COMMONWEALTH OF AUSTRALIA

INSTITUTE OF SCIENCE AND INDUSTRY

FIRST

ANNUAL REPORT

OF

THE DIRECTOR

For the period from the Date of his Appointment (18th March, 1921) to the 30th June, 1922

MELBOURNE, 31ST JULY, 1922

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(Covering Letter.)

Commonwealth Institute of Science and Industry,
314 Albert-street,
East Melbourne.

The Hon. A. S. RODGERS, M.P.,
Minister for Trade and Customs,
Melbourne, 25th September, 1922.

DEAR SIR,

In accordance with the provisions of the *Institute of Science and Industry Act* 1920 (Section 18), I beg to forward herewith my First Annual Report covering the period from the date of my appointment (18th March, 1921) to the 30th June, 1922.

Section 19 of the Act provides that the Report shall be laid before both Houses of the Parliament within 30 days after the receipt thereof if the Parliament is then sitting, and, if not, within 30 days after the next meeting of the Parliament.

Yours faithfully,

(Signed) G. H. KNIBBS,
Director.

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COMMONWEALTH INSTITUTE OF SCIENCE AND INDUSTRY.

FIRST ANNUAL REPORT

OF

THE DIRECTOR

FOR THE PERIOD FROM THE DATE OF HIS APPOINTMENT (18TH MARCH, 1921) TO THE 30TH JUNE, 1922.

I.—ORIGINATION OF THE TEMPORARY INSTITUTE.

The initiatory steps for the establishment of a Commonwealth Institute of Science and Industry were taken in January, 1916, when the Prime Minister convened a Conference in Melbourne to consider the matter. At this Conference a scheme was prepared for the creation of a permanent Institute, and, pending the establishment of this, a temporary Advisory Council was nominated to carry out certain initial work. It was then anticipated that the Institute would be established by Act of Parliament shortly after the return of the Prime Minister (Rt. Hon. William Morris Hughes, P.C., LL.D., M.P.) from England in 1916 ; proposals for constituting a temporary body to pave the way for the permanent organization were adopted, and members of the Advisory Council agreed to undertake the preparatory work.

II.—THE TEMPORARY ADVISORY COUNCIL.

The temporary Advisory Council was accordingly appointed by the Government, and held its first meeting in April, 1916. From this body an Executive Committee was appointed and a State Committee was established in each State. The movement was enthusiastically supported by leading industrial and scientific men throughout the Commonwealth, and great public interest was unquestionably awakened.

The temporary body, created—as said above—to prepare the ground for the proposed permanent Institute, was appointed " particularly to carry out " the following objects, viz., to—

(*a*) " consider and initiate scientific research in connexion with or for the promotion of primary or secondary industries in the Commonwealth," and

(*b*) " collect industrial scientific information and to form a bureau for its dissemination amongst those engaged in industry."

III.—INITIAL WORK OF TEMPORARY ADVISORY COUNCIL.

The work of the temporary organization was carried out mainly by the Executive Committee and the State Committees. By the middle of 1917 the temporary body had completed the work for which it was specifically appointed, and informed the Commonwealth Government accordingly, urging it to establish the permanent Institute forthwith. At the request of the Government, however, the temporary body continued in existence, and for a further period of over three years carried out work of a quasi-permanent nature. The scheme of organization necessarily involved working mainly through committees, which were honorary. The powers and financial resources of the temporary body were, however, quite insufficient to establish the Institute on an adequate basis.

This initial and preparatory work included :—

(*a*) An industrial-problem census, to ascertain the main scientific and technical problems affecting industries.

(*b*) A register of the equipment and *personnel* of the laboratories in the Commonwealth which would be available for industrial scientific research.

(*c*) A register of research work in progress at Australian laboratories and at Government Experiment Farms.

(*d*) A register of facilities available for training scientific investigators.

(*e*) Arrangements for co-operation with State Governments; with scientific and technical departments ; with Universities, Technical Schools, Scientific Societies, &c.

IV.—RESEARCH WORK OF THE TEMPORARY ADVISORY COUNCIL.

Owing to the fact that the temporary Institute had neither laboratories nor research staff, nor apparatus of its own, it had perforce to arrange as best it could for investigations to be carried out at various existing laboratories and institutions in Australia. The plan of action in each case was the following :—After thorough preliminary inquiry, a small Special Committee of experts was appointed, either (*a*) to give further advice and information with a view to future research by the permanent Institute, or (*b*) where practicable, to carry out actual experimental work. This plan clearly recognised that, before an investigation is undertaken, the most complete information practicable should be obtained. This discloses the existing state of knowledge on the subject, and the extent to which any question involved therein has already been solved. The *personnel* and equipment requisite for the work and its probable duration more clearly appears, as also the expense likely to be involved ; the probability of success can be better gauged, and finally the economic measure of the importance of the investigation can be more accurately apprais ed.

Despite the great labour involved in this procedure, the enthusiasm and help of the members of the Special Committees generously acting, be it said, *in a purely honorary capacity*, made it possible to carry on the work of the temporary Institute. In a number of cases even actual research was also undertaken, and quite gratuitously, by highly-qualified men, their time and resources being freely devoted thereto. In a few instances sufficient funds were available to enable salaried investigators to be employed to carry out work under the supervision of the Special Committees. With only three exceptions the maximum amount of money available for any particular investigation did not exceed £400 or £500, and in many instances was considerably less. The exceptions were the investigations on (*a*) Prickly Pear, (*b*) Life-history of the Cattle-tick, and (*c*) Means of Transmission of Worm Nodule Disease in Cattle.

The executive authority of the temporary body was in the hands of the Chairman of the Committee and the Chief Executive Officer. The former attended the weekly meetings; the Chief Executive Officer was vested with but limited powers and authority. At its head-quarters the temporary Institute had, in addition to the Chief Executive Officer, only one other technically qualified officer. Under such limitations as these, it was not possible for very substantial progress to be made in the organization, equipment, and work of a national scientific institution. From time to time the Committee considered various problems, and it soon became obvious that there was a very extended field of work which might properly be undertaken in the national interest. Owing, however, to the above reasons, and to the fact that the Government was not then prepared to authorize work of a continuous or permanent nature to be undertaken by the temporary Institute, its activities must be regarded as only partially satisfactory; they could hardly be otherwise under the limitations of the situation.

Despite the great difficulties under which the temporary Institute laboured for five years, a large amount of valuable work was performed, as is evident from the following list of the more important subjects that were investigated or were inquired into by the temporary Institute:—

A. Agricultural and Pastoral Industries—

1. Cattle Tick Pest.
2. Worm Nodule Disease.
3. Tuberculosis in Stock.
4. Sheep Blowfly.
5. White Ant Pest.
6. Prickly Pear.
7. Flax Industry.
8. Seed Improvement.
9. Native Grasses and Fodder Plants.
10. Viticultural Problems.
11. Castor Beans.

B. Forest and Vegetable Products—

1. Paper Pulp.
2. Tanning Materials.
3. Grass Tree Resin.
4. Zamia Palms.

C. Manufacturing Industries—

1. Leather and Tanning.
2. Pottery.
3. Power Alcohol.
4. Posidonia Fibre.
5. Mechanical Cotton Picker.
6. Engineering Standardization.
7. Liquid Fuels.

D. Mining and Metallurgy—

1. Gold Deposits on Bendigo Gold-fields.
2. Ferro Alloys.
3. Alunite.

In addition to the above, a large number of miscellaneous matters were dealt with, and the nucleus of a Bureau of Information was established with an appropriate commencement of a library of scientific and technical books and journals. This last, however, now urgently requires considerable development, and is quite inadequate for the permanent Institute if it is to function as the Act requires.

Information regarding the work carried out by the temporary Advisory Council of Science and Industry is furnished in the annual reports of that body for the years 1916–17 and 1917–18 and in a pamphlet entitled "The Work and Present Position of the Temporary Institute."

V.—SCOPE OF WORK IN PROGRESS.

The mere fact that, at the time the scheme for the Institute was launched, it was proposed that it should cover a very extensive field of work and should be adequately equipped and financed, has of itself created difficulties, inasmuch as it has not been possible to adequately fulfil the Institute's statutory functions. This has made it necessary to very severely restrict the Institute's work to a few special investigations. Obviously, with a staff of only a few experts at head-quarters, and an annual vote of, say, £15,000, it is quite impossible to cover the whole prescribed field even in the most superficial way. The Institute's existing resources and funds are, in short, wholly insufficient to deal effectively and comprehensively even with single important branches of applied science in Australia. Of the sum of £15,000 available in 1921–22, no less than £4,000 was required for the prickly pear investigations alone (in accordance with an agreement made—during the existence of the temporary body—with the Governments of New South Wales and Queensland, which together contribute a like amount) and £6,000 was required for administrative expenses, the Bureau of Information, salaries, contingencies, &c., at its head-quarters, leaving a sum of only £5,000 available for researches into all the scientific and technical problems affecting both our primary and secondary industries. Comment on this state of affairs is superfluous.

The Vote for the Institute was not increased for the year 1921–22, and practically the whole of the available money was necessarily used for the continuation of the various activities initiated by the temporary Institute, since to these the Director is of course committed. Additional funds, however, were made available (*a*) for certain investigations on carburetters and liquid fuels, and (*b*) for paper-pulp investigations on a semi-commercial scale. The position consequently has been that, with the two exceptions named, the Director has not been able to embark on new activities which might involve substantial expenditure, or to carry out researches, though these might already have yielded important results.

The experimental work in progress in the Institute is shown in the following statement :—

TABULAR STATEMENT OF EXPERIMENTAL RESEARCH WORK IN PROGRESS.

Investigations.	Bodies co-operating with Institute.	Present Position.
1. Prickly Pear ..	New South Wales and Queensland Governments	Results already obtained in laboratory indicate that certain parasitic insects and fungus diseases have now been established, and that, provided they are as effective in the field as they are in the laboratory, complete biological control of the prickly pear pest may ultimately be brought about.
2. Pottery ..	Victorian Mines Department and Ballarat School of Mines	Nearing completion. Successful methods evolved on laboratory scale for production of white earthenware from local raw materials are likely to be adopted industrially on commercial scale. Causes of discolouration of semi-vitrified ware ascertained; method of eliminating these causes is being investigated.
3. Paper-pulp ..	State Forestry Departments and Aust. Paper and Pulp Co. Ltd.	Results obtained from laboratory investigations show that there is a reasonable probability of the manufacture of paper-pulp from Australian timbers being successfully established on commercial scale. Semi-large scale experiments in progress in co-operation with the Aust. Paper and Pulp Co. Ltd., at Geelong, and further laboratory tests on various timbers being carried out at Perth.
4. Blow-fly ..	Queensland Pastoralists and Queensland Department of Agriculture	Valuable results obtained *re* jetting and increasing arsenical strength.
5. Western Australian Redgum (*Marri Kino*)	Western Australian Forestry Department	Method devised for increasing solubility and getting rid of objectionable colour in redgum tannin.
6. Western Australian Tannin Survey	Western Australian Forestry Department	Valuable information *re* new sources of tannin hitherto wasted.
7. New South Wales and Tasmanian Tannin Surveys	New South Wales and Tasmanian Forestry Departments	Tannin survey of materials available in respective States; work in progress.
8. Cattle - tick Dips	New South Wales and Queensland Agricultural Departments	Experiments to ascertain strength of dips, periods for dipping, &c., in progress.
9. Carburetters and Liquid Fuels	Defence Department and Navy Office	In progress.
10. Viticultural Investigations	Victorian Department of Agriculture, State Rivers and Water Supply Commission, Mildura Vineyards Protection Board	Successful method devised for treatment of "black spot," so that this disease is now largely under control. Preventive treatment adopted for Fruit-moth pest. Other chemical and biological investigations in progress.
11. Seed Improvement	Agricultural Departments in each State	Classification and description of wheats and barleys completed with results that work of plant breeders facilitated, undesirable varieties eliminated in favour of more prolific and disease-resistant varieties.

A.—Agricultural and Pastoral Industries.

1. **General.**—The loss caused by diseases, pests, and parasites to the agricultural and pastoral industries of Australia, and to the secondary industries dependent on them, amounts to millions of pounds per annum. Nearly all the serious pests here have been introduced from other countries. Many of them have now spread over the whole or a great part of Australia, and thus the work of eradication is costly and will take a number of years.

From plant diseases alone the loss has been estimated at £5,000,000 annually. An attempt to estimate the loss from the sheep-fly pest gives as much as £4,000,000 in a bad year. Prickly pear already covers an area in Australia greater than the total area under all forms of cultivation. New South Wales alone has expended £600,000 during the past fifteen years in an attempt to keep back the cattle-tick pest. The loss from fruit diseases and pests is estimated at £1,000,000 annually.

A condition precedent to organizing an efficient campaign against any of these pests is, that existing knowledge shall have been supplemented by the results of a considerable amount of scientific investigation, this being reached by the co-ordination of effort in the various States. For example, it is an essential that the life-histories of the various pests shall be more fully understood.

As already pointed out herein, before any investigation is undertaken, the most complete information possible should be collected from all sources by experts in the particular branch of science concerned. In this way the existing state of knowledge and the extent to which the problem has already been solved is disclosed.

For example, in several of the investigations already undertaken by the Institute (*e.g.*, cattle-tick pest, worm nodule disease in cattle, &c.) a very considerable amount of investigation had already been carried out both in Australia and in other countries. Therefore, before the Institute could lay down definite lines for further research it was eminently desirable for the whole position to be thoroughly reviewed by experts. A thorough and expert examination of the whole problem and of the existing state of knowledge in regard thereto is universally recognised as an indispensable preliminary to effective research.

This necessary preliminary involves considerable labour, and the existing resources and staff of the Institute are inadequate to permit of its being undertaken over a sufficiently wide area. This is particularly the case in regard to problems affecting the agricultural and pastoral industries. In dealing with these as they come before the Institute, the initiating of research work on specific matters would be a very unsatisfactory and inefficient method of procedure. It is imperative that the whole field should first be comprehensively studied. This, however, is quite impracticable until at least the nucleus of a Bureau of Agriculture, as required by the Institute of Science and Industry Act, has been established.

If the example of other countries be followed in Australia, comprehensive investigations will be carried out with a view to formulating effective, practical, and economical measures for the control, for example, of the various pests. In a later part of this Report attention is directed to the numerous requests which the Institute has received from various sources to undertake such investigations. But it is unable to comply with many of them, owing to the fact that the necessary funds are not available.

