75 Years of Scientific Progress

Bureau of Sugar Experiment Stations

1900 - 1975

foreword

The Bureau of Sugar Experiment Stations has achieved 75 years of service as the principal research organization for the Queensland sugar industry. One wonders whether, when the Bureau was legislated as a statutory body in 1900, its founders could have envisaged the immense contribution that it would make to the industry.

This anniversary booklet recalls the important advances made by Bureau personnel in solving agricultural and milling problems and setting the scene for the industry's present buoyant economy.

When the Bureau was formed, the infant industry was largely incohesive, having little expertise available either to growers or millers to assist in improving production. Initially, the Bureau collected and collated background information and records and identified problems. As facilities developed, specialist staff were recruited for research and extension.

Agricultural activities were rationalized; a programme of fertilizer and cultural practices was instigated, and steps taken to reduce losses caused by the many sugar cane diseases. Entomological research was commenced, cane breeding gained new impetus and investigations began into new milling techniques. With these developments came the expansion of advisory services so that information gained from research could be disseminated and put into practice.

Today, the major insect pests have been brought under control. Many formerly serious diseases have been eliminated, and control measures for other diseases are being evolved. The plant breeders have consistently produced increasingly superior varieties and evaluated and released suitable imported canes.

Better crop nutrition, drainage and irrigation methods have been developed, and milling research has consistently made valuable contributions to the processing of the crop. A computerized farm managerial service is in the process of development.

On the world scene, the Bureau has gained an enviable reputation for the objectivity and quality of its research into sugar cane problems. Testimony to this is the constant flow of overseas workers who benefit from discussion with Bureau staff.

The Bureau looks back on its achievements with pride. Despite the many advances made, the original tenets of 1900 remain—service to the sugar industry.

To this end, work has already begun on the fifth Experiment Station, where problems that apply specifically to the "super-wet" area will be studied. Experiment Station building programmes such as this have been made possible through monies provided by the Queensland State Government. During the past three years, State Government grants to the Bureau for special research projects have totalled more than $500 000.

Improvement of sugar quality and milling techniques continues to maintain a high priority, and extension services are constantly seeking more effective methods of communicating information to the industry.

The future is as challenging as it was in 1900, and there is no doubt that the Bureau, with continuing Government and industry support, can meet each new challenge with efficiency and confidence.

Mr. Joh. Bjelke-Petersen, M.L.A., Premier of Queensland

contents

The Sugar Experiment Stations Board

Mr. V. B. Sullivan, M.L.A., Minister for Primary Industries, Chairman

Dr. J. M. Harvey, I.S.O., Under-Secretary of Department of Primary Industries, Deputy Chairman

Mr. J. T. Elliott, Canegrowers' Representative

Mr. J. H. Webster, Millowners' Representative *preface*

the bureau today

Seventy-five years ago, on 14th December, the Bureau of Sugar Experiment Stations came into existence during an era when the terms "research" and "extension" had no special meaning. Circumstance and experience have since moulded the Bureau into the balanced research-extension organization that exists today.

Important amendments to the "Sugar Experiments Stations Act 1900-1973" and a flexibility of staff deployment and responsibility have achieved the necessary balance in the overall strategies and functions of the Bureau. Today, research, advice and regulation are high on the list of priorities.

Over many decades, staff have maintained a rapport with canegrowers and millers, despite their regulatory role which may involve litigation against either group. This reciprocal confidence stems from a complete understanding of canegrowing and milling operations, a technical and practical competence and a traditional impartiality in disputes between growers and millers.

Top administration has evolved steadily. Today the Bureau is under the control of the Sugar Experiment Stations Board whose members have a vast depth of experience of the sugar industry and Government, together with the strong backing of their respective organizations. Against this background, industry and government objectives became an integral part of the Board's policies, and Bureau activities readily attune to the economic, social and political influences of the day. The integration and co-ordination of objectives within a policy framework are important assets and, among international sugar organizations, are unique to Queensland.

By statute, the Bureau is the official research-extension organization of the Queensland sugar industry. Staff are not only involved in a broad and varied programme of research and extension, but also supervise Cane Pest and Disease Control Boards, approve cane varieties for every mill area, give technical and business advice to over 7 000 canegrowers and 30 mills, interface with State and Australian Government departments, and collect and collate industry statistics.

The Board's policy is one of decentralization of resources throughout canegrowing districts of the State, and this policy is coupled with a varying measure of local autonomy. This requires a greater administrative effort to optimize and regulate services than would be possible with a centralist policy. If the Bureau's resources were brought together at one location, its resource image would indeed be impresive; but centralization would significantly diminish immediacy of services and appreciation of changing needs, from one district to another.

