NEW SOUTH WALES
DEPARTMENT OF AGRICULTURE

1956 Farrer Memorial Oration . . .

SCIENCE SERVICES FOR PRIMARY INDUSTRY

By Arthur F. Bell, B.Sc., M.S. (Agr.), D.I.C., A.R.A.C.I., Under Secretary, Queensland Department of Agriculture and Stock

IN every field of endeavour progress is made by pulling away obstacles, and by pulling aids into position. The efficiency with which this is done depends on the proportion of the people pulling—and the degree to which they pull their weight, pull at the same time, pull in the same direction, and pull in the right direction.

SCIENCE has a great deal to offer industry and in this highly competitive world it is essential that scientific aids be so placed, and obstacles so removed, that science may make the greatest possible contribution to industry in the shortest possible time.

Last year Mr. E. A. Southee, when delivering the Farrer Oration,* spoke of the dividends accruing from the application of the findings of science to practice in primary industry. I propose to comment on the complementary theme of the provision of scientific services for primary producers and of some of the principles and problems involved.

In using the term "science service" I refer to a balanced and reasonably complete applied-science service which is equipped to deal with at least the great majority of the production problems confronting a primary industry. I do not refer to research institutes which might be set up for restricted or particular fields, as, for example, an institute to carry out research into relations between wheat quality and baking.

The Sugar Industry

To aid me in my purpose I will first sketch the development of the sugar industry, and then trace the history and development of the Bureau of Sugar Experiment Stations, the scientific institution in which I spent most of my adult life, and which is in many respects unique in Australia. With this background for frequent reference I shall discuss in some detail the requirements and implications of a science service for any primary industry.

* "Practice with Science", Agr. Gaz., N.S.W. 66: 420-5, 482-7.

The Australian cane sugar industry commenced at Port Macquarie under the patronage of the then Governor of this State of New South Wales, Sir Thomas Brisbane; 70 tons of sugar was made in the year 1823. The prevalence of frosts gradually forced the industry northwards and the northern boundary had reached the Brisbane district by the early eighteen sixties. This northern trend continued for many years and at the present time more than three-fourths of Australia's sugar is produced north of the Tropic of Capricorn, and less than 5 per cent is produced in New South Wales.

While this change in geographic distribution of the industry was taking place, there were also great changes in its structure. In the eighteen eighties about 200 small mills produced only 50,000 or 60,000 tons of sugar, the cane being hauled from the farms in drays. To-day thirty-four mills produce about 1,250,000 tons of sugar and the cane is hauled on tramline systems aggregating more than 2,000 miles in length; in New South Wales river punt transport is also used. In 1863 the indenture of Kanaka labour from the South Sea Islands was commenced and soon most of the cane was grown with island labour on a plantation system. Repatriation of the Kanakas commenced in 1907 and the industry is now based on the farm system, using European labour only.

Without the sugar industry the present highly developed northern tropical coast must have remained sparsely populated cattle country. We would then have lacked the harbours, transport systems, and other facilities which made North Queensland a springboard for launching the attack which turned back the invaders in 1942.

Among Australian crops sugar cane ranks second in economic importance to wheat. The raw sugar industry now earns about £50,000,000 annually, including £25,000,000 in sterling and dollar currencies—a very important contribution in these days of difficult overseas financing.

The leaders of the sugar industry early gave evidence of interest and belief in technical guidance for their industry. Following the establishment of the world's first sugar experiment stations in Java and Louisiana in 1885, witnesses before a State Royal Commission in 1888 urged the establishment of such a station in Queensland. The Government of the day compromised by establishing "State nurseries" for general tropical agriculture at Cairns and Mackay, but the sugar industry insisted that this must be regarded as merely a preliminary step, and renewed its pressure on the Government.

Mr. Bell.

In 1899 Dr. Walter Maxwell, then Director of the Experiment Station of the Hawaiian Sugar Planters' Association, was invited to Queensland to report on the sugar industry and advise as to the provision of scientific services for it. After inspection and inquiry Dr. Maxwell recommended that a chain of sugar experiment stations be established, and in 1900 there was enacted "The Sugar Experiment Stations Act" in furtherance of these recommendations.