2. **Sheep Blowfly Pest.**—Important investigations on this problem have been carried out by the Institute, both in New South Wales and in Queensland ; in the former State under the control of a joint Committee representing the Institute, the Pastoralists' Association of New South Wales, and the State Department of Agriculture ; in the latter State as explained below. The results obtained have been satisfactory, and afford hope that if the methods recommended are put into general operation the seriousness of the pest will be considerably diminished. The results of the work have been published in a Bulletin issued by the New South Wales Department of Agriculture.* The following are the members of the New South Wales Committee for investigating the pest :—

MEMBERS OF THE PASTORAL COMMITTEE FOR INVESTIGATION OF BLOWFLY PEST IN NEW SOUTH WALES.

J. KIDD (Australian Mercantile Land and Finance Co. Ltd.), President.
Sir H. Y. BRADDON (Dalgety and Co. Ltd.).
E. R. GRAHAM (New Zealand Loan and Mercantile Agency Ltd.).
S. McCOLL McCOWAN (New Zealand and Australian Land Co. Ltd.).
K. DE L. CUDMORE (Goldsbrough, Mort and Co. Ltd.).
R. R. DANGAR (Baroona, Whittingham).
Hon. J. ASHTON, M.L.C.
Hon. A. E. HUNT (Pastoralist).
J. MACKAY (Pastoralist and President of Graziers Association of New South Wales).
O. E. FRIEND.
T. A. STIRTON (Ben Lomond Station).
C. BINNIE (4D Station, Quirindi).
F. N. YARWOOD (Yarwood, Vane and Co.).
G. VALDER (Under-Secretary and Director, Department of Agriculture).
W. W. FROGGATT, F.L.S., (Government Entomologist).
Professor J. DOUGLAS STEWART, B.V.Sc., M.R.C.V.S. (University, Sydney).
Dr. N. W. KATER (Pastoralist).
Professor L. HARRISON, B.A., B.Sc., (University, Sydney).

* See, Sheep Maggot Flies, No. 5. Methods of Control recommended by the Department. Farmers' Bulletin No. 144, March, 1922. Department of Agriculture, Sydney, by W. W. Froggatt, F.L.S.

In Queensland, experimental work, initiated in 1917, has been continued under the control of a Special Committee, consisting of the following members, viz.:—

MEMBERS OF SPECIAL COMMITTEE ON BLOWFLY PEST IN QUEENSLAND.

S. P. FRASER (Chairman), Brisbane.

A. H. CORY, M.R.C.V.S., Chief Inspector of Stock, Department of Agriculture, Brisbane.

W. G. BROWN, Sheep Expert, Department of Agriculture, Brisbane.

J. B. HENDERSON, F.I.C., Government Analyst, Brisbane.

W. A. RUSSELL, Dalmally Station, Roma.

The work done during the year was largely an extension of that carried out in previous years. It consisted of experiments along the lines of—

(*a*) Jetting large numbers of sheep with a solution of arsenic (As_2O_3) in soda ash containing from 0·7 per cent. to 1·0 per cent. of arsenic.

(*b*) Dipping with comparatively strong solutions of arsenic (As_2O_3).

(*c*) Jetting and dressing with arsenic (As_2O_3) and oil mixtures.

(*d*) Dressing with crude fuel oil.

(*a*) *Jetting.*—Many thousands of sheep were jetted during the year, and, owing to very bad and recurring fly attacks from the months of February to October, the protection was thoroughly tested. It was found to be nearly perfect, the losses through fly attack at Dalmally on the treated sheep being practically nil, while serious losses occurred at certain stations in the surrounding district where jetting was not practised. The solution is now made up by adding 2 lbs. of soda ash to each 100 gallons of boiling water, and while still boiling adding from 7 to 10 lbs. of arsenic and boiling until the arsenic is dissolved. This simple cheap formula has been found to give better results than any of the other mixtures tested.

As a rule 7 lbs. to 100 gallons or 0·7 per cent. of arsenic is enough. Fears of poisoning from the use of such a comparatively strong solution have been expressed, but so far not a single case of poisoning through jetting with arsenical solutions of such strength has been seen or reported, and the wool is not injured in any way.

(*b*) *Dipping.*—The protection obtained in previous years by dipping with the shower dip was still found to be the most suitable and effective in the case of ewes in lamb, weak sheep, and those with six or more months' growth of wool. For other sheep a swim dip was built, and found to be preferable, being quicker. As it was found that dipping with the ordinary strength of 0·2 arsenic gave little protection from fly attack, the strength was gradually raised, and during the year many sheep have been put through the dip at a

strength of 0·5 per cent. arsenic. This gave good protection from fly attack, and so far not a single case of arsenical poisoning has appeared. Owing to the weaker strength of arsenical solution which has to be used, dipping has not given so good a protection against fly attack as jetting, though it is necessary where protection is required for other parts of the body than the breach. Over 90 per cent. of fly attack is on the breach, however. Further experiments in dipping with stronger solutions of arsenic than 0·5 per cent. are in progress.

(*c*) *Jetting and Dressing with Oil Mixtures.*—Experiments in jetting and dressing with oil mixtures were continued during the year, but the apparently promising results obtained in the earlier experiments were not confirmed by the later experiments on a larger scale. Owing to the presence of the oil the arsenic is not nearly so poisonous to the flies or maggots, and, owing to the agent being present only as an emulsion, the results are apt to be irregular. Definite recommendations as to the use of arsenic and oil mixtures cannot yet be made.

(*d*) *Dressing with Crude Fuel Oil.*—It was found that ordinary crude fuel oil is a very good dressing for rams' horns, preventing fly attack for a considerable time, and it has proved the most effective dressing of the many which the Committee has tried in the case of extensive lesions where dressings containing poison might be detrimental.

3. **Prickly Pear Pest.**—Prickly pear in Australia is estimated to cover an area of about 23,000,000 acres, which is greater than the total area of cultivated land in the Commonwealth, which was never more than 18,500,000 acres. The pear is stated to be spreading at the rate of about 1,000,000 acres annually. In November, 1916, the Institute submitted to the Commonwealth Government a scheme of investigation with a view to the eradication of the pest. This scheme was ultimately approved by the Commonwealth, New South Wales, and Queensland Governments, and came into force on the 1st June, 1920. It provides as follows :—

(*a*) That investigations should be carried out as to the suitability of insects and fungi known to be inimical to prickly pear, for acclimatisation in Australia, as to the method of action of such insects or fungi on the pear, and as to such other matters as may arise in connexion with any biological or chemical researches found necessary.

(*b*) That the work should be placed under the authority of a biological expert, who shall be responsible to the Executive Committee of the Advisory Council of Science and Industry, and who should receive a salary of £1,200 per annum.

(*c*) That three laboratories, comprising one central laboratory and two subsidiary laboratories, should be established and maintained in Queensland and New South Wales.

(*d*) That the central laboratory should be established at Brisbane, where the insects would be received immediately they reached Australia, and where the staff would have access to literature and facilities for the use for special investigations of University and Government laboratories.

(*e*) That the two subsidiary laboratories should be established in country infected with prickly pear. One of these should be in New South Wales, whilst, for the other, the Queensland Government's offer of the Dulacca Experiment Station should be accepted. These stations would carry out the work of breeding and testing the introduced insects, and should be in charge of thoroughly qualified entomologists, at salaries of £750 per annum.

(*f*) That field laboratories should be established, at such places and at such times as may be deemed necessary by the biologist in charge, for the purpose of introducing such insects as are found suitable into particular areas, or for other special purposes.

(*g*) That the sum of £8,000 per annum for a period of five years should be made available for this work, of which sum £4,000 should be contributed by the Commonwealth Government and £2,000 each by the Governments of New South Wales and Queensland.

In order to control the expenditure of the money and in general the business side of the investigations, a Commonwealth Prickly Pear Board was appointed and has held three meetings. It now consists of the following :—

COMMONWEALTH PRICKLY PEAR BOARD.

G. H. Knibbs, C.M.G., F.R.A.S., F.S.S., Director, Institute of Science and Industry, representing the Commonwealth. (Gerald Lightfoot, M.A., F.S.S., represented the Commonwealth up to the date of the Director's appointment).

A. G. Melville, Under Secretary, Department of Lands, Brisbane, representing Queensland.

G. Valder, Under Secretary and Director, Department of Agriculture, Sydney, representing New South Wales.

The Scientific Controller, Professor T. Harvey Johnston, M.A., D.Sc., is an Associate Member of the Board, without however power of voting.

The investigations, which aim at the possible control of prickly pear by biological means, were continued during the year 1921–22, and a number of consignments of material, collected and bred by officers employed in the U.S.A., especially in Texas and Florida, have been received during the year. A considerable measure of success has attended the introduction of the cactus enemies, and various bacteria, fungi and insects are now established in the Prickly Pear Board's Laboratories in Queensland.

The imported fungi have been carefully tested and, with one exception, have been ascertained to be restricted apparently to prickly pears. Experimental work with them, however, has not led to optimistic hopes being entertained as to their importance as controlling factors. Several species have been rejected as practically valueless, while others have been ascertained to be destructive only under certain conditions of temperature and humidity. Their means of transmission has not yet been satisfactorily determined.

A bacterial disease was discovered, and its causal organism has been successfully isolated and cultivated and is now being studied in the laboratory. It has been proved to be able to destroy inoculated joints or pads of all kinds of prickly pear naturalized in Australia. The organism, however, does not make its way from joint to joint as the disease progresses, and as a consequence is dependent on some insect for its transmission to other joints or plants. Certain of the insects introduced from America have been proved to be efficient carriers of the organism. As in the case of the fungoid diseases, climatic factors play a very important part in controlling the spread of the bacteriosis.

Amongst the insects introduced, the most destructive to prickly pears naturalized in this continent, have been found to be the moth borers (*Melitara*) from Texas and Florida, and the *Mimorista* moth from Texas. These all feed in their larval stage on the internal parts of the plant and rapidly destroy the attacked part, especially in humid weather. They are capable of transmitting the bacterial organism referred to above.

Other insects of importance which have been imported, are certain cactus bugs (several species of *Chelinidea*), beetles (*Moneilema*), scavenging flies which destroy prickly pear damaged by other insects or by disease producing organisms, and cochineal insects. In addition to these various other insects (chiefly beetles and plant bugs) have been introduced, but their effects, as observed in Australia, have been of so little value from the point of view of prickly pear control, that they are not now receiving special attention. Certain other insects (moths, flies, and midges) are being imported, but as yet they have not become established in the laboratories.

4. *Cattle Tick Pest.*—The cattle-tick pest, which annually levies a huge toll on the cattle industry of Australia, has received special attention. Scientific investigations into the life-history of the cattle tick in Australia have been undertaken, and important results thus obtained point to a means of effective control by a system of quarantine. Although this work constitutes a big advance, the Institute has neither the necessary administrative powers nor funds to undertake a campaign for the eradication of the tick. A Conference was, however, held in February, 1918, with the New South Wales and Queensland authorities, and recommendations were made to initiate such a campaign. It was estimated that the necessary expenditure during the first two years would be £65,000 and £39,000 respectively. Another matter which is being investigated by the Institute, in co-operation with both the New South Wales and Queensland Departments of Agriculture, is the determination of the composition and strength of cattle-tick dips.

The Special Committee which was appointed by the Institute to report on the matter in 1917 stated that the loss from mortality caused by tick fever is estimated at £7,000,000 for Queensland alone. Considerable loss from this cause occurred also in the Northern Territory and in Western Australia. The decrease in the value of leather production of Queensland owing to this pest amounts to about £114,000 for one year alone. Further, the affected States have suffered considerable direct loss from mortality caused by tick worry, interference with the natural increase of the herds, retardations of growth and improvement of stock, from diminished production of meat, milk, and dairy products.

If over the series of years since the advent of the pest, the collective losses from the varied causes directly attributable to it could be enumerated, they would amount to many millions of pounds.

Apart from the direct losses which have been particularly referred to, the expenditure occasioned in connexion with the erection and maintenance of dipping vats, and general disturbance of stock business, is also very considerable. As the effects of loss to the stock industry ramify through commerce in an extensive manner, the secondary industries also pay their toll to the pest.

Further, the restrictive measures various States have been compelled to put into operation have led to considerable expenditure. For instance the cost to New South Wales alone has amounted during the past fifteen years to £600,000.

Loss is also occasioned to owners of stock within quarantined areas by the application of the restrictive measures imposed, not only in connexion with treatment enforced, but in the interference and curtailment of their business, and deterioration of their herds.

Moreover, the value of land in infested and adjoining areas has depreciated even to 40 per cent. When the extent of acreage involved is considered, this loss alone becomes stupendous.

The above statements give a measure of the economic loss to the Commonwealth from the tick pest. If it could be accurately expressed in figures, the total amount would give a startling indication of its seriousness.

So long as it is allowed to exist, the pest will enforce each year a heavy penalty, to be met not only by the stock-owners, but by all interested in business directly and indirectly dependent upon the cattle industry, as well as by members of the general public in the increased cost of necessary commodities such as meat, milk, butter, &c.

The Special Committee appointed in 1917 made recommendations that further scientific investigations should be carried out (*a*) as to the life-history of the cattle tick, (*b*) on the micro-organism conveyed by the tick and which causes tick fever, (*c*) on the methods of treatment of cattle, and (*d*) on the

improvement of tick-destroying agents. As already stated, the Institute has completed certain investigations on the life-history of the tick. A related matter now being investigated by the Institute, in conjunction with the Agricultural Departments of New South Wales and Queensland, is the determination of the composition and strength of cattle-tick dips.

Although the official cattle-dipping formula used in New South Wales and Queensland has hitherto proved efficient and generally satisfactory, it was suggested that the same results might be maintained and certain ill-effects obviated by an alteration of the composition of the active agent. This suggestion is supported by evidence that solutions of lower arsenical content than officially stipulated are effective in the warmer climates, which would indicate that the parasiticide used might possibly be varied with advantage according to the seasons and climatic conditions.

A Committee was appointed in 1920 by the Institute of Science and Industry in conjunction with the Governments of New South Wales and Queensland, to make investigations in conformity with the above suggestions. The members of that Committee are as follows :—

SPECIAL COMMITTEE ON CATTLE-TICK DIPS.