Some brief comment on the recent inflationary spiral is justified in the light of the Bureau's history of service at low cost. The influence of inflation on budgetary controls became evident in the fifties and is sorely felt as it accelerates into the seventies. In 1972, the State Government responded to the request of industry leaders by providing welcome relief to growing budgetary pressures through the allocation of research grants; these have progressively increased in successive years from $100 000 in 1972-73 to $286 000 in 1974-75. Such grants, totalling $572 000, are separate from the statutory annual subsidy of $14 000.

Today, the annual budget approaches $2 million. For many, it may be difficult to reconcile the sharp rise in levy paid by growers and millers equally on each tonne of cane weighed at the mill for processing with the more or less static staff position over the past three to four years. Board members, like their counterparts elsewhere, are on a financial tread mill—running at an ever-increasing financial rate yet remaining stationary in respect of available resources.

While the life blood of research institutions is finance, the corporate body of the Bureau is its staff. Attention is therefore focussed upon staff, suitably qualified and directed, who operate with a reasonable degree of local autonomy. These dedicated professionals, working side by side with sugar producers, identify and solve problems. Some degree of flexibility in the duties and location of a multi-disciplinary team is the key to success and to the confidence the industry expresses through its current level of funding. The Bureau invests heavily in staff, for it is people,

Owen W. Sturgess, Director

K. C. Leverington, Deputy Director

not institutions, who make the important decisions.

The many and varied services the industry and its organizations have come to expect from the Bureau today, and which are readily available to all sugar producers, result from distinctive staff qualities. These are generally acquired through a low-key period of in-service training, a multi-disciplinary outlook and judgment, a degree of self-reliance, great dedication, and an innate confidence in the future of the industry.

Beyond question, the gradual moulding of staff into multi-disciplinary practitioners has been a driving force, somewhat unseen, behind the industry's stability and productive capacity. The Bureau, as an indirect consequence, has become an "institution" in more ways than one. Internationally, it has commanded respect through fellowship and contributions to technology; traditionally, its integrity and confidence are beyond reproach.

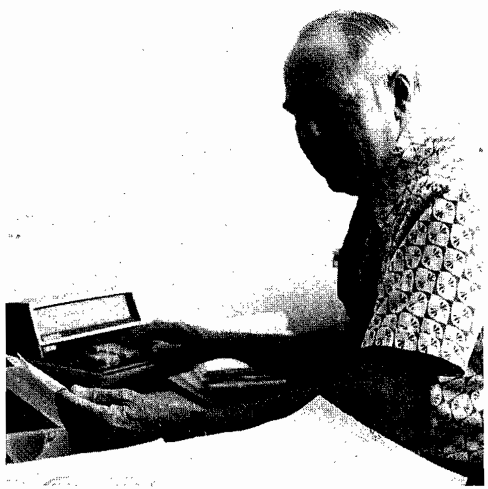
Moreover, research institutions should not stand in isolation or remote from the industries they serve. Largely by personal contact at the grass roots, Bureau staff have contrived for decades to maintain reciprocal lines of communication with sugar producers. The outflow of information is not in one direction only, for canegrowers and millers are well-organized, and transmit requests from one group to the next. Sectional groups keep their lines of communication open to the Bureau. The final link or "hot line" is through the growers' and millers' representatives on the Sugar Experiment Stations Board.

A close liaison exists between staff of the Bureau and of Cane Pest and Disease Control Boards, District Canegrowers' Executives, Mill Suppliers' Committees and mills. These relationships promote the speedy transfer of findings from the research specialists to growers and millers as well as the reverse flow of requests from canegrowing and milling groups.

By adopting this broad interface with the industry, the definition of problems bring others into focus. One recent example was the widening sphere of studies with chopper-harvested cane. The monitoring of problems, past and present, and an underlying theme of basic and applied research, are the main planks in the Bureau's platform of research and extension.

The distant rhetoric of Thomas Carlyle underlines those intangible yet essential forces which have motivated the body corporate. "What is all knowledge too but recorded experience and a product of history; of which, therefore, reasoning and belief no less than action and passion are essential elements?"

The Bureau's achievements are not to be measured by the depth of its research contributions slowly gathering dust on library shelves



C. C. Horne, Secretary

but by the extension of its research findings into industry practice. Its reward is the industry's outstanding record of sound technology and economic stability.

Only on rare occasions such as this—the 75th anniversary—might the Board state that it is justifiably proud of the contributions of its staff to the technological and economic progress of the Queensland sugar industry. Benefit accruing from these advances far outweigh the funds necessary for the Bureau's maintenance.

Finally, the staff are grateful for the confidence that the Board and industry organizations has conveyed to them over a lifetime's service. The vigorous and constant pursuit of improved technology through research and extension persists as the Bureau's primary objective.