THE FARRER MEMORIAL MEDAL is awarded annually to commemorate the work of Australia's great wheat breeder, William James Farrer, and to mark distinguished service to agricultural science. The oration by the recipient is an important item on the programme of the congress of the New South Wales Agricultural Bureau at which the award is made.

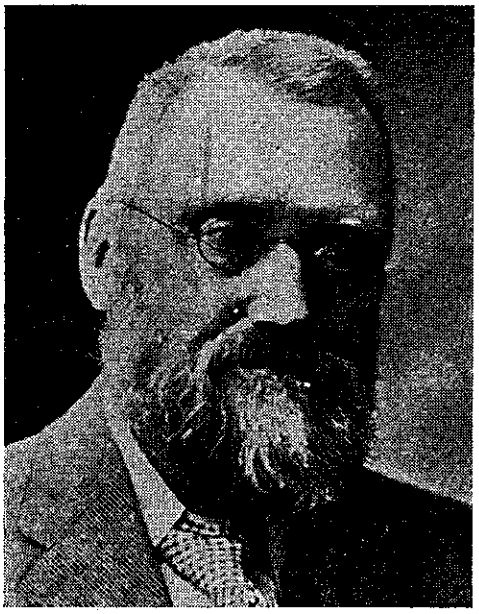
Sugar Experiment Stations

This Act brought into being the Bureau of Sugar Experiment Stations and provided that it be financed by a levy per ton of cane payable by both millers and growers, this industry contribution to be endowed pound for pound by the Government.

In due course Dr. Maxwell was offered, and accepted, the position of first Director of the Bureau. And thereby hangs a tale: Dr. Maxwell reputedly cabled from Hawaii that he would accept a salary of "three thousand" which was interpreted here as meaning pounds, whereas he had had dollars in mind. Be this as it may, he was appointed at the then princely salary of £3,000 a year, whilst the next senior officer received but £125 a year! Dr. Maxwell remained in office for nine years, after which he returned to the United States. The Director's salary then nose-dived, and nearly fifty years was to pass before it re-attained the £3,000 level.

William James Farrer

—1845-1906—



Son of an English farmer, Farrer came to Australia in 1870, and was a surveyor on the staff of the N.S.W. Lands Department. In 1898 he was appointed to the staff of the Department of Agriculture following the recognition of the value of his experiments with wheat. For his work as a wheat breeder, Farrer has been termed "Australia's greatest benefactor", pioneering the development of varieties suitable to Australia and making possible the extension of our wheat-growing areas by millions of acres.

For the next decade or so the Bureau functioned as a typical branch of the Department of Agriculture, with three field experiment stations and a very small head office administrative staff. However, industry leaders were not satisfied that the Bureau was adequately staffed or equipped and pressed for further development.

In 1923 it was decided to select three graduates from the Queensland University and send them abroad for a period of four years, for both specialised training in overseas universities and practical experience in other sugar-producing countries. In the meantime, also, a number of local scholarships were granted to undergraduates in training. These actions were taken entirely at the expense of the sugar industry.

In 1928 the travelling specialists returned and assumed control of the old and the newly-recruited graduate staffs. The Bureau might then be said to have entered upon the second phase of its life. The first phase was largely exploratory and observational; a good deal of field knowledge had been accumulated and there had been many relatively simple field trials. There had been little long-range or fundamental research into problems—and up to the mid-twenties this was probably true of Australian Departments of Agriculture generally.

Co-ordinated Research

The scene now changed; co-ordinated researches were initiated, extensive field trials using modern techniques were instituted, and extension activities were intensified. And in a decade the yield of sugar per acre had increased by 50 per cent.

At this stage it was felt that the industry, which down the years had borne half of the cost of the Bureau, should be brought into closer association with its policy direction. Accordingly in 1933 the Minister for Agriculture invited the industry to nominate representatives on an Advisory Board, which would comprise the Minister, the Director, two representatives nominated by growing interests, and two representatives nominated by milling interests.