G. E. BUNNING, Chairman.
C. J. BOOKER.
A. H. CORY, M.R.C.V.S., Chief Inspector of Stock, Brisbane.
J. C. BRUNNICH, F.I.C., Agricultural Chemist, Brisbane.
C. J. POUND, F.R.M.S., Government Bacteriologist, Brisbane.
H. TRYON, Government Entomologist, Brisbane.
S. T. D. SYMONDS, F.R.C.V.S., Chief Inspector of Stock, Sydney.
F. B. GUTHRIE, F.I.C., F.C.S., Agricultural Chemist, Sydney.
C. J. SANDERSON, M.R.C.V.S., Chairman, Tick Board of Control, Lismore, New South Wales.
L. COHEN, Chemist, Tick Board of Control, Casino, New South Wales.
W. C. CARMODY, Metropolitan Inspector of Stock, Brisbane, and R. FERGUSON, Officer in Charge of the Border Cleansing Area, Queensland, were added as a sub-committee to assist in the supervision of the investigations.

The first experiment took place at Tallebudgera in February, 1921, when it was found that mature female ticks survived after seven days in tests and re-tests of various arsenical strengths from 5 to 8 lbs. of arsenic ($As_2 O_3$) per 400 gallons of water, with and without emulsions. There was strong evidence that rain which fell during the progress of the experiments prejudiced the results, and the tests could not be considered conclusive.

At Oxenford, in June, 1921, the experiments were repeated, when for the various strengths mature female ticks survived for ten days after dipping, and in some cases laid eggs. Larval ticks were found on the animals on the third day after dipping, and there was every indication that re-infestation occurred within 24 hours after dipping.

Arrangements are now in hand for further experiments at an early date to ascertain the fate of larval ticks which re-infest cattle after dipping, to test the fate of surviving mature ticks after dipping, and to estimate the effect of rainfall on the efficacy of dipping fluids at varying periods after dipping. These experiments must be carried out at an appropriate time, and it is hoped to continue them during September, 1922.

5. *Viticultural Problems.*—In co-operation with the Victorian Department of Agriculture and Associations of irrigators representing New South Wales, Victoria, and South Australia, important investigational work is being carried out by the Institute regarding viticultural problems, including both methods of cultivation and treatment for insect and fungus pests. The Associations recognise the value of Scientific research on viticultural problems, and are contributing up to £1,500 a year towards the cost of the work. The Institute contributes on the basis of 10s. for every £1 expended by the growers. The work is being carried on under the supervision of the Institute and the Mildura Vineyards Protection Board. Experimental work was commenced in the Mildura district in 1919, and an Experimental Station in charge of A. V. Lyon, B.Agr.Sc., has been established at Merbein on land made available for that purpose by the Victorian State Rivers and Water Supply Commission. This station comprises a number of experimental fields dealing with fertilizer trials, irrigation and cultural problems, and plant selection. A laboratory has been erected and partially equipped.

Interim reports in the form of bulletins have been published in cases when the data obtained warranted such a course. These reports have dealt with the projects mentioned hereunder :—

(*a*) *Manurial Problems.*—The manurial problems have so far been limited to trials of phosphatic fertilizers, as this is the dominant requirement of most of our soils. A report covers the results of trials extending over three years.

(*b*) *Drying of Vine Fruits.*—Research work on the subject of fruit drying has been the basis of a report previously published by the Institute. The report deals with the maturation of the grapes, the Beaumé test as a measure of ripeness, and the various factors affecting quality and quantity of the fruit.

(*c*) *Treatment of Vineyard Pests.*—In connexion with fungoid diseases and entomological pests, standardized methods of control have been evolved from field and laboratory trials, and are already in general practice among viticulturists.

(*d*) *Dried Fruit Pests.*—The life-histories of the principal dried-fruit pests have been recorded under the conditions of the industry, and recommendations for control of the pest have been issued.

A notable feature in connexion with the viticultural investigations has been the readiness of the growers to adopt recommendations when issued. As a result substantial improvements in viticultural practice have followed, particularly with respect to—

(i) The use of systematic and adequate dressings of fertilizers.

(ii) The general adoption of preventive treatment for fungoid diseases and insect pests.

(iii) The general adoption of special precautions to preserve the quality of the fruit in the drying season.

(iv) The general adoption of the Beaumé test as a measure of ripeness.

(v) The control of the principal dried-fruit pest (*Plodia interpunctella*) is becoming a feature of the year's work among fruit packers.

There is an increasing demand for instructive literature dealing with viticulture, and the Institute proposes to meet this demand by the publication of a special report on the problems of the industry.

6. *Seed Improvement.*—Considerable loss and inconvenience result in Australia from the absence of any proper classification of cultivated varieties of crops. As a result of a recommendation, made by an Inter-State Conference of agricultural experts, the Institute has undertaken investigations in connexion with the nomenclature of cereals, the elimination of undesirable varieties, and the exchange and dissemination of seed samples for research work in the several States. Valuable progress has been made, and already all the leading varieties of wheat, barley, and oats have been dealt with.

The work is being carried out in co-operation with the Agricultural Departments of all the States and under the supervision of an Inter-State Committee consisting of the following members:—

MEMBERS OF SEED IMPROVEMENT COMMITTEE.

New South Wales—

A. H. E. McDONALD, Chief Inspector of Agriculture.

J. T. PRIDHAM, Plant Breeder, Cowra Experimental Farm.

H. WENHOLZ, B.Sc. Agr., Department of Agriculture.

Victoria—

A. E. V. RICHARDSON, M.A., B.Sc., Superintendent of Agriculture (Chairman).

H. PYE, Cerealist, Dookie Agricultural College.

South Australia—

Professor A. J. PERKINS, Director of Agriculture.

ELLINOR ARCHER, M.Sc., Secretary and Investigator.

Queensland—

F. F. COLEMAN, Department of Agriculture.

R. E. SOUTTER, Manager Roma State Farm.

Western Australia—

G. L. SUTTON, Director of Agriculture.

Tasmania—

L. A. EVANS, Acting Director of Agriculture.

H. M. NICHOLLS, Department of Agriculture.

The *personnel* of the Committee suffered a serious loss in the middle of the year, owing to the resignation of the Chairman, Professor A. J. Ewart, D.Sc., Ph.D.

During the year 1921–22 the Committee concentrated attention on barley and oats, in order to complete the work on the nomenclature of the principal cereals.

The results of work on wheat and barley have been published in the First and Second Reports of the Committee (Bulletins Nos. 18 and 22). These Bulletins contain an account of the chief botanical and agricultural features of the wheat and barley plants respectively to be used in the identification of varieties. Detailed descriptions are given of Australian varieties, and a key to aid in their identification. A similar report on the oat varieties has been completed, and will be published in Bulletin form.

In co-operation with the State Departments of Agriculture an interesting experiment is being conducted with wheat varieties, in order to obtain some idea of the variations due to environment to be expected in different localities. Grain from a single plant of each variety was distributed to an experimental farm in each State, and careful observation made at all stages during the life of the plant. Specimen plants were collected from each locality at the end of the season, and comparisons made. From these some idea can be gained of what may be expected from the varieties when grown in different districts. This experiment is to be repeated with a few varieties over a number of seasons. A report of the experiment is in the course of preparation.

In addition to the 46 varieties of wheat classified in the first report of the Committee, 40 other varieties have been carefully examined, and an attempt is being made to prepare an identification key which will include the whole of the 86 varieties so far described. With the publication of this work on wheat the task of classifying and describing the more important variteies of cereals at present grown in Australia will be completed.

The Committee proposes, in the event of sufficient funds being available, to attempt similar work with potatoes. The nomenclature of potato varieties is probably in a worse condition than that of cereals, and certain identification of any one variety is at present practically impossible.

Another matter to which attention has been given is the preparing of a publication on the Native and Introduced Leguminous Herbaceous Fodder Plants. Pastures in the districts of higher rainfall are becoming much improved by the introduction of clovers and trefoils, and it is realized that the collection and dissemination of further information on this class of plants is advisable.

Although the value of this work cannot readily be directly expressed in terms of money, it is obviously of very considerable economic importance. The work of plant-breeders has already greatly increased the average yield of wheat in Australia, and has resulted in the evolution of varieties which are disease-

resistant and are suitable for cultivation in areas where the rainfall is low. It is only as a result of the work of the plant-breeder that cultivation and settlement have been rendered practicable in some of these districts.

At the present time the work of any grower, but more particularly the plant-breeder, is hampered by the existence of a vast number of supposed varieties, about the majority of which very little information is available. It is only by systematic classification and description that the valuable varieties can be sorted out from the inferior, and the identity of synonyms established. Of late years so many varieties have been produced that unless some system of registration and standardized description can be established, the more valuable productions have little chance of becoming recognised, while the number of inferior varieties being grown is in no way lessened.

As a measure of the economic importance of this work, it may be mentioned that the value of an increase of 1 bushel per acre in the average yield of wheat per acre at current prices would be £2,200,000, while the economic results of the production of strains sufficiently hardy to give a payable yield in our semi-arid districts would be of enormous value to the Commonwealth.

7. *White-ant Pest.*—The white-ant pest causes great losses in Australia by reason both of the damage done to buildings and to agricultural crops. From G. F. Hill, F.E.S., W. W. Froggatt, F.L.S., and other experts, both in Australia and abroad, the Institute collected a considerable amount of information on the matter, and the New South Wales Government offered to co-operate with the Institute in carrying out a scheme of investigational work. A Special Committee, comprising the following representatives of the Institute and the New South Wales Department of Agriculture, was appointed and formulated a scheme of investigation. Owing, however, to lack of funds, the Institute was unable to accept the offer of the New South Wales Department of Agriculture to contribute towards the cost, or indeed to take any further steps for initiating experimental work.*

SPECIAL COMMITTEE ON WHITE-ANT PEST.

G. F. HILL, F.E.S., Entomologist, Institute of Tropical Medicine, Townsville.

E. E. TURNER, B.A., M.Sc., Lecturer on Organic Chemistry, University of Sydney.

A. A. RAMSAY, Agricultural Chemist, Department of Agriculture, Sydney.

G. P. DARNELL SMITH, D.Sc., F.I.C., F.C.S., Department of Agriculture, Sydney.

* A Bulletin has been published by the Institute summarising available information. See Bulletin No. 21, "The White-ant Pest in Northern Australia," by Gerald Hill, F.E.S.

8. *Worm Nodule Disease.*—The presence of worm nodules in cattle in certain areas of Australia causes serious loss to the beef-export trade. Little, however, was known how the disease is transmitted. The Institute carried out investigations, and has obtained valuable evidence concerning the means by which the disease is transmitted. Experiments are necessary to determine this more definitely, and to ascertain the most likely methods for the effective control of the disease. The investigations are in abeyance, owing to the illness of the chief investigator.

The following are the members of the Special Committee supervising the work :—

SPECIAL COMMITTEE ON THE MEANS OF TRANSMISSION OF THE WORM NODULE PARASITE.

Professor S. J. JOHNSTON, B.A., D.Sc., Sydney University, Chairman.
E. W. FERGUSON, M.B., Ch.M., Bureau of Microbiology, Sydney.
Professor J. DOUGLAS STEWART, B.V.Sc., M.R.C.V.S., Sydney University.

9. *Tuberculosis in Stock.*—This is another matter the investigation of which has been initiated. The first step was the obtaining of authoritative information from each State as to the prevalence of the disease, the sources of infection, the losses caused, and preventive methods at present in operation. The preliminary work has been completed, and, as in other cases, was performed gratuitously by leading veterinary officers, pastoralists, and others scientifically and economically interested. Further action has, perforce, been postponed pending the creation of the Bureau of Agriculture provided for by the Institute's Act.

SPECIAL COMMITTEES ON TUBERCULOSIS IN STOCK.

New South Wales.—Professor J. DOUGLAS STEWART, B.V.Sc., M.R.C.V.S., Chairman.

SYDNEY DODD, D.V.Sc., F.R.C.V.S.
S. T. D. SYMONS, M.R.C.V.S.
R. C. BELL, M.R.C.V.S.
J. C. MACEACHRAN, M.R.C.V.S.
J. ROBERTSON, M.R.C.V.S.
Hon. J. C. WHITE, M.L.C.
J. T. COLE.
A. BARNES.

Victoria.—Professor H. A. WOODRUFF, M.R.C.V.S., M.R.C.S., L.R.C.P., Chairman.

S. S. CAMERON, D.V.Sc., M.R.C.V.S.
W. C. ANGLISS, M.L.C.
E. F. J. BRODEAUX, B.V.Sc.
W. C. GREAVES.
J. HANCOCK.
W. A. N. ROBERTSON, B.V.Sc.
J. ROBERTSON.
P. TUCKETT.

Queensland.—G. E. BUNNING, Chairman.

Dr. J. MOORE.
Professor T. HARVEY JOHNSTON, M.A., D.Sc.
Hon. W. R. CRAMPTON, M.L.C.
A. H. CORY., M.R.C.V.S.
D. J. KERR.
C. J. POUND.

South Australia.—T. H. WILLIAMS, Chairman.

C. A. LOXTON, B.V.Sc.
L. B. BULL, D.V.Sc.
N. A. COLEBATCH, M.R.C.V.S., B.Sc. Agr.
T. A. BURRAGE, B.V.Sc.
L. COWAN, B.Sc. Agr.
D. FORBES.
H. O. WRIGHT.

Western Australia.—R. C. E. ATKINSON, Chairman.

G. A. GREENHILL.
R. G. WEIR.
A. WATSON.
E. BROWN.
W. WATSON.

Tasmania.—J. C. NEWTON, M.H.A., Chairman.

T. PHILP, L.V.Sc.
R. C. FIELD.
A. COULON.
C. PROPSTING.
D. C. LEWIS.
J. W. DOWNIE.

B.—Forest and Vegetable Products.

1. *General.*—The vegetation of Australia possesses quite special characters, a great number of the commonest and most widely distributed plants of the continent being quite distinct from those of other countries. Many whole groups of plants, comprising the genus Eucalyptus, which includes most of our forest trees, are entirely Australian. This fact in regard to Australian flora renders it essential, for the full development of the forest and vegetable resources of our continent, that researches into the products of all our indigenous plants should be undertaken. It is not improbable that work of this nature may reveal new oils and drugs of importance to mankind, new sources of dyes and tannin, or timbers specially appropriate for particular purposes. Most of the drugs, spices, &c., of India and America were discovered and utilized by the natives of those continents before intercourse with Europe opened up a trade in the products. In Australia, however, the natives have made very little similar use of the indigenous plants. In the early days of settlement, primitive experiments were made, and the useful properties of some Australian plants were discovered. More recently definite chemical researches on scientific lines have been carried out in various States, specially at the Technological Museum, Sydney, and much important information has been obtained. The work, nevertheless, must still be regarded as only in its infancy, and there can be no question that further researches are urgently required.