Owen W. Sturgess,
Director

foundation of the bureau

For some time before the turn of the century, the sugar industry had agitated for the establishment by the State Government of some form of experiment stations. In 1888, witnesses at the Royal Commission into the sugar industry urged the formation of a properly-equipped and well-staffed Sugar Experiment Station, and the need for such an organization was voiced by numerous people, including the local press in various cane-producing districts. A Mackay publication, *The Sugar Journal and Tropical Cultivator*, strongly supported these suggesttions.

At the same time, the old system of large plantations or estates supplying their own mill was being superseded by a system which involved larger numbers of small farm owners who supplied cane to central mills in much the same fashion as today. Many of the older plantations were cut up and sold or leased to new growers, and new land was opened up adjacent to the Central Sugar Mills built under "The Sugar Works Guarantee Act". Such farms were limited in size so that they could be operated by one grower with a small work force. Unfortunately, many of these new growers had little or no knowledge of growing sugar cane and, since there were no properly qualified agricultural advisers to help them, they had to seek guidance from their established neighbours who were by no means experts on the subject.

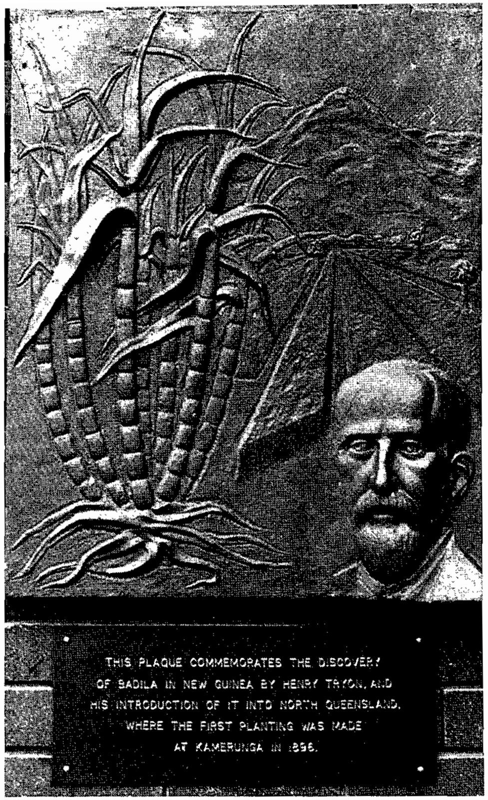
The pioneering days. An early cane planter.

Very little was known by anyone about correct farming methods for sugar cane, such as land preparation, planting, cultivation of the growing crop, ratooning and determining the correct time for harvesting; some growers estimated the ripeness of their crop by chewing. Very few growers used artificial fertilizers, because they had no way of determining what plant foods were required.

Virtually nothing was known about insect pests and their control. Grubs had caused severe losses to the industry practically since its inception, but the only method of control tried was the collection of beetles, which were paid for by the various Cane Pest Destruction Funds and Divisional Boards (the forerunners of Shire Councils). The Government provided a subsidy on a pound-for-pound basis, but these measures had little or no effect on grub populations.

Diseases were also a problem, but the cause and effect of many were not known. Gumming was certainly a problem, both in the growing crop—where it caused severe losses and death under adverse weather conditions—and in the mill—where it caused difficulties in manufacture, particularly in boiling and crystallization. Another disease frequently mentioned was rust, but whether this was true rust or another disease or pest is not known.

In spite of all these difficulties, the industry had reached the stage where it could supply the sugar requirements of the other Australian colonies and have a small surplus for export. Other countries were also increasing their sugar production and threatening the Australian market with sugar produced by cheap native labour or Government-subsidized beet industries. The realization of this situation convinced the Queensland industry that it must improve efficiency in all sections if it were to survive and compete successfully on the world market.



The first Government help came in 1887 when the Department of Agriculture recommended the establishment of Government nurseries at Kamerunga and Mackay for sugar cane and other tropical plants. The Mackay nursery was opened in 1889 and the Kamerunga nursery two years later. In 1893, the manager of Kamerunga nursery brought back several useful varieties from New Guinea. He was followed in 1895 by Mr. Henry Tryon, entomologist and pathologist in the Department of Agriculture. Tryon brought back 66 varieties, including "Badila", which later became the predominant variety in northern Queensland.

In the same year, Tryon submitted a report on his enquiries into the origin and nature of gumming disease affecting sugar cane in the Wide Bay and Burnett districts. In the concluding section of this report he made a strong plea for systematic investigations relating to sugar cane and its cultivation. He remarked on the general absence of precise information regarding the qualities of cane varieties, and all aspects of their cultivation, and submitted that this situation could be largely overcome by the institution of an efficient Sugar Experiment Station. It was suggested that such a station could be erected and equipped in the first instance by the Government, and afterwards maintained partly by contributions from the general revenue and partly by a levy on growers.