*73729—2

The innovation was so well received, and proved so successful, that the Advisory Board was in the next year given statutory recognition by an amendment of The Sugar Experiment Stations Act. With the concurrence of the industry the contribution of the Government was pegged at the existing level—that is, all future increases in cost would be borne by the industry.

The composition of the Advisory Board remained the same, with a small but notable proviso, namely, that one of the members versed in milling must be nominated by the Queensland Society of Sugar Cane Technologists.

This set-up prevailed during the difficult war and reconstruction periods but a further evolutionary step was taken in 1950. The industry was quite satisfied with the system of Department-cum-Advisory Board control except for one thing—the relative inflexibility of Public Service salaries. Three Directors had been lost in four years and it was felt that conditions of employment should be made more attractive.

In 1950 the Act was again amended. Control of the Bureau and the administration of the Act was vested in an independent Board of four and the staff was removed from the operation of the Public Service Act.

Thus, coinciding with the celebration of its golden jubilee, the Bureau had completed a full cycle. Beginning as a small unspecialised section of the young Department of Agriculture of the nineties, there had later been established a small Branch deriving income from the industry. The Branch slowly grew in size and importance and eventually the industry was called upon to bear an increasing share of the costs, but was given a partnership with an increasing share in responsibility. Finally it has emerged as an independent institution deriving 95 per cent of its income from the industry it serves.

The time is now appropriate to examine its achievements.

For the first half of its life the Bureau was inhibited by the very serious dearth of trained personnel. This is no criticism of its administrators, because it was not until after World War I that Australian universities commenced to turn out graduates from the science faculties in any reasonable numbers. Moreover, facilities for post-graduate study were almost entirely lacking—as evidenced by the fact that in 1924 the Bureau had to seek post-graduate training abroad for its key men.

One of the Sugar Experiment Station buildings at Meringa, near Cairns, seen through tropical trees and shrubs.

During the second half of its life the sugar industry made remarkable technical and economic progress and it is generally and freely accepted that the Bureau has been the guiding spirit in these advances.

The current annual yield of sugar per acre is about 3.5 tons. With approximate annual cropping this represents a yield approaching 600 lb. of sugar per acre per month, which, in world performance, is second only to Hawaii. And it may be noted that Hawaii has all the technical advantages of the plantation system but that our crop is produced by over 8,000 relatively small farmers. Total Australian production has more than doubled since 1928.

Disease Control

In 1928 Australia was possessed of far the most comprehensive sugar cane disease collection in the world. The sugar industry, having extended from Port Macquarie to Cooktown, has covered the entire climatic range of commercial cultivation, and varieties of sugar cane, and its diseases, were early imported from all over the sugar world. Australia was in fact famous—or infamous—for this remarkable collection of diseases, and pathologists came from far and wide to study symptoms. Their visits here must, however, be regarded as at least a doubtful compliment. The picture has now completely changed; the then three most serious diseases have been eliminated as factors of importance and the whole disease situation is now under control.

It early became evident that orthodox plant pathological methods would not of themselves suffice to obtain permanently effective disease control. With the aid of the Advisory Board the industry was induced to accept what was then regarded as drastic regulatory legislation. There was also established a system of decentralised local district boards for the continuous implementation of recommended pest and disease control measures. These, coupled with an intensified cane breeding programme, have combined to bring about the present satisfactory state of affairs.

Australia also had an array of insect pests of cane, two of them being among the most serious of the sugar world. These have been brought under complete control and the Bureau now employs a staff of two entomologists largely as an insurance against possible future unforeseen developments.

Cane breeding has been intensified and, increasing rapidly from a negligible quantity, Queensland-bred canes already constitute over 80 per cent of the crop. In this work we are following the trail blazed by Farrer so many years ago. Varieties of plants which are bred and selected under local conditions are much more likely to dovetail into those local conditions than varieties imported from elsewhere. Over 30,000 new seedling varieties are raised each year and painstakingly tested against the existing commercial varieties.

The milling operation has changed from a largely traditional rule-of-thumb routine to a precise instrument-controlled technical process—based on continuing researches into methods and equipment.

So much for the origin and evolution of this science service, its record of achievement, and its acceptance as a highly important component of the sugar industry. However, before proceeding to examine the elements of a successful science service it is as well to sound some warning notes in respect of separate crop organisations. One frequently hears leaders of producers of smaller crops say "Look what sugar has done, let us do likewise".

First of all let us always remember that an agricultural industry is a complex affair. It has, amongst other things, problems of soil, climate, cultural treatment, varieties, pests, diseases, harvesting, storage, and processing. An animal industry may have an even greater range. These problems are all inter-related and usually it is not practicable to concentrate work on one or two alone—the attack must be made on a broad front. Consequently it is not feasible to operate efficiently a small separate scientific organisation; there is a certain minimum size for efficiency. Often proponents of small separate organisations controlled by industry unconsciously visualise concentrating on one or two attractive avenues of work, promising quick returns, and leaving the less promising

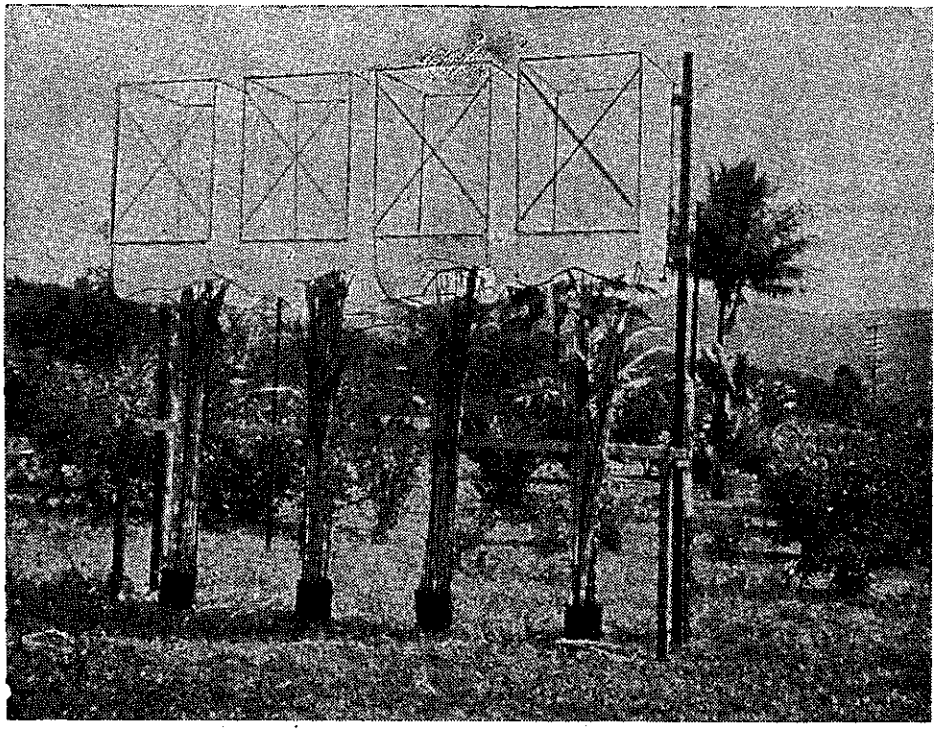
but equally necessary work to someone else. In these circumstances, however, it will not be very long before there is no "some one else" to accept responsibility for this other work.

It must also be remembered that the sugar industry is a £50,000,000 industry and so can afford a much greater expenditure on research and allied services than most industries. Moreover, its activities are confined mainly to one State and not scattered over the Commonwealth as are most primary industries. The Bureau has an administrative, clerical, research, and extension staff of over sixty but nevertheless still suffers seriously from lack of size. For example, it needs the services of specialists in such things as farm economics, principles of extension, biometrics, biochemistry, and so on. The sugar industry is large enough to employ these specialists as they become available, but how many smaller industries could?