2. *Paper Pulp.*—On account of its economic importance, quite special attention has been given by the Institute to this question. As a first step, all the available information regarding the pulping qualities of various Australian timbers and grasses was collected. Laboratory investigations were then carried out by the Institute at Perth in order to ascertain the pulping qualities of a considerable number of Australian timbers and other materials. About half-a-dozen of the most promising woods were then

selected, and preliminary paper-making experiments were made. The results were sufficiently encouraging to warrant further investigation. In this connexion, it should be pointed out that earlier investigations of Australian timbers by experts in other countries had indicated that such timbers were not suitable for pulping purposes. The Institute's work shows, however, that the poor results obtained by these investigators were largely due to the fact that the experiments were carried out under conditions which, though quite satisfactory for the pulping of timbers (especially softwoods) in other countries, are not generally suitable to the timbers of Australia.

During 1921–1922 the investigations have developed through three stages up to the present position :—

(*a*) *Pulping Experiments.*—The laboratory experiments were extended with a view to determining the most economical methods of pulping those woods which the earlier experiments had shown to be the most promising. The results showed that in point of yield, and consumption of chemicals, six of the most abundant eucalypts are at least equal to the woods now used abroad for the production of similar pulp.

(*b*) *Paper-making Tests.*—In order to ascertain the uses to which each pulp might best be put, an extensive series of bleaching and paper-making tests was made. The laboratory model paper machine was used for this purpose. It was ascertained that some of the pulps would be suitable only for wrappings, whilst others would probably find their best application in the manufacture of the better grades of paper.

(*c*) *Availability of Timber Supplies.*—Thus far the investigations had shown that the eucalypts apparently offered the best prospects as a source of supply for relatively high grade pulp. They were, as a group, fast growing, and could be economically converted into pulp, apparently suitable for the manufacture of typings, writings, book, lithograph, and the better grades of printings.

In order to focus the issue still better, definite information as to the probable quantity of timber available for pulping purposes was sought from the various Forestry Commissions associated with the Institute in the investigations. The wood requirements of a 3,000-ton-a-year pulp mill were taken as a minimum. According to the information received, and taking into consideration the laboratory results, the following timbers were selected as being capable of supplying that demand :—Blackbutt, New South Wales (*E. pilularis*) ; Karri, Western Australia (*E. diversicolor*) ; and a mixture of Mountain Ash (*E. regnans*), Woollybutt (*E. delegatensis*), and Silvertop (*E. sieberiana*) from Victoria.

Some time after the research was initiated, Tasmania also co-operated, and laboratory results show that the woods submitted are amongst the best examined. To the above list it is considered, therefore, that a mixture of so-called Tasmanian swamp gum (*E. regnans*), stringybark (*E. obliqua*), and gum-top (*E. delegatensis*) may be added.

(*d*) *Semi-commercial Tests.*—In order to check the laboratory tests in a much larger way, and to determine the actual paper-making value of the pulps from the above woods on a manufacturing scale, a plan to erect a semi-commercial pulping plant at the Geelong Paper Mills was recommended and approved.

This plant, which was constructed in Western Australia, was shipped in April, and has been erected at Geelong. Pulping was commenced about the middle of June, and the systematic testing of the woods from four States is now proceeding satisfactorily. With the very generous assistance of the Australasian Paper and Pulp Co. Ltd., the proprietors of the Geelong Mill, it is expected that useful information as to the commercial value of the pulp will be obtained, while the pulping tests preparatory to paper-making will enable important data bearing on the cost of production to be obtained. The paper-pulp investigations are in charge of L. R. Benjamin.

3. *Tanning Materials.*—For some time past the world shortage of vegetable tanning materials has occasioned anxiety in the leather trade. The natural materials are being rapidly exhausted. Mallet bark (Western Australia) has fallen from an export of 155,000 tons (1906) to about 500 tons (1920) owing to the cutting out of supplies. Wattle bark is now being imported into Australia, the home of this material, from the plantations of Natal. The hemlock of U.S.A. has almost entirely disappeared from commerce to be replaced by chestnut oak and quebracho. The former is estimated to be disappearing five times quicker than re-growth takes place, and the latter (from South America) is being slowly cut out.

Thus any considerable increase in the supplies of the older cultivated tanning materials cannot be expected, and, apart from the cultivation of Australian wattles in South Africa, no new materials have been cultivated on a large scale. Consequently there is a unique opportunity for the forests of the Commonwealth to provide a supply of tanning materials if available, and, when the amount of forest country cleared every year is considered, the quantity of bark destroyed in clearing is seen to be enormous. Saw-mills also destroy much bark. From these two sources alone, it appears that there might be obtained a regular supply of tanning material which would turn to good account a product at present regarded as of no value. Probably, also, the virgin forests hold large quantities of valuable tanning materials which, with proper working, could provide a regular supply for many years.

One material which contains a considerable percentage of tannin is the kino, produced by the Western Australian marri or redgum (*E. calophylla*). The tree is widely distributed and abundant in south-west Australia, and its

kino possesses the advantage that it can be scraped off and collected without injuring the tree, whereas with other sources of tannin the collection of the bark results in the death of or injury to the tree. This substance, however, unless specially treated, imparts a red colour to leather tanned with it, and this is considered objectionable. The Institute has completed an investigation of the use of the kino as a tanning agent. The Western Australian Forestry Department contributed a sum of £250 towards the cost of this work in the financial year 1921–22. The result of the investigation is that an effective method has been devised for treating it so as to get rid of the objectionable colour without serious loss of the tanning agents therein. It is believed that this will become a new and important tanning material.

The Institute has also carried out a comprehensive investigation of the tanning materials of Western Australia. The Western Australian Forestry Department contributed a sum of £100 towards the cost of this work, and also co-operated by making the services of its officers available for collecting the necessary samples of barks, &c., for analysis. Valuable results have been obtained, and, in view of this, the Institute has approached the Forestry Departments of other States with a view to co-operating in similar tanning surveys. The States of New South Wales and Tasmania have already expressed their desire to co-operate in this matter, and the work is now in progress.

Another bark which contains a high percentage of tannin, but which at present is not used, as it also imparts a red colour to leather, is the bark of the Queensland mangrove. Arrangements have accordingly been made to try out the applicability to that bark of the process devised for treatment of the Western Australian "redgum" kino. Arrangements have also been made to carry out investigations of tanning materials submitted to the Institute from Papua.

(*a*) *Marri Kino.*—The Institute's researches have shown that Marri kino can be so treated as to make a satisfactory tanning material. The two defects in the raw material are its insolubility and its red colour. The question of the insolubility was overcome last year, and the continuation of the work has resulted in the elimination of the other defect. The investigator (Harold Salt, M.Sc.) found that, on treating the kino with salts of sulphurous acid, the solubility is considerably increased and much of the red colour is removed. The whole process of treatment is rather cheaper than with tannins of a similar nature, *e.g.*, quebracho tannins. Provided the kino can be collected in a satisfactory and economical manner, the manufacture of a tanning extract on a commercial scale can be begun at any time. A provisional patent has been granted for the process of treatment, but it has been decided to allow the use of the patent gratis on application to the Director.

(*b*) *Tannin Survey.*—In the tanning survey of Western Australia most of the materials examined have been barks, of which some 140 have been dealt with. Among these there are upwards of twelve suitable for extract manufacture, and found in sufficient quantities to warrant the building of extract

plants. Certain others exhibit desirable properties, and although less common could be used in the manufacture of mixed extracts. Of the former class the barks of Gimlet (*E. salubris*), Karri (*E. diversicolor*), and Ridge Gum (*E. alba*), formerly regarded as waste materials, are the most valuable, and it is believed that these barks will be utilized commercially as a direct result of the Institute's investigations. Barks of the Mallet tree (*E. occidentalis*, var. *astringens*), grown in different types of soil, have been examined, in order to ascertain the effect thereof on their tannin content, but mature trees are now so scarce that definite results have not as yet been obtained. The tannin survey has now been extended to include most of the barks found in quantity in Western Australia.

4. *Miscellaneous.*—Work is also in progress at the Institute's laboratory at Perth on the question of the soaking of dried sheepskins, with the object of preventing much of the loss of pelts that now occurs in the common practice of fellmongering. Preliminary investigations have been carried out regarding sandalwood oil, dyestuffs from vegetable sources, insulating materials, and castor oil seeds. A considerable amount of work has also been done in connexion with investigations on the preservation of timber by the " Powellising " process, particularly in regard to the determination of the distribution of arsenic through powellised timber which has been exposed to the weather. Some consideration has also been given to the question of using zinc chloride, which can be readily produced in large quantities in Australia.

C.—Manufacturing Industries.

1. **Pottery.**—Though there are numerous deposits of clays and kaolins in Australia, owing to the absence of necessary investigation they are not yet used for the manufacture of white earthenware or high-class pottery, such as is ordinarily used for dinner services, &c. The Institute is carrying out researches at Ballarat, where a great number of clays have been tested, and results have been obtained which give promise of early success and of the adoption on a commercial scale of the process evolved in the laboratory for the manufacture of white earthenware from local raw materials.

The work is being carried out by R. C. Callister, under the supervision of a Special Committee, of which the members are :—

POTTERY INVESTIGATIONS—MEMBERS OF SPECIAL COMMITTEE.

A. MICA SMITH, B.Sc., F.I.C., Chairman, School of Mines, Ballarat.

V. G. ANDERSON, Analytical Chemist, Melbourne.

W. BARAGWANATH, Department of Mines, Melbourne.

W. MILLER, The Eureka Tile and Pottery Co., Ballarat.

Field work in the Wodonga District conducted during December, 1921, proved that a number of large deposits of felspar and Cornish-stone exist in that neighbourhood. Samples obtained on the surface have shown that several of these are suitable for use in high grade white wares and glazes.

Experimental work during last year showed clearly that the principal ingredients of white ware bodies, *i.e.*, china clay, ball-clay, Cornish-stone and quartz, cannot by blending alone produce satisfactory white vitrified or semi-vitrified ware ; it is essential that the raw materials should be of high quality.

Porous and opaque white earthenware, which has a chalky fracture, *i.e.*, neither vitrified nor semi-vitrified, can within narrow and sharply defined limits be made from local unpurified materials. The more vitrified white wares, however, all develop colour, and apparently the only way of preventing this is by removing as far as possible the colour-forming compounds of iron and titanium from the china clay in use. Two purification processes have been worked on. Both involve the use of small quantities of chemicals, and result in the removal of a portion only of the colouring agents present. In purifying the clay the plasticity and general working quantities have been increased. This effort to increase the purity has so far only been made on the china clays or kaolins.

Economically both processes appear to be promising, but until they have been more fully investigated, their economic feasibility cannot be regarded as definitely assured.

All white wares made from the purified china clays are of a higher colour-grade than when the more impure clay is used, and they compare favourably with better grades of imported wares. Satisfactory glazes for the wares manufactured have also been developed. The ball mills and filterpress deal satisfactorily with the materials available and permit of the working up of bodies in bulk.

2. **Power Alcohol and Industrial Alcohol.**—The whole question of the production and utilization of alcohol for power and industrial purposes in Australia has already been thoroughly investigated by the Institute and the results published in Bulletin form. The work was carried out under the supervision of a Special Committee, of which the members are —

POWER-ALCOHOL.—MEMBERS OF SPECIAL COMMITTEE.

Professor Sir Thomas LYLE, M.A., Sc.D., F.R.S., Chairman.
T. BAKER, Managing Director, Kodak Ltd., Melbourne.
W. RUSSELL GRIMWADE, B.Sc., Melbourne.
G. HARKER, D.Sc., University of Sydney.
W. N. KERNOT, M.Mech.E., M.Inst.C.E., Melbourne University.
G. LIGHTFOOT, M.A., F.S.S., Institute of Science and Industry.
H. V. MCKAY, C.B.E., Sunshine, Melbourne.

There are no scientific, technical or intrinsic difficulties in the way of the production or of the utilization of power-alcohol or industrial alcohol in Australia, *e.g.*, the main difficulty which previously existed in regard to power-alcohol, viz., the difficulty of starting " from cold " on alcohol having

been overcome in a simple and effective manner discovered by the Institute. Demonstrations of starting "from cold" have been given successfully by the Institute before the Motor Traders Associations in Sydney, Adelaide, and Brisbane. Already, and mainly as a result of the Institute's work, power-alcohol is being manufactured and marketed in considerable quantities in Australia, while various important developments for increasing the production are proposed.

The main difficulties which militate against the more extended production of power-alcohol and industrial alcohol in Australia are of an economic and fiscal nature. The economic difficulty is the procuring of abundant supplies of suitable raw material for distillation purposes at a low price. This matter is fully dealt with in the Institute's Bulletins (Nos. 6 and 20). The fiscal difficulty is due to the fact that the present denaturants prescribed by the Excise Regulations add materially to the cost of the fuel. As far back as 1918 recommendations were made by this Institute to the Department of Trade and Customs to the effect that the denaturation regulations should be amended so as to permit of the use of cheaper denaturants. After some delay the question of denaturation was taken up by the Commonwealth Board of Trade, which provisionally decided to recommend the use of certain alternative new denaturants. Effect has not yet, however, been given to the recommendations made on this matter.

On present prices the cost of the prescribed denaturants increases the price of "Industrial Spirits" by approximately 2½d. per gallon, and the price of "Mineralized Spirits" by 2d. per gallon. It is obvious that these sums add to the total cost of production of alcohol for power and industrial purposes, and that they might militate against the development of production on a profitable basis. In the United States of America the compulsory use of methyl alcohol as a denaturant has been dispensed with. In that country no less than five denaturation formulæ are now prescribed for "completely denatured alcohol," while in addition there are forty-five formulæ allowed for denaturation of alcohol for special purposes.