The industry continued to criticize the lack of research and experimentation at the existing State nurseries and expressed the desire to have sugar experiment stations and laboratories along the lines of some overseas countries. Such stations were already in operation in Louisiana and Java (dating from 1885) and Hawaii (1895).

In 1898, the Minister for Agriculture agreed to add a laboratory to the State Nursery at Mackay. The next year, following increased pressure, the site of the nursery was allocated to sugar experimental work only. Later that year, the sugar industry, led by the Bundaberg Planters' and Farmers' Association, approached the Government to invite Dr. Walter Maxwell, Director of the Sugar Experiment Station of the Hawaiian Sugar Planters' Association, to visit Queensland to advise on the industry here. No time was lost in making arrangements for the visit and Maxwell arrived in Queensland on 9th December 1899. He visited a number of cane-growing districts and, in January 1900, submitted a comprehensive report on the condition of the Queensland sugar industry to the Minister for Agriculture.

The report recommended that the various local associations of cane growers and manufacturers in the respective districts unite themselves into one body to be known as "The Sugar Growers' and Manufacturers' Association of Queensland". The chief function of the association would be to introduce modern scientific methods in the growing of cane and to improve the modes of manufacture. The lines upon which these reforms should be carried out were set forth in detail.

To carry out the reforms it was advised that three experiment stations be established to serve northern, central and southern districts, respectively. The main experiment station at Bundaberg would be the headquarters of the Director and house the main laboratory and chemical staff. The Director should be a highly trained scientist, a thorough agriculturalist, and be conversant with all questions of the field and mill, thus securing the absolute confidence of canegrowers and millers. It would be the Directors' responsibility to establish the said stations, appoint an assistant director on each station, and engage chemists for all laboratory requirements.

Following representations from the industry, the Queensland Government offered Maxwell the position of Director, which he accepted on a salary of £3 000 per annum and took up the post in November 1900. In December of that year, Parliament passed the Sugar Experiment Stations Act of 1900. It consisted of three pages, compared with the 100 pages of the Act and Regulations of today, but it sufficed for that time. The Bureau of Sugar Experiment Stations was established under this Act and was financed by a levy at the rate of one penny per ton of cane delivered to sugar works, half being paid by the grower and half by the miller, and the total being matched by a similar amount from the Queensland Government.

development of stations

The original concept of three experiment stations to serve the northern, central, and southern regions of Queensland was found to be inadequate to meet industry needs. The present five operational stations are well distributed to coincide both with the important producing districts of the State and with a range of climates. Four of the Stations are in the tropics, the fifth and the Pathology farm, are further south. In order of latitude the Stations are Meringa, Tully, Ayr, Mackay, Bundaberg and the Pathology Farm. The development of the network of Stations will be discussed according to their historical order.

MACKAY

The foundation of the Mackay Station preceded the passing of the original Act. It was founded at The Lagoons, on Nebo Road, as a State Nursery in 1889. In 1898, in response to industry pressure, a laboratory was added, and the following year the site was allocated fully for experimental work on sugar cane. Much of the Bureau's early field experimental work was conducted at The Lagoons, as well as virtually all the field and laboratory testing of varieties. But the 43 acres of undulating, variable alluvial soil were not ideal for experimental work, so, in the early 1930s, negotiations were finalized for a block of about 70 acres on Palms Estate near the Te Kowai siding. At the time, the soil in the block was considered to be very poor for cane, although typical of some major district soils.

The new station was ready by late 1935. The laboratory and some outbuildings were brought from The Lagoons, and two residences and a dormitory for rat studies were built. In 1938, the glasshouse for raising seedlings was erected, and it still functions. These buildings served until 1956, when a brick office and soils laboratory complex was finished. Extensions in 1971 nearly doubled the office space and added an air-conditioned laboratory and a combined conference room and library. The laboratory houses modern automated analytical equipment. Earlier, a controlled-climate insectary had been built for studies on soldier fly.

The Mackay Station has been an important centre for several fields of research. Initially, it was the headquarters for Mill Technology research, but this work was later transferred to Brisbane. In the 1930s, important research on wireworms and rats was conducted at Mackay and, more recently, detailed studies of soldier flies. A total of 13 "Q" canes has been approved in the Mackay area, including the important varieties Q50, Q63 and Q96. Q50 was the leading variety in the district for 11 years. A variety of agronomic trials has been conducted on the Station and, in recent years, it has become a major centre for plant nutritional research. In 1974, the irrