B.Sc., A.M.I.C.E. (Lond.), A.I.I.E. (Aust.), Water Conservation and Irrigation Commission, Griffith, New South Wales.

COMMONWEALTH RESEARCH STATION, MERBEIN—ADVISORY COMMITTEE.

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S. P. Bromfield, Esq., State Rivers and Water Supply Commission, Victoria.
A. Lever, Esq., Mildura Vineyards Protection Board.
A. V. Lyon, Esq., M.Agr.Sc., Commonwealth Research Station, Merbien.
S. Thompson, Esq., Citrus Growers' Association, Merbein.
F. K. Watson, Esq., B.Sc., A.M.Inst.C.E., Commonwealth Research Station, Griffith, New South Wales.
D. C. Winterbottom, Esq., Mildura Packers' Association.

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J. S. Vagg, Esq., Griffith Fruit Growers' Co-operative Co.
E. S. West, Esq., B.Sc., M.S., Commonwealth Research Station, Griffith.
V. C. Williams, Esq., Murrumbidgee Irrigation Areas Research Bureau, Griffith.

POISON PLANTS COMMITTEE.

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Colonel Max Henry, M.R.C.V.S., Department of Agriculture, New South Wales.
Professor T. G. B. Osborn, D.Sc., Department of Botany, University of Sydney.
Associate-Professor H. J. Priestley, M.D., Ch.M., B.Sc., Department of Physiology, University of Sydney.
H. Seddon, D.V.Sc., Glenfield Veterinary Research Station, Department of Agriculture, New South Wales.
G. P. Darnell-Smith, D.Sc., Botanical Gardens, Sydney.

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L. Cohen, Esq., Chemist, New South Wales Tick Board of Control, Lismore.
A. H. Cory, Esq., Chief Inspector of Stock, Department of Agriculture and Stock, Queensland.
Professor E. J. Goddard, B.A., D.Sc., Department of Biology, University of Queensland.
Colonel Max Henry, M.R.C.V.S., Department of Agriculture, New South Wales.
C. J. Pound, Esq., Department of Agriculture and Stock, Queensland.
A. A. Ramsay, Esq., Agricultural Chemist, Department of Agriculture, New South Wales.
W. A. N. Robertson, D.V.Sc., Director of Veterinary Hygiene, Federal Department of Health.
C. L. O'Gorman, Esq., Chairman, New South Wales Tick Board of Control, Lismore.
R. Veitch, Esq., B.Sc.Agr., B.Sc.For., F.E.S., Chief Entomologist, Department of Agriculture and Sotck, Brisbane.

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A. J. Gibson, Esq., A.M.I.C.E., Hon. Secretary, Australian National Research Council.
Sir George A. Julius, Kt., B.Sc., B.E., *ex-officio* member.
A. C. D. Rivett, Esq., M.A., D.Sc., *ex-officio* member.
Professor A. E. V. Richardson, M.A., D.Sc., *ex-officio* member.

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E. W. Trend, Esq., Australian Chemical Institute.
Captain L. R. Sundercombe, Marine Branch, Commonwealth Navigation Service.
G. A. Cook, Esq., M.Sc., B.M.E., Council for Scientific and Industrial Research.

LIAISON COMMITTEE—BRAXY-LIKE DISEASE INVESTIGATIONS IN WESTERN AUSTRALIA.

B. Peiry, Esq., (*Chairman*), Box K.766, G.P.O., Perth, Western Australia.
G. L. Sutton, Esq., Director of Agriculture, Perth, Western Australia.
H. W. Bennetts, Esq., M.V.Sc., Department of Agriculture, Perth, Western Australia.
A. J. Monger, Esq., Perpetual Trustees Buildings, Perth, Western Australia.
L. W. Phillips, Esq., M.Sc. (Secretary), Box K.766, G.P.O., Perth, Western Australia.

MEAT PRESERVATION COMMITTEE.

J. A. Gilruth, D.V.Sc., Acting Chief, Division of Animal Health (*Chairman*).
R. P. Allen, Esq., Chief Veterinary Officer, Department of Markets, Dudley Buildings, 527 Collins-street, Melbourne.
Hon. W. Angliss, M.L.C., 44 Bourke-street, Melbourne.
Professor H. G. Chapman, Physiology School, University of Sydney.
R. Crowe, Esq., Department of Agriculture, Melbourne.
Ross Grant, Esq., B.V.Sc., Department of Markets, Melbourne.
J. Hepburn, Esq., Government Cool Stores, Victoria Dock, Melbourne.
G. Lightfoot, Esq., Secretary, Council for Scientific and Industrial Research.
Professor W. A. Osborne, Physiology School, University of Melbourne, Carlton.
Professor J. D. Stewart, Veterinary School, University of Sydney, New South Wales.
F. H. Vincent, Esq., Manager, Metropolitan Farm, P.O., Werribee.
C. Wilson, Esq., Proprietor, Scott's Hotel, Collins-street, Melbourne.
Dr. W. J. Young, Biochemistry Department, University of Melbourne, Carlton.

SULPHURING OF APRICOTS COMMITTEE.

A. V. Lyon, M.Agr.Sc. (*Chairman*), Viticultural Research Station, Merbein.
W. R. Jewell, M.Sc., Research Chemist, Department of Agriculture, Victoria.
G. Quinn, Chief Horticultural Officer, Department of Agriculture, South Australia.
C. G. Savage, Director of Fruit Culture, Department of Agriculture, New South Wales.

B.—Committees Controlling Work in which the Council is Co-operating.

GEOPHYSICAL EXECUTIVE COMMITTEE.

A. C. D. Rivett, M.A., D.Sc., Council for Scientific and Industrial Research, Melbourne (*Chairman*).
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