The question of the local production of liquid fuels is generally recognised to be one of very high importance, both in respect of national safety and industrial development. Owing partly, however, to the requirements of existing Excise regulations, the production on a large scale of power-alcohol is hindered, thus the efforts of the Institute to promote the production and use of power-alcohol have not yet attained a full measure of success.

3. **Engineering Standardization.**—Further progress has been made in the movement for carrying out the standardization of engineering materials. As a result of a conference between representatives of the Institute of Science and Industry, the Institution of Engineers (Australia), the Australasian Institute

of Mining and Metallurgy, and the Australian Chemical Institute, agreement was reached as to a scheme for establishing an Australian Engineering Standards Association. This scheme was as follows :—

Scheme for Establishment of Commonwealth Engineering Standards Association.

1. That an immediate recommendation be made to the Commonwealth Government urging the formation of an Engineering Standards Association, and the early appointment by the Government of a main committee.

2. That the constitution of this main committee be as follows :—

(*a*) Three members to be nominated by the Commonwealth Government on the recommendation of the Institute of Science and Industry.

(*b*) Six members—accredited engineers—to be nominated, one by each of the State Governments.

(*c*) Six members to be nominated by the Institution of Engineers, Australia.

(*d*) Three members to be nominated by the Australasian Institute of Mining and Metallurgy.

(*e*) Three members to be nominated by the Australian Chemical Institute.

(*f*) The Committee to have power to nominate members to be co-opted on account of their professional eminence.

(*g*) It shall be an instruction to the Committee that immediately upon its formal establishment it shall take steps to secure the assistance of the various Chambers of Manufacturers and such other interested bodies throughout Australia as may be found desirable.

3. That the appointment of nominees be made by the Commonwealth Government.

4. That the head-quarters of the proposed association be at the head-quarters of the Institution of Engineers, Australia.

5. That the Secretary of the Institution of Engineers, Australia, be the first secretary of the Australian Engineering Standards Association.

6. That the association co-operate with the British Engineering Standards Association, and, if desired, act as its Advisory Committee for the Commonwealth.

7. That the Commonwealth Government be asked to furnish the necessary funds for the preliminary expenses of the organization, and from time to time to provide funds for the conduct of research work.

8. That the principal functions of the main committee be as follows :—

(*a*) To decide what standardization work shall be undertaken.

(*b*) To appoint members of the sectional committees or panels, to which the work of preparing specifications will be intrusted.

(*c*) To arrange for the carrying out of research work on the recommendations of the sectional committees.

(*d*) To receive and deal with the reports and recommendations of sectional committees.

(*e*) To arrange for the publication of the specifications through a standing committee.

(*f*) To keep in touch with "Engineering Standards" organizations in other countries.

(*g*) To control finance through a standing committee.

(*h*) To control the secretarial staff of the Association.

(*j*) To work in co-operation with the Institute of Science and Industry, especially in respect to research work.

9. That the organization and functions of sectional committees and sub-committees be generally along the lines adopted by the British Engineering Standards Association.

The general organization of the British Engineering Standards Association and details of the constitution and functions of the Main Committee, Sectional Committees, Sub-Committees, and Committee Panels composing it were set out by Mr. Lightfoot in Pamphlet No. 2 of the Institute of Science and Industry.

Subject to the necessary funds being made available, the above recommendations have been approved by the Commonwealth Government. Steps are being taken to obtain the nominations for representatives on the Main Committee, and it is hoped that the Association will come into existence at an early date.

In the meantime the Institute has continued to take action in the direction of formulating standard specifications. It has collected a large amount of information, with a view to the preparation of a standard specification for cement. A revised edition of the Standard Specification for Structural Steel Sections is in course of preparation.

As a result of action taken at the Inter-State Conference of Railway Commissioners held in May, 1921, the Institute has been asked to take up the preparation of a standard set of specifications for the railway engineers of Australia in collaboration with the Chief Mechanical Engineers of the Australian Railways, covering the Australian manufacture of railway materials, more especially materials used in locomotives and carriage sections, such as wheels and axles and parts, brass boiler tubes, &c.

In collaboration with the Commissioner for Commonwealth Railways (N. G. Bell, M.Inst.C.E.), the Institute has prepared the necessary preliminary information relating to these matters, and has taken steps for a conference to meet, at which representatives of the Railway Departments and of the Manufacturers will be present to finally agree as to the terms of standard specifications.

4. *Carburetters and Liquid Fuels.*—In co-operation with the Defence Department and the Navy Office, the Institute has undertaken certain investigational work on a special type of carburetter, which admits of immediate adjustment to adapt it to any change of fuels within very wide limits. Two experimental engines have been installed, and arrangements have been completed to commence forthwith a series of experiments to ascertain the efficiency of fuels produced from various sources in Australia, and at the same time to test the efficiency of various forms of the new carburetting device.

D.—The Bureau of Information.

In addition to the experimental work in progress, an important field of the Institute's activities is that carried out by the Bureau of Information, which, already established on a small scale, is furnished with a library of scientific, technical, and industrial books and journals, the whole of which have been catalogued and indexed on the card system. Information has been furnished on a great variety of subjects to a large number of persons inquiring *re* scientific and technical matters, especially concerning new processes, manufacturing difficulties, and the utilization of new raw materials or substitutes therefor. The number of inquiries received show that the Bureau has come to fill a place in the needs of the community, and this class of work will doubtless play a very significant part in the work of the permanent Institute. With an adequate library, a larger staff, and above all facilities for carrying on experimental work, this sphere of activity could well be expanded, and certainly could be made of greater service to the industrial effort of Australia.

The total number of inquiries received and dealt with up to the 1st June, 1922, was 541. The following selection from recent inquiries shows the wide scope of this class of work :—

BUREAU OF INFORMATION—NATURE OF INQUIRIES DEALT WITH.

Manufacture of :—

1. Stainless steel cutlery.
2. Handles for table knives.
3. Plaster of paris for dental purposes.
4. Asbestos sheets.
5. Magnesium-chloride.
6. Chlorine.
7. Fly-papers.
8. Dressing and finishing fluids for leather.
9. Adhesive paste.
10. Sand-soap.
11. Writing inks.
12. Casein.
13. Glucose, &c., from maize.
14. Linoleum.

Manufacture of :—*continued.*

15. Lanoline.
16. Processes for manufacture of picric acid.
17. Process for etching steel blades, &c.
18. Roasting of Australian alunite for manufacture of potash.
19. Separation and purification of disinfectants.
20. Production of para-nitro-toluene.
21. Fixation of atmospheric nitrogen.
22. Sulphur-dioxide in foodstuffs.
23. Action of phosphoric acid on plant life.
24. Malic acid from waste apples.
25. Testing of road-making materials.
26. Utilization of asbestos for paper making.
27. Analyses of numerous minerals and reports on their suitability for various industrial purposes.
28. " Borers " in timber ; method of treatment.
29. Cultivation of medicinal herbs.
30. Utilization of grass tree resin.

VI.—PRINCIPAL RESULTS ACHIEVED.

From what has already been stated in this Report, it will be realized that although a considerable amount of valuable work has already been accomplished, the results so far obtained are—in the nature of the case—not such as are likely to invoke widespread public attention by reason of their intrinsic character. As regards the important activities coming within the scope of the Bureau of Information, it may be remarked that as a rule it is not possible to express exactly the economic value of the advice and information furnished to the inquirer. At the same time it is definitely known that such advice and information have often been of material value and assistance, and the Institute has received appreciative answers in reply to letters furnishing particulars sought.

The following statement summarizes some of the more important results already achieved :—

Summarized Statement of Results Achieved.

Subject.	Results.
1. Posidonia fibre ..	A thorough investigation was completed and methods devised for increasing the strength and flexibility of the fibre. Large scale tests on the Institute's lines are being carried out by one of the companies interested.

Subject.	Results.
2. Engineering standardization	As a result of the Institute's conferences and propagandist work, an agreement between the Institute and Engineering Societies, &c., has been reached as to a scheme for an Australian Engineering Standards Association. Standard specifications have been adopted for structural steel sections, for railway rails, and for tramway rails, resulting in great economy. Extension of this work is in progress.
3. Road construction	As result of conference a scheme was prepared for scientific control of road construction and investigation of road-making materials and methods.
4. Mangrove tanning	Process for getting rid of objectionable colour in mangrove tanning has been devised.
5. Alunite ..	A process for manufacturing potash from Australian deposits of alunite has been worked out.
6. Seed improvement	Valuable work done in classification and description of types of wheat and barley has been undertaken, with results that farmers can now obtain seed true to type and undesirable varieties are being eliminated in favour of more prolific and suitable varieties.
7. Cattle-tick pest ..	The life-history of the cattle tick has been worked out, and the length of time taken to pass through different stages ascertained. These are important results in connexion with quarantining infected animals. A scheme for Federal co-operation in control of pest has been prepared in consultation with State authorities.
8. Sheep-fly pest ..	In New South Wales valuable results in co-operation with pastoralists and New South Wales Department of Agriculture have been obtained; in Queensland a new and effective method has been devised (by jetting and increasing arsenical strength). Jetting machines for the adoption of process are now on the market.
9. Clays in Western Australia	Investigational work has been carried out at Perth and valuable assistance rendered, with the result that a new pottery industry has been established.
10. Red-gum tanning	A method has been devised for increasing the solubility of and getting rid of the objectionable red colour in the raw material.

Subject.	Results.
11. Tannin survey ..	Samples of tanning materials have been obtained and analyzed, and disclose the fact that new valuable sources of tannin are available.
12. Viticultural investigation	Systematic methods have been devised for the treatment of black spot. These have been widely adopted in Mildura District, with the result that the disease is now largely under control. A successful method of control by dipping fruit has been devised. Preventive methods and curative treatment have been ascertained for fruit moth pest. Other chemical and biological investigations are in progress.
13. Prickly pear ..	An investigation for the destruction of prickly pear by insect and fungoid enemies is in progress. If the results obtained in the laboratories can be reproduced in the field, complete control of the pest may ultimately be achieved. Special care will be taken to insure that none of the insects liberated are harmful to existing crops.
14. Macrozamia ..	Complete investigations on the yields of starch and alcohol have been made, and a factory has been established in the South Coast District of New South Wales for the manufacture of starch.
15. Stainless steel ..	As a result of information furnished by the Institute, a factory has been established for the manufacture of stainless cutlery.
16. Worm nodules in cattle	Evidence as to the means of the transmission of this disease has been obtained. Owing, however, to the illness of the Chief Investigator, the work is at present in abeyance.
17. Welfare work ..	A bulletin has been compiled furnishing information.
18. Paper pulp ..	It has been demonstrated, for the first time in Australia, that good quality paper can be made from the wood of Australian trees. Experiments on a semi-commercial scale are being carried out to follow up laboratory results, to ascertain the paper-making qualities of pulps made from Australian materials, and to obtain data as to commercial possibilities.

Subject.	Results.
19. Substitutes for tin plate	The question of substitutes for tin plate for containers has been thoroughly investigated, and as a result many industries have been assisted.
20. Flax cultivation	A Commonwealth Flax Industry Committee has been established and the area cultivated in Australia considerably extended. But the future development must depend upon the economic aspects of the question.
21. White earthenware	Many clays, especially those in the Ballarat District, have been investigated and the causes of discolouration in firing have been discovered. Processes for getting rid of the defects have been devised, and the question of their industrial application is now receiving attention.
22. Power alcohol ..	The whole question of the use and value of power-alcohol has been thoroughly investigated, and alcohol is now in general use as liquid fuel. In particular a simple and effective method has been devised of starting engines from " cold." Consideration is being given to the use of alcohol for industrial purposes generally.
23. Weights and measures	Comprehensive information has been collected from the States. Steps are now being considered with a view to securing uniformity and proper control of imports, and a survey of the whole position is being made.

VII.—FUNCTIONS OF THE INSTITUTE INDICATED BY PRIME MINISTER.

As already stated, the Institute was initially under the direction of an Advisory Council, which was a merely temporary body. It was thus necessarily limited as regards any programme for systematic work; its resources were inadequate, and its executive authority and control for carrying on its work were insufficient. It was then believed that the need for its temporary character would require to continue for a few months only, but, as already said, it carried on its work as a temporary body for no less than five years. It was always understood that the permanent Institute, when created, would be adequately provided with resources, that being indicated in the Report of the initial Conference convened by the Prime Minister, the Rt. Hon. W. M. Hughes, P.C., LL.D., M.P., in January, 1916, for the purpose of preparing a scheme for its organization.

The Prime Minister outlined the scope of the work of the Institute in his address to that Conference. He then stated that "the objective was to apply to the pastoral, agricultural, mining, and manufacturing industries the resources of science in such a way as to more effectively develop our great heritage, and that the attainment of this would involve a central laboratory with a staff of the best scientists, who would have at their disposal ample facilities for original research work," and he stated "that upon the calibre of these men the usefulness of the institution would depend."

Giving point to his comment he said, also, that "provision would be required for :—

"(*a*) A Bureau of Standards for the purpose of investigating and testing standards and measuring instruments, and determining the physical constants and properties of material . . . . including the comparison and verification of weights, measures, thermometers, &c., with Commonwealth standards.

"(*b*) Investigation and industrial research . . . . . problems associated with our great primary industries, pastoral, agricultural, viticultural, the mining of coals and metals, and the metallurgical treatment of the latter.

"(*c*) The chemical and physical study of problems bearing on the secondary industries with a view particularly to the improvement of quality of manufactures, the reduction of the cost of production . . . the utilization of waste materials."

In regard to the scale of operations, the Prime Minister urged that we should "not be pessimistic," but approach the question with "a heart full of courage." He said that "they were prepared to go up to £500,000 . . . . they would spend as much as was necessary. That policy recognised also that we had to 'make up leeway' and put the scheme on a sound footing."

Commenting on the proposed scheme of work of the Institute, *The Australian Manufacturer* in a recent issue* pointed out that "Original scientific research would languish and die if it were left entirely to private enterprise. No man could hope to make a living by scientific research. It is, therefore, largely a case of original research at the expense of the community, or no original research at all."

As an indication of the scope of the Institute's work, in the Prime Minister's mind, he stated that some of the problems awaiting solution were the following :—

Eradication of vegetable pests, such as prickly pear, Bathurst burr, Noogoora burr, California thistle, Darling pea, St. John's wort, onion grass, poison plants, &c.

* See *The Australian Manufacturer*, Vol. 7, No. 335, September 2, 1922.