Lesson from Sugar

The obvious lesson is that where the scope of a proposed primary industry scientific organisation is not to be quite restricted, the setting up of such an organisation should not be contemplated unless the finance is available to make it a fairly large one. It is difficult to attract scientists of good calibre to small units where there may be only one or two engaged in their particular sphere; they will feel that professional contacts and opportunities for advancement are lacking. It is also particularly difficult to attract them to an organisation centred entirely in a rural area; technologists show at least as much tendency to drift to the city as anyone else.

Although the Bureau has established an interesting and valuable evolutionary pattern, only large industries can follow that pattern in its entirety. Moreover, it must always be remembered that canegrowers for the most part grow only sugar cane, and there is thus no complicating problem of



Controlled cross-pollination of sugar cane varieties. Selected parent stalks which are flowering are placed together in muslin-covered lanterns. The ripened seed is collected and planted in glasshouses to produce new varieties.

other crops. Let us assume that soybeans become a major crop in Australia: They would not be grown on "soybean farms" but on mixed farms, and their production would be but part of the farm programme. Where would a soybean science service begin and end; would it break into soybean utilisation, animal husbandry, land utilisation, and so on, in competition with and, which is important, oft-times in contradiction of other services? Its path would certainly be strewn with difficulties, and it would scatter more difficulties in the paths of others.

There are two main components in a science service for industry, the providers and the acceptors, and both must play their part. A first-class service is of little use unless industry desires the service and is determined to use it to improve its own efficiency.

Some of you, at least, will have heard the American story of the young graduate, fresh from his University training, who joined the extension service in the Middle West. Descending upon a farmer he announced who he was and that his mission was to bring to the farmers of the county the results of scientific research so that they could become better and ever better farmers. The farmer heard him out and then said, "Son, yer wastin' yer time. I ain't farmin' half as good as I know how now".

This is not a rare attitude and in some places it may even represent the attitude of the majority. It is therefore essential that there be inculcated the basic desire for continuous improvement of standards; the urge to improvement should not wait until stark economic pressure demands it—perhaps too late. It is here that leaders of industries have a very great responsibility and it is here that the sugar industry has been very fortunate; the leaders of seventy years ago did a great deal to establish an attitude which has persisted since. Equally, of course, the rank and file have a responsibility to follow the lead given them.

Correct Attitudes

The development of correct attitudes is greatly fostered by the existence of organisations such as agricultural bureaux and junior farmers' associations. Leadership can be particularly important in uncovering the real needs of producers, for once a need is recognised the battle of extension is already nearly won. For example, a farmer might think he badly needs more mechanisation, or community-owned silos, whereas the first need may be crop diversification. Once this principle is uncovered the extension job of the agronomist is greatly simplified. Leadership, like most things, requires early training for proficiency and agricultural bureaux are important schools for such training; the State of New South Wales is to be commended not only on their establishment but on the vigour with which they have been maintained.

At the other end of the scale, I feel that some of the world's systems of commodity price support, which have been evolved in recent years, do not foster the development of desirable attitudes towards efficiency. A "cost plus" system of pricing can easily produce a "cost plus" frame of mind unless the goal of efficiency is kept always in view.

Pricing systems, too, can be important in another way. Sugar cane is bought on the basis of individual analysis of each supplier's cane and consequently there is always a powerful incentive to improve quality. This is far from being the case in all industries; indeed, some price structures favour the production of second-grade commodities. The butter industry operates under the disability that the margin for highest quality cream provides no price incentive at all. Obviously research and extension designed to improve quality can be greatly assisted, or hampered, by the price structure. Australia receives a deal of criticism of the quality of some of the goods she exports and this is criticism which we cannot afford to earn.

Contact between a science service and the industry, or industries, which it serves should be continuous and broad. The special or one-crop industry organisation such as the Bureau of Sugar Experiment Stations may have a very distinct advantage for a number of reasons:

1. An industry by contributing to, or bearing, the cost develops a sense of responsibility; something bought is always valued more highly than something donated.

2. Laboratory as well as field members of a one-crop organisation soon become personally known to the producers, with all the advantages that implies.