Eradication of animal and insect pests, such as rabbits, flies, tick, mosquitoes, white ants, mice, locusts, codlin moth, &c.

Liquids for branding sheep and cattle that will be harmless to skins.

Preparation of skins for market, and removal of wool and hair, prior to tanning.

Maintenance of high-class types in sheep, cattle, and horses.

Scientific method of killing, dressing, and classifying meat for export.

Possibility of establishing carbonizing works for the removal of burr and grass seed from wool.

Utilization and recovery of by-products from blood, bones, glue, gelatine, &c.

Prevention of evaporation and absorption of water from tanks and dams.

Utilization and purification of artesian water for irrigation purposes.

Cultivation of Australian saltbushes and indigenous grasses.

Re-establishment of salsolaceous plants on alkaline soils in dry districts, with and without artesian water.

Cultivation of medicinal plants.

Cultivation of fibre plants for paper-making.

Manufacture of nitrogenous fertilizers from the atmosphere.

Manufacture of nitric acid from the atmosphere.

Production of potash salts for agriculture.

Reduction of losses of coal in coal-mining, recovery and utilization of by-products of coal and coke industries.

Recovery of zinc from its ores.

Manufacture of calcium carbide.

Manufacture of alkalies.

Production by electric furnace of ferro-chrome, ferro-tungsten, ferro-molybdenum, ferro-manganese, ferro-titanium, ferro-nickel.

Production of aluminium and its alloys.

Recovery of sulphuric acid, arsenic, &c., from minerals.

VIII.—STATUTORY FUNCTIONS OF THE INSTITUTE.

The Act to establish the permanent Institute was passed in September, 1920, and the Director was appointed on 18th March, 1921. From the beginning it had been assumed by the scientific and industrial men who had lent their aid to the labours of the temporary Institute, that, as soon as the permanent Institute was established, it would be provided with the necessary staff and resources to enable it to perform the whole of its statutory functions, these being in accord with the Prime Minister's original indication. Set out at length in the Act, they are as follow :—

(*a*) The initiation and carrying out of scientific researches in connexion with, or for the promotion of, primary or secondary industries in the Commonwealth ;

(*b*) The establishment and awarding of industrial research studentships and fellowships ;

(*c*) The making of grants in aid of pure scientific research ;

(*d*) The recognition or establishment of associations of persons engaged in any industry or industries for the purpose of carrying out industrial scientific research and the co-operation with and the making of grants to such associations when recognised or established ;

(*e*) The testing and standardization of scientific apparatus and instruments, and of apparatus, machinery, materials, and instruments used in industry ;

(*f*) The establishment of a Bureau of Information for the collection and dissemination of information relating to scientific and technical matters ; and

(*g*) The collection and dissemination of information regarding industrial welfare and questions relating to the improvement of industrial conditions.

The Director shall, as far as possible, co-operate with the existing State organizations in the co-ordination of scientific investigations, with a view to—

(*a*) The prevention of unnecessary overlapping ; and

(*b*) The utilization of facilities and staffs available in the States.

The gratuitous labours of the scientific men and industrial experts of Australia, very generously undertaken during the existence of the temporary Institute, cannot be expected to continue now that a permanent Institute has been created with the statutory functions above outlined. These disclose the fact that the scheme for the establishment of the Institute, sanctioned by Parliament, is very wide in its scope. So far as I am aware, it is the first instance in which a Government has created a single organization charged with the duty of carrying out investigations covering practically every branch of applied science and of industry, both primary and secondary. In other countries large separate institutions have been established from time to time and developed effectively to deal with the different branches of science, pure or applied. In the United States of America, for example, there are the Bureau of Standards, the Bureau of Mines, the Smithsonian Institution, and the Department of Agriculture, with its numerous scientific and technical bureaux. Further reference to these will be made later.

IX.—APPROPRIATE SCALE OF OPERATIONS.

Of course, Australia cannot hope to develop institutions on the scale of countries having many times its population. But, in view of the magnitude of its territory and the extent of its resources, it may properly be expected to respond to its national needs in respect of scientific and industrial research *at least* in the ratio of population. How far at present it falls short of this will appear from the following statements of the relative position of this country and others.

The population of the United States of America is, say, nineteen times that of Australia. Its *Bureau of Standards* at Washington, D.C., cost over £300,000 to build and equip, and its average annual expenditure for the years 1919, 1920, and 1921 was about £460,000. The corresponding annual expenditure for Australia would be £24,200 for this *one branch of work alone.* The staff of this Bureau in the last-mentioned year was 850, of whom 200 were scientific men permanently employed, and 500 were engaged on special research work authorized by Congress. The corresponding number for Australia would be 45 officers, or, say, 11 scientific experts permanently employed and 34 others.

The general technological work at the *Department of Agriculture,* Washington, U.S.A., involves an annual average expenditure which, for the years 1919, 1920, and 1921, was £6,620,000, being as much as £7,506,000 for the last-named year. There are, of course, many other activities of the same kind besides those of this Department, for example, those of the *National Research Council,* consisting of leading American investigators and technologists. This Council is providing no less than £15,000 a year merely for the study for two years of Fatigue in Metals; and to this £6,000 has been added for special work of the same character on nickel-steel alone.

The *Forest Products Laboratory,* which originally cost £50,000, and is part of the Department of Agriculture, had an annual expenditure of £42,000 as far back as 1916. Its staff, which prior to the war numbered 80, was increased during the war to 450, the annual grant being also increased to £140,000.

The *Carnegie Institution* has an annual revenue of £220,000. It is mainly devoted to researches in biological and physical sciences, employing 154 research officers in that work.

The *Mellon Institute,* which engages in research in co-operation with industries, cost £100,000 to build and equip, and has an annual expenditure of £77,000.

The *Food Research Institute of California,* for investigating the production, distribution, and consumption of food, expends annually £14,000.

For investigational work alone, the annual expenditure of the *Federal Bureau of Mines,* devoted to researches in the Mining and Allied Industries, is £110,000.

The *Canners' Research Laboratory,* conducting researches on problems relating to food, also spends a considerable amount annually.

The *National Electric Association's Laboratory* employs no less than 200 investigators.

The *Pennsylvania Railway Laboratories* employ 360 persons. It cost £60,000, and possesses a locomotive testing plant valued at £40,000.

The *General Electric Company's Research Department* employs a staff of 150, and has an annual expenditure of about £50,000.

The *Eastman Kodak Company's Laboratory* cost £30,000, and its annual expenditure is about £30,000.

The above account could be supplemented, but is perhaps sufficient to indicate the American attitude to research of the type which, according to its statutory functions, the Institute of Science and Industry should attack.

In Canada a comprehensive scheme for establishing a National Research Association has been approved by the Government. A Bill to ratify the scheme has already passed the House of Commons without division and is to be brought before the Senate next Session. In the meantime the Government has given a special grant of £20,000. The general scheme of organization of the Canadian Institute and the principles on which it is based are almost exactly in accord with those which were originally approved by the Commonwealth Government in 1916 and along which it was intended the Commonwealth Institute would develop.

The first unit of the Institute, which is to be erected near Ottawa, on a site large enough to give ample room for expansion, will cost initially over £100,000. It will be the Bureau of Standards for Canada, and in this respect its work will be similar to that of the Bureau of Standards at Washington or that of the National Physical Laboratory in England. Closely associated with its functions as a Bureau of Standards, it will carry on fundamental research in chemistry, physics, and related fields, as well as investigations in abstract science similar to those carried on in the scientific laboratories of the Universities. Its activities will include investigations in biochemistry and bacteriology, both fundamental and as applied to such industries as the fisheries, the canning, cellulose, and packing industries, as well as investigations undertaken on the recommendation of the Canadian National Research Council to promote the utilization of the natural resources and valuable waste materials of the country.

The permanent staff will consist of a Director and eight or ten highly qualified heads of departments. The latter will be allowed trained assistants and all facilities and freedom to carry on *abstract research*, each along his own line. The importance of the individual in research is recognised. The Director, in consultation with the National Research Council or a committee of that Council, will have the power of deciding on the technical processes and methods which require and would justify investigation, and the conditions under which they should be undertaken.

The scheme also provides for establishing in Canada a number of Associations for research in the industries, similar to those in England. These Associations will pay their own specialists, but will be housed in the Institute, which will provide the laboratory accommodation and other facilities in its building without rental, a charge being made only for power and materials at cost price. Several of these Associations are now being organized.

Under conditions to be determined in each case, laboratories will be placed at the disposal of individual industrial firms for study of improvements in processes and products. Regulations regarding the length of time the laboratories may be occupied, the right to secrecy regarding the work, &c., &c., will be similar to those enforced in the Mellon Institute of Pittsburg, which has so effectively demonstrated to manufacturers in the United States the value of industrial research. The Canadian Research Institute will work on similar lines to the Mellon Institute, but with this difference, that instead of the Institute being maintained by private endowment it will be endowed by the Government of the country.

The Institute will not be under a Department of the Government, and will, therefore, be free from political influence. The Director will be given a very free hand in organizing and directing the Institute. The responsibility for the success or failure of the whole venture is, therefore, placed upon the shoulders of the National Research Council and the Director.

The organization of the Institute is based upon the following general principles :—

(*a*) Recognition of the claims of abstract science for permanent State endowment apart from Universities ;

(*b*) The development equally in the Institute of fundamental and industrial research, thus bringing into constant and profitable contact men interested and skilled in academic or abstract science with those engaged in its application to industry ;

(*c*) The encouragement of special workers employed by the industries to solve their specific problems in association with a permanent staff of highly trained investigators.

In Great Britain the *Department of Scientific and Industrial Research*, created about five years ago, has a fund of £1,000,000 for grants to industrial research associations, and has also an annual vote of £200,000. In 1920–21 its total expenditure was £550,000. As the population of the United Kingdom is about eight and a-half times that of Australia, on a population basis the equivalent expenditure in Australia would be £64,700 annually.

The number of research associations established by the Department is 26, the grants to them being £75,000 in the last financial year. In the year 1921–22 £41,000 was devoted to researches in the following subjects, viz. :—Glass technology, hard porcelain, technical optics, corrosion of condenser tubes, degumming of silk, tides, corrosion of aluminium, tool steel, industrial fatigue, domestic heating, dye problem, &c., &c.

The *National Physical Laboratory* at Teddington spent about £213,000 in 1921–22.

As a further instance of Great Britain's attitude to research, it may be pointed out that a sum of no less than £140,000 has been expended on a *Fuel Research Station*, and for this branch of work alone highly-qualified experts

have been appointed to deal, for example, with such subjects as powdered fuel, domestic heating, power alcohol, the low temperature distillation of coal, the utilization of heat, &c. The annual expenditure of the Board of Control of this station in 1921–22 was estimated to be £63,000.

Since the war there has been a world-wide awakening in regard to the value of scientific research. The Swedish Government, for example, has granted £40,000 per annum for industrial research, and the Royal Swedish Academy of Industrial Science has subscribed £100,000.

In Japan the *National Laboratory for Scientific and Industrial Research* at Tokyo provides £200,000, the Emperor £100,000, and various companies £220 for the purposes of national research.

Sufficient has been indicated to show the scale on which the modern world is endeavouring to promote the application of Science to Industry. Taking into account the magnitude of the losses of Australia from such causes as plant diseases, the blow-fly pest, the cattle tick pest, and the prickly pear pest, which reveal the magnitude of some of the interests involved, it is evident that a like necessity exists here for a provision adequate for the purposes for which the Institute was created by Parliament. In reviewing the whole position, one is struck by the way in which the actual scientific needs of industry are being met elsewhere. To quote only a single instance: The Shirley Institute in Manchester, just erected, has a capital grant of £200,000 (£50,000 initially, £30,000 annually for five years) and an annual expenditure of £15,600 for the study of cotton only.

It is not suggested that Australia can emulate at the present time what has been done in older and wealthier countries. But it is proper to realize that, since the first steps were taken for the establishment of the Institute, the whole situation has not appropriately advanced. And it is necessary to point out that it is useless to hope to attack industrial scientific problems generally unless the Institute has the necessary equipment in *personnel* and material, and can employ highly-qualified experts. The necessity for establishing national research organizations has been recognised also in New Zealand and South Africa, where a commencement has been made in the creation of such institutions.

X.—INSTITUTE'S PRESENT INABILITY TO CARRY OUT PRIME MINISTER'S INDICATIONS OR TO FULFIL ITS STATUTORY FUNCTIONS.

It has already been pointed out that the existing provision for the Institute is inadequate: at present it can neither undertake the comprehensive carrying out of its statutory functions, nor can it engage in many investigations of high importance to Australia. Nor can it engage in general research. The significance of this can be readily illustrated by a comparison. For example, brief reference has been made above to fuel research by the

British Department of Scientific and Industrial Research. That is only one of many similar activities of that Department. In Australia the liquid fuel problem is recognised to be of great national importance. The Institute made a recommendation for the employment of a technically qualified officer at a salary of £500 per annum to act as secretary to a representative and influential committee (which the Institute appointed to inquire into the whole matter). The necessary funds were not, however, available, and the Committee was therefore unable to continue its work. At a later stage the Institute convened a conference of persons interested in the liquid fuel problem. The trade interests represented at that conference testified their earnestness by offering to subscribe a sum of £5,000 to cover cost of investigations, provided the Commonwealth contributed a similar sum. A recommendation by the Institute that this offer should be accepted was not, however, approved. This is an instance in which the Institute had not only taken all necessary initial action for the investigation of an important problem, but had also obtained the full sympathy and co-operation of the industries concerned, but, nevertheless, has not been able to proceed further owing to the limitation of provision for its normal activities.

When examined in the light of the functions explicitly set out in the Science and Industry Act and the indications given by the Prime Minister of what the Institute was intended to do, the existing situation cannot be regarded as normal. The disparity between the requirements of the Act and actual possibilities under existing limitations run the risk of creating a false public impression as to the value of a national industrial research organization. The State Agricultural and other Technical Departments, the industrial and technical organizations, and the scientific societies have most naturally expected that the Institute will play its part in the development of industrial scientific work. But, so far from being able to take the lead in these matters, the Institute at present is quite unable to meet the various organizations and departments half-way, and to comply with their reasonable requests for co-operation. Many of the leading scientific and industrial men of Australia have continued to give their sympathy and gratuitous support to the Institute in the belief that the existing state of affairs will soon terminate, and that adequate financial provision will be made for the Institute. Without doubt, if the necessary facilities are given it the Institute will develop its work in accordance with the original scheme approved in 1916, and with the provisions of the Act creating it, and there would be a ready response on the part of those persons who have co-operated in supporting the movement for its establishment.

Briefly, the position is that the Institute is at present financially so limited that it is unable to carry out all its statutory functions. With reasonable endowment and annual subsidy it could create proper laboratory accommodation and obtain an expert staff; its utility and value would then increase at a rate out of all proportion to the increased expenditure.

The following are some instances of cases in which the Institute has been asked to carry out investigations, but has been unable to do so owing to lack of funds :—

Instances of Requests to carry out Investigations with which Institute unable to comply mainly owing to lack of Funds.

Subject.	From whom Request Received.
1. Tomato Blight ..	New South Wales Association of Nurserymen and New South Wales Department of Agriculture.
2. Sawdust for Alcohol ..	Saw-millers in various localities.
3. Flying Fox Pest ..	New South Wales Department of Agriculture.
4. Timbers, Utilization of	Coach and Waggon Makers' Association.
5. Fruit Diseases ..	New South Wales Department of Agriculture.
6. Brown Spot in Mandarins	New South Wales Fruit-growers' Association.
7. Research in Citriculture	Mildura District Citrus Co-operative Association Ltd.
8. Cold Storage of Fruit ..	New South Wales Municipal Cold Stores, and Victorian Department of Agriculture.
9. Maize Grub	Queensland Acclimatisation Society.
10. Liquid Fuels	Royal Automobile Club of Victoria, and various trade interests.
11. Rabbit Pest	New South Wales Pastoral Protection Board, and various other persons.
12. White Ant Pest ..	New South Wales Department of Agriculture.
13. Dairying Investigations	Commonwealth Dairy Expert.
14. Dingo Pest	Miles District Council, Queensland, and New South Wales Zoological Society
15. Australian Timbers for Aeroplane Construction	Department of Defence.
16. Soil Survey of Australia	New South Wales Farmers and Settlers' Association.
17. Problems in Wine-making Industry	Messrs. Penfold and Co.
18. Economic Mineral Resources of Australia	C. O. G. Larcombe.
19. Tuberculosis in Stock ..	Queensland State Committee of Institute.
20. Fruit Fly	Australian Conference of Fruitgrowers.
21. Phosphatic Rocks of Australia	Agricultural Department, University of Western Australia.
22. Kimberley Horse Disease	Western Australian Government.

XI. ORGANIZATION NECESSARY TO FULFIL STATUTORY FUNCTIONS.

Before the Institute can attempt to carry out the functions initially indicated by the Prime Minister the funds and resources available for the work will have to be materially increased. Soon after my appointment as Director of the Institute, viz., on the 21st April, 1921, I furnished a report to the Minister for Trade and Customs outlining in a general way an appropriate scheme of organization which would enable the statutory functions to be fulfilled, and I pointed out that :—

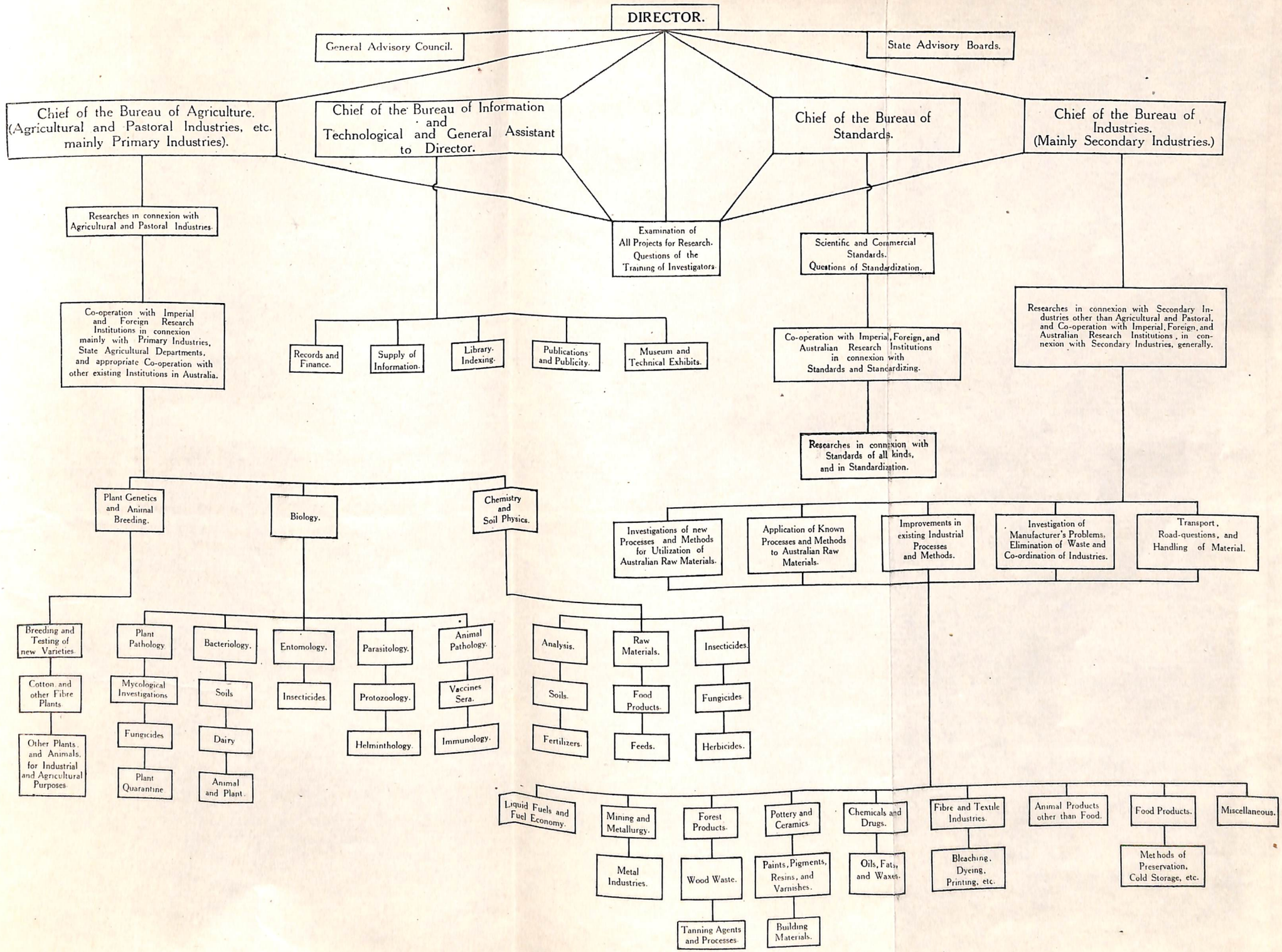
> " (*a*) It will be impracticable at the outset to cover anything like all branches of scientific industrial research.
>
> " (*b*) To deal adequately and comprehensively with any single branch of scientific industrial research, such, for example, as the Forest Products Investigations, a sum considerably in excess of the total available in the past for the temporary Institute would be required.
>
> " (*c*) If the permanent Institute is to fulfil at all adequately and even on a very restricted scale, the scope of functions contemplated by the Act, it will require a very large increased annual vote.
>
> " (*d*) The scale of operations of the future Institute and the adoption of a definitive programme of work must depend primarily on the amount of the votes to be made available from year to year.
>
> " (*e*) The scheme of organization of the Institute, involving such questions as the creation of the Bureau of Agriculture and the Bureau of Industries, provided for in the Act, unequivocally depends on the funds to be made available."

With that report a diagram was furnished showing the general scheme of organization and work of the Institute when it has been properly developed: this scheme is substantially represented in the diagram attached hereto.

The diagram of course outlines only in a general way the scope of work and functions of, and an appropriate scheme for the organization of, the Institute. It is obvious, however, that the full development on so comprehensive a scale would cost a very large sum of money and could be effected only in the course of a number of years. Initially, its scope, work, and functions will certainly have to be concentrated on the more important branches of the work, owing to limitations both of finance and *personnel* (*e.g.*, shortage of trained investigators).

The significance of the existing position appears only when it is realized that, to deal adequately with any one of the main branches of scientific industrial research, the expenditure of a substantial sum of money considerably larger than the total vote which has been available in the past for all the purposes

Proposed Organization of the Institute of Science and Industry.



of the temporary Institute (£15,000 for current financial year) is necessitated. For example, a complete Forests Products Laboratory could not be established at a capital cost of less than £40,000 or £50,000, with an annual expenditure of from £25,000 to £30,000 ; while if it was proposed to undertake standardization work, the cost of a properly equipped Bureau of Standards, even on a relatively small scale, would certainly be not less than £100,000.

Reviewing the whole question of finance in relation to the future policy and programme of work of the Institute, it is recognised that *the efficiency of an industrial research Institute increases rapidly as its scale of operations extends.* This is due partly to the fact that, with a relatively small expenditure such as that of the temporary Institute, the overhead charges for administration, control, &c., cover a considerable proportion of the total funds available. For example, with a total annual expenditure of, say, £15,000, administrative and overhead charges would account for, say, £5,000, equivalent to one-third of the total expenditure ; but with a total vote of, say £30,000, the overhead charges would be only slightly increased, leaving a very much larger proportion of the funds available for actual investigational work. Secondly, it is the universal experience of scientific research institutes that what may be called the " yield per man " increases rapidly as the number of men co-operating and the size of the establishment are increased.

Actual experience as to the problems that present themselves for the attention of the Institute show that the scope of its functions, as originally outlined by the Prime Minister and later embodied in the Act, were singularly apposite to the needs of Australia, with its great range of latitude, its diversities of climate and geophysical characters, and the present stage of development of its industries, both primary and secondary.

A comparative study of the effort to utilize systematized knowledge (science) in other parts of the world, as well as direct attention to the problems arising here—some of which we are certainly not facing—has satisfied me that the scale of existing effort is insufficient for normal needs. An examination of the amount of money made available in many other countries, to which reference has already been made, shows that the sum at present being expended in Australia is quite inadequate.

In the report to which reference is made above, I stated that unless the Institute's vote is substantially larger than was that of the temporary body, it will become necessary to restrict the experimental research work mainly to a few problems, and I pointed out that the formulation of a suitable scheme for the activities of the Institute is governed by the available vote.

In order to place the affairs of the Institute on a satisfactory and effective basis, it is necessary that appointments be made to the positions of Chief of the Bureau of Agriculture, Chief of the Bureau of Industries, as prescribed by the Act, and Chief of the Bureau of Information.

If these appointments were made, and if the vote for the Institute were appropriately increased, it would be practicable to arrange forthwith for investigational work on an appropriate scale to be initiated on the lines of the following programme :—

A.—Agricultural and Pastoral, in co-operation with State Agricultural Departments.

(Definite programme cannot be formulated until nucleus of Bureau of Agriculture established.)

(*a*) *Plant Genetics.*—The breeding and testing of new varieties of plants, &c., especially in relation to drought resistant and disease resistant types. Crop acclimatisation; investigation of fibre plants; the introduction of new plants from other countries (*e.g.*, fodder grasses, sorghum, cotton, and other plants for industrial purposes).

(*b*) *Plant Pathology, Entomology, &c.*—Insect and fungoid pests; remedial measures for disease of plants, fruit, &c., and for weeds and pests; entomological and mycological investigations; insecticides and fungicides (*e.g.*, rusts, smuts, blights, spots, scabs. &c.).

(*c*) *Soil Fertility and Bio-chemistry.*—The improvement of soils by the use of fertilizers and appropriate cultural methods; the treatment of alkaline soils; the utilization of natural phosphates; maintenance of soil fertility; causes of unproductive soils and means for their improvement; the application of electricity to plant culture.

(*d*) *Irrigation Problems.*—Transpiration and investigations on the quantities and periods of application of water in relation to surface and subsoil characters, natural rainfall, &c.; fertilization and cultivation of irrigation crops.

(*e*) *Animal Husbandry.*—The breeding and feeding of stock; investigations of meat and animal food-products, of stock rations, and of metabolism in relation thereto; silage investigations and the conservation of fodder generally.

(*f*) *Animal Pathology.*—The control and eradication of diseases of stock, whether parasitic or other, in co-operation with the Stock Diseases Institute which the New South Wales Department of Agriculture is establishing (*e.g.*, contagious pleuro-pneumonia, sheep blow-fly, braxy, contagious abortion, animal tuberculosis, cattle-tick pest, nodule disease, &c.).

B.—Horticultural and Viticultural.

Acceptance of offer of New South Wales Department of Agriculture to co-operate in investigations on fruit diseases, and extension of viticultural work in progress at Mildura, in co-operation with Mildura Research Committee and Victorian Department of Agriculture.

C.—Tanning Materials and Processes.

Co-operation with State Forestry Departments in examination of new tanning materials. Investigations on manufacture of tanning extracts for local use and export. Investigations on Tanning and Fellmongering problems in co-operation with Master Tanners' and Fellmongers' Association.

D.—Engineering Standardization, in co-operation with the proposed Australian Engineering Standards Association.

E.—Liquid Fuels and Fuel Economy.

Investigations on processes for distillation of liquid fuels from Australian shales and coals and experiments on utilization in internal combustion engines of liquid fuels made in Australia, in co-operation with Royal Automobile Club, shale-oil industry, and other trade interests concerned (which offered, two years ago, to contribute £5,000 on a £1 for £1 basis with the Institute).

F.—Pottery and Ceramics.

Extension of work now in progress to include investigations on utilization of Australian raw materials for manufacture of refractory materials, tiles, glazes, enamelled iron-ware, &c.

G.—Production of Dyes and Other Chemicals from Australian raw materials.

H.—Timber and Forest Products Investigations.

Tests of Australian timbers to ascertain their suitability for various industrial purposes; preservation of timber and miscellaneous forest products investigations.

I.—Cold Storage and Food Problems.

Investigations on cold storage of soft fruits and beef, in co-operation with State Departments of Agriculture and the trade interests concerned.

J.—Manufacturing Industries (Bureau of Information).

Investigations on new processes for utilization of Australian raw materials; improvements in existing industrial processes; investigations of manufacturers' problems.

K.—Geological Survey.