3. There is a fixing of responsibility on the leaders of the organisation and its component sections. It is very disconcerting to a farmer to pose a disease problem to a field man who must then refer it to a mystic Pathology Laboratory over which he has no direct influence. He cannot guarantee that the problem will be tackled or that, if tackled, it will not first have to take its place at the end of a long queue. Nobody knows who the particular pathologist will be or, later, who he was. In a specific organisation, on the other hand, the responsibility is obvious and undodgeable.

4. Few practical problems remain confined within the boundaries of a particular subject and team work is usually necessary for their proper solution. Team work is more readily obtained in a crop organisation than it is in a large departmentalised organisation.

5. There is usually a great deal more esprit de corps in a small organisation than in a large one.

The foregoing five points are all very important in the provision of a science service. However, if we accept the thesis that efficient separate crop institutes are economically feasible only with major crops, the question then arises as to whether these advantages can be fully developed in other circumstances.

I think that the answer is "yes" and that they can be, and indeed have been, achieved within large organisations by the creation of specialist teams to serve important crops. A team can be built around a nucleus of crop specialists by the attachment of other specialists from the laboratories. For example, one or two plant nutrition officers can be seconded to a potato section while still remaining on the staff of the plant nutrition laboratory, and having their work continuously guided and assessed by a highly qualified director of the laboratory. This latter is a very important aspect of science services; isolated organisations with but one or two specialists in each field suffer from lack of continuous direct professional contacts for those specialists, and from lack of supervision and guidance by "top" men.

Therefore the development of crop sections, as and when they are justified, can rapidly attain many of the advantages of the separate specialist organisations—and retain some additional advantages not available in a smaller organisation.

The establishment of an advisory board is, I am convinced after long experience, an important factor in the success of crop sections. In the hands of suitable personnel it can be a very potent force in the integration of science and the particular industry, and in generating a sense of responsible partnership on both sides. Since an advisory board is essentially a policy-making body the Departmental representatives should be quite senior technical administrators; specialists can be called for consultation as required. Industry representatives need to be chosen for their appropriate capacity, not because of any office they hold in a farmers' organisation; an advisory board will soon fail if it becomes a pressure group, or a reward for time servers, or a depository for hacks.

In 1934 we introduced into The Sugar Experiment Stations Act some revolutionary legislation on variety control which was designed to aid the pathologists in their fight against the serious array of cane diseases. This legislation has had spectacular success and any attempt to repeal it now would certainly cause a minor revolution. However, it is very doubtful if the proposals for new legislation would have been accepted if the Advisory Board, having convinced itself, had not then convinced the sugar industry that the legislation was necessary and that it would be applied with discretion. Carrying the science service to the industry is just as important as carrying the industry to the service.

Partnership

Primary industries should, I think, make a direct contribution to the cost of the science services made available to them. This is not only so in common equity but gives in-

A promising seedling cane, Q57, bred at Meringa Sugar Experiment Station, North Queensland. This variety drops its trash during growth, thus facilitating harvesting.

dustry that higher sense of partnership, and justification for a share in the shaping of policies.

Internally a science service is broadly divisible into two parts, a fact-finding part and a fact-dissemination part.

All universities now provide well-established courses for the training of personnel for the fact-finding or research activities, and procedures are clear-cut. The same cannot be said for the fact-dissemination or extension personnel. No university in Australia as yet provides any comparable

course of training in extension work and in general the only applied training available is the "in-service" training provided by Departments of Agriculture. Only one institution has, to my knowledge, carried out any serious research in Australia on the relative merits of different forms of extension in primary industry.

These are serious deficiencies which require adequate and early attention. A science service with a defective extension component is like a bird with an injured wing—it does not go high, or far, or fast.

The lack of general availability of formal training in extension principles and methods is of particular importance to small organisations. A large organisation can make do, at least to an extent, by running its own in-service extension schools; a small one obviously cannot employ the specialised staff necessary to do this.

In recent years a new concept has been given to extension and it is now realised that it must cover not only the education and persuasion of the individual, but that it must also approach the community and foster community receptivity and trains of thought.