The establishment of a Bureau of Geological Survey on the lines recommended by the Australian National Research Council, the work to be:—

(*a*) Systematic, including such branches as stratigraphy, structural geology, palæontology, petrology, the correlation of the geology of the various States, and other purely scientific geological investigation affecting the whole Commonwealth and the Mandated Territories, as well as the preparation of a geological map of the Commonwealth.

(*b*) Economic as applied to all Federal and Mandated Territories, together with such other economic investigations as may be mutually referred to it for the time being by the joint action of the States and the Commonwealth.

XII.—ADVISORY COUNCIL AND ADVISORY BOARDS.

The Institute of Science and Industry Act provides (section 6) that a General Advisory Council and Advisory Boards in each State may be appointed by the Governor-General to advise the Director in regard to:—(*a*) the general business of the Institute or of any bureau thereof; and (*b*) any particular matter of investigation or research. This Council and these Advisory Boards have not yet been created. At a meeting of members of the former Executive Committee of the temporary Institute convened on the 5th April, 1921, the members present expressed their willingness to act temporarily as an advisory body, and to assist in every possible way in the work of the Institute, and to do this gratuitously. The following provisional Council and provisional Boards are accordingly acting until the appointment under the Act of the permanent bodies:—

Provisional General Advisory Council.

D. Avery, M.Sc.; S. S. Cameron, D.V.Sc.; G. D. Delprat, C.B.E.; H. W. Gepp; Professor T. R. Lyle, M.A., Sc.D., F.R.S.; C. S. Nathan; A. B. Piddington, K.C.; A. E. V. Richardson, M.A., B.Sc.; Professor J. Douglas Stewart, B.V.Sc., M.R.C.V.S.; Professor R. D. Watt, M.A., B.Sc.

The following Chairmen of the State Advisory Committees are *ex-officio* members of the provisional General Advisory Council:—*New South Wales*—F. Leverrier, K.C.; *Queensland*—J. B. Henderson, F.I.C.; *Western Australia*—Professor J. W. Paterson, B.Sc., Ph.D.; *Tasmania*—L. Rodway, C.M.G.; *South Australia*—Professor E. H. Rennie, M.A., D.Sc.

Provisional State Advisory Boards.

New South Wales.

Chairman	.. ..	F. Leverrier, K.C.
Members	.. ..	Hon. R. T. Ball, M.L.A., Minister for Agriculture; J. T. Elliott, D.Sc.; Professor C. E. Fawsitt, D.Sc., Ph.D.; F. B. Guthrie, F.I.C., F.C.S.; A. B. Piddington, K.C.; Professor R. D. Watt, M.A., B.Sc.; Professor J. D. Stewart B.V.Sc., M.R.C.V.S.; J. B. Trivett, F.R.A.S., F.S.S. (Associate Member).
Secretary	.. ..	E. Alfred, Education Department, Sydney.

Victoria.

Chairman	.. ..	Professor Sir Thomas R. Lyle, M.A., D.Sc., F.R.S.
Members	.. ..	Hon. H. S. W. Lawson, M.L.A.; D. Avery, M.Sc.; W. T. Appleton; S. S. Cameron, D.V.Sc. M.R.C.V S.; D. Clark, M.M.E., B.C.E.; G. D. Delprat, C.B.E.; H. W. Gepp; Sir John M. Higgins, K.C.M.G.; Professor T. H. Laby, M.A.; Hon. G. Swinburne; W. Percy Wilkinson, F.I.C.; A. E. V. Richardson, B.Sc., M.A.; A. M. Laughton, F.I.A. (Associate Member).
Secretary	.. ..	Gerald Lightfoot, M.A., F.S.S., 314 Albert-street, East Melbourne.

PROVISIONAL STAFF ADVISORY BOARD—*continued.*

Queensland.

Chairman	.. ..	J. B. Henderson, F.I.C.
Members	.. ..	Hon. J. Neil Gillies, M.L.A., Minister for Agriculture; Professor B. D. Steele, D.Sc.; N. Bell, A.M.I.C.E. (Associate Member); A. J. Gibson, M.E., A.M.Inst.C.E., (Associate Member); J. Gibson (Associate Member).
Hon. Secretary	..	Professor H. C. Richards, D.Sc. (Associate Member), William-street, Brisbane.

South Australia.

Chairman	.. ..	Professor E. H. Rennie, M.A., D.Sc.
Members	.. ..	Hon T. Pascoe, M.H.A., Minister for Agriculture; G. Brookman; W. W. Forwood; W. A. Hargreaves, M.A., D.Sc., B.C.E.
Secretary	.. ..	F. W. Reid, B.Sc., School of Mines and Industries, Adelaide.

Western Australia.

Chairman	.. ..	Professor J. W. Paterson, B.Sc., Ph.D.
Members	.. ..	Hon. H. K. Maley, M.L.A., Minister for Agriculture; C. S. Nathan; J. W. Sutherland; S. Bennett (Associate Member); A. Montgomery, M.A., F.G.S. (associate Member); G. L. Sutton (Associate Member); A. Gibb-Maitland, F.G.S. (Associate Member).
Secretary	.. ..	A. Tomlinson, M.Sc., A.M.Ins.C.E., University of Western Australia, Perth.

Tasmania.

Chairman	... ..	L. Rodway, C.M.G.
Members	.. ..	Hon. J. B. Hayes, M.H.A., Minister for Agriculture; H. W. Gepp; H. J. Colbourn (Associate Member); Professor J. H. Mackay, M.C.E. (Associate Member); H. M. Nicholls (Associate Member); C. H. Slayter, (Associate Member).

Communications to : Box "U," G.P.O., Hobart.

It should be mentioned that, during the period for which the original temporary Advisory Council was in existence, in anticipation of the creation of the permanent Institute, the late F. M. Gellatly, LL.D. was appointed Director as from the 30th April, 1918. Pending the passing of the necessary legislative measure for the establishment of the permanent Institute, he was appointed

a member of the temporary Advisory Council and Chairman of its Executive Committee. Dr. Gellatly died on the 24th September, 1919. At a special meeting of the Executive Committee held on that date the following resolution was passed :—

> " That the Executive Committee desires to record its high appreciation of the valuable services rendered to the Institute by its first Director, the late Dr. Gellatly, and its sense of the severe loss the Institute and the Commonwealth have sustained by his untimely death. The Committee feels deeply that the Australian movement for bringing science to bear upon the practical problem of industry will always owe a debt to the untiring energy, the alertness of intellect, the wise and moderate counsels, and the sympathetic temperament of the late Director."

XIII.—LABORATORIES.

For the purpose of carrying out the research work of the Institute existing laboratories will be utilized, as far as suitable and available. It may often, however, prove impracticable for the research work of the Institute to be carried out efficiently, expeditiously, and economically, solely at existing laboratories, especially where these are fully occupied with routine work or with academic instruction. For example, Government laboratories are devoted largely to work of a *routine* nature, while the staffs of University laboratories are ordinarily, and quite properly, occupied so much with *instructional* and other duties as to prevent them from giving the continuous and prolonged attention required for the successful and speedy solution of technological problems. Ordinarily the existing laboratories in Australia are not equipped with apparatus for conducting " large-scale" experiments, though these are often a necessary intermediate step between the solution of a problem in the laboratory and the profitable application of the solution to the problem as it is presented on a commercial scale. Further, the accommodation available in and the staff and equipment of existing laboratories in Australia are insufficient for the carrying out of their fundamental work, which must be attended to before other pressing problems can be solved.

Up to the present the work of the Institute has suffered severely owing to the fact that, with the exception of its temporary laboratory at Perth mainly devoted to Forest Products investigations, the Institute has had no laboratories of its own. In December, 1921, an offer was made to the Institute by the Council of the Brunswick Technical School to make certain rooms (built in connexion with the Returned Soldiers' Vocational Training Scheme) available to the Institute for laboratory purposes, provided that the Institute agreed among other things to carry out investigational work on pottery and ceramics. That offer has been accepted on terms which are advantageous to the Institute, and steps are now being taken to equip the laboratory for general physical and chemical investigations.

XIV.—EXPENDITURE AND CONTRIBUTIONS TO COST OF INSTITUTE'S WORK.

The following statement furnishes particulars of the expenditure of the Institute during the financial year 1921–22 :—

COMMONWEALTH INSTITUTE OF SCIENCE AND INDUSTRY.

Expenditure during Financial Year, 1921–22.

	£	£
1. Salary of Director		2,000
2. Contingencies—		
(i) Postage and telegrams	91	
(ii) Office requisites, exclusive of writing paper and envelopes	68	
(iii) Writing paper and envelopes	51	
(iv) Account, record, and other books ..	4	
(v) Other printing	17	
(vi) Travelling expenses	244	
(vii) Temporary assistance	2,747	
(viii) Miscellaneous and incidentals	681	
(ix) Telephone service	81	
(x) Printing of engineering standard specifications	61	
		4,045
3. Investigations—		
(i) Prickly Pear Investigations	4,000 (*a*)	
(ii) Paper Pulp Investigations	893 (*b*)	
(iii) Cattle Tick Dips	92 (*c*)	
(iv) Worm Nodules in Cattle	9	
(v) Sheep Blow-fly—New South Wales ..	537	
(vi) Sheep Blow-fly—Queensland	522	
(vii) Seed Improvement Committee	287	
(viii) Viticultural Investigations	622 (*d*)	
(ix) Castor Beans—Queensland	14	
(x) Western Australia—Red-gum Tanning ..	438 (*e*)	
(xi) Tannin Survey, Western Australia ..	156 (*f*)	
(xii) Timber Impregnation, Western Australia	202 (*g*)	
(xiii) Forest Products Laboratory, Western Australia—Maintenance	690	
(xiv) Power Alcohol	65	
(xv) White Earthenware, Ballarat	444	
(xvi) Carburetter and Liquid Fuel Investigation	583 (*h*)	
		9,554
4. Bureau of Information		806
Total		16,405

(*a*) In addition New South Wales and Queensland each contribute £2,000 per annum.

(*b*) In addition the following contributions aggregating £1,200 were received :—New South Wales, Victoria, Western Australia, and Tasmania, £250 each; Queensland, and the Australian Paper and Pulp Co. Ltd., £100 each.

(*c*) In addition New South Wales and Queensland each contribute on a £1 for £1 basis with the Institute.

(*d*) In addition the Mildura Vineyards Protection Board expend £1 for every 10s. expended by the Institute.

(*e*) In addition Western Australia contributed £250.

(*f*) In addition Western Australia contributed £100.

(*g*) In addition Western Australia contributed £200.

(*h*) In addition the Department of Defence and the Navy Office each contribute 10s. for each £1 expended by the Institute.

The above statement shows that the Institute's expenditure on actual investigational work was £9,554. The fact that the total contributions to supplement the cost of the Institute's work amount to £7,494, or 78 per cent. of the expenditure on investigations from the Institute's vote, is *a striking illustration of the extent to which State Government departments and other bodies are prepared to co-operate with the Institute.* The following statement shows the contributions received during the year 1921–22 :—

Contributions Received during Financial Year, 1921–22, *towards Cost of Institute's Investigations.*

Investigation.	Source.	Amount. £	£
1. Prickly Pear Pest ..	New South Wales Government ..	2,000	
	Queensland Government ..	2,000	
			4,000
2. Paper Pulp ..	New South Wales Forestry Department	250	
	Victorian Forestry Department	250	
	Queensland Forestry Department	100	
	Western Australian Forestry Department	250	
	Tasmanian Forestry Department	250	
	Australian Paper and Pulp Co. Ltd.	100	
			1,200
3. Cattle Tick Dips ..	New South Wales Department of Agriculture	250	
	Queensland Department of Agriculture	250	
			500
4. Western Australian Tanning Survey	Western Australian Forestry Department		100
5. Western Australian Marri Kino	Western Australian Forestry Department		250
6. Timber Impregnation	Western Australian Forestry Department		200
7. Viticultural Investigations (*a*)	Paid direct by Mildura Vineyards Protection Board		1,244
	Total		7,494

XV.—ACKNOWLEDGMENTS AND STAFF.

I desire to express my appreciation of the valuable assistance received from a large number of persons throughout the Commonwealth, including correspondents who have forwarded valuable suggestions and information, and authorities on various subjects who have gratuitously placed their knowledge at the disposal of the Institute. My thanks, and those of the Commonwealth as a whole, are also due to the members of the Advisory Council and Advisory Boards, and of the Special Committees who are voluntarily giving their time and skill to the solution of the various problems referred to in this Report.

(*a*) The Institute contributes 10s. for every £1 expended by the Mildura Vineyards Protection Board. The sum specified is the amount expended by the Board during the financial year 1921–22.

In conclusion, I desire to place on record my appreciation of the services of the officers of the Institute in connexion with the work on which it has been engaged. The following are the scientific and technical officers of the Institute :—

SCIENTIFIC AND TECHNICAL OFFICERS OF THE INSTITUTE.

1. *Head Office Staff.*

GERALD LIGHTFOOT, M.A., Acting Chief of Bureau of Information.

EWEN MACKINNON, B.Sc., B.A., Investigator and Chief Science Abstractor.

G. A. COOK, M.Sc., B.M.E., Investigator and Science Abstractor.

Pottery Investigations.

R. C. CALLISTER, Investigator.

Paper-pulp Investigations.

L. R. BENJAMIN, in charge of Investigations.

H. SOMERVILLE, B.Sc., Assistant.

Tanning Investigations.

H. SALT, M.Sc., in charge of Investigations.

D. COGHILL, Assistant.

Miscellaneous Forest Products Investigations.

R. A. FOWLER, B.Sc., Investigator, and Officer in charge of the Institute's Laboratory at Perth.

Seed Improvement Committee.

ELLINOR ARCHER, M.Sc., Secretary and Investigator.

Viticultural Investigations.

A. V. LYON, B.Agr.Sc., Investigator.

Carburetter and Liquid Fuel Investigations.

Captain C. M. DYER, R.A.F., in charge of Investigations.

Captain R. F. JONES, R.A.F., Assistant.

Commonwealth Prickly Pear Board.

Professor T. H. JOHNSTON, D.Sc., M.A., Scientific Controller.

W. B. ALEXANDER, M.A., Assistant.

J. C. HAMLIN, M.Sc., Assistant.

(Signed) G. H. KNIBBS,
Director.

Commonwealth Institute of Science and Industry,
314 Albert-street, East Melbourne,
31st July, 1922.

BY AUTHORITY:
ALBERT J. MULLETT, GOVERNMENT PRINTER, MELBOURNE.