Modern facilities such as wireless and television have greatly enlarged the scope of the extension officer and have also greatly increased the power and application of centralised extension. To-day the head office administrator and specialist can become almost as well known in a district as the local officer.

Leadership

However, it is freely conceded that whatever the forms of extension used, they are fully effective only when the industry has receptive leaders at all levels. Development of leadership must therefore be also one of the primary aims of extension. Treat five hundred farmers solely as individuals and the extension project advances only slowly. On the other hand if they are treated as a group, and group consciousness and group leadership developed, then progress is much more rapid. Individual approach is still necessary but is limited and so the time of the extension worker is conserved.

In the past the extension side has been the Cinderella of science services and it is only now emerging as a full partner of the research services. It is the duty of us all to see that this rise in status is maintained. That is not to say, of course, that every extension officer must be a high-powered graduate touched with genius. With the small-farm system to which Australia is committed, a large part of the extension must always be in demonstration, for which research-type personnel are certainly not required. No tribe can exist with all chiefs and no Indians and a squad of variable training is required in extension, as in most things. Moreover, the individual farmer is often more susceptible to approach by people who have had their hands in the tar bucket.

The extension services of the future must include research men who will thoroughly investigate methods of extension and determine methods suitable for the evaluation of the results of extension drives. At the same time I feel we should be on guard against the segregation of field extension personnel into a distinct compartment, without direct and continuous contact with the investigation services.

One great advantage of the crop organisation such as the Bureau of Sugar Experiment Stations is that the field extension officer is an active two-way medium. He transmits research and experimental findings to the farmer, but equally he presents field problems direct to the researcher—and hammers away at them. I remember clearly the rapidity with which a cheap effective field method of treating cane cuttings for sett rot was developed, mainly because the extension officers were under pressure and had a foot in both camps. This is an important factor but it is also available in a crop team set-up. The field extension officer can be personally associated with an investigation and he is all the better for spending a proportion of his time on field investigations.

Seemingly the profession of agriculture did not prove sufficiently attractive in the post-war years to compete with other professions for students and intake of the agricultural science faculties was disturbingly

low. There is some evidence of steps being taken to correct this defect and it is well that it should be so. Australia is acutely short of scientists and technicians so that competition is keen and will remain so, at least for many years; there is only one way to ensure that primary industry gets its quota.

A Complex Field

Every field of science grows daily more complex as the store of knowledge is increased. Fifty years ago, when the ceiling of scientific knowledge was much lower, it was possible for a man to start on the bottom step and work his way to the top, learning as he went. This is no longer possible and, at least for higher grades of technical work, a university training is an essential prerequisite. As fields continue to become more and more complex so will it be necessary for a greater measure of post-graduate training, with perhaps longer undergraduate courses. We must accept this and prepare for it. We can find a parallel in modern tall buildings: Years ago we had time to climb up the steps one by one; now nobody can afford to go all the way up by the steps and elevators are provided. However, it is well to remember that the final assault on the central towers is always made by climbing a staircase; education is not a complete substitute for intelligence.

Overseas experience for a proportion of the officers of a science service will also lift standards and pay good dividends. In the second part of its developmental phase the Bureau of Sugar Experiment Stations has sent some twenty men overseas, several of them more than once, and the present policy is to send one man abroad each year.

The Minister for Primary Industry has recently stated that in the year 1954-55, Australia exported goods to the value of £760,000,000, and of this no less than £700,000,000 was contributed by the export of primary products.

Australia has a vulnerable economy in that there are many essentials of modern life such as liquid fuel, rubber, chemicals, and much machinery which must be imported, and continue to be imported. But essentials or not, they can only be imported to the extent that we have the exports to pay for them. Consequently an ever-increasing flow of export produce of high quality is necessary if we are to develop, and so populate and hold, this continent.

In view of our very great dependence on primary products as a source of overseas credits, primary industries demand our very special attention. We have a number of obvious disabilities in selling on the world's competitive markets and we can only overcome these disabilities by developing efficiency of the highest order. This in turn needs adequate scientific guidance of the highest order; it is our common job to see that we have it.

Sydney: A. H. Pettifer, Government Printer—1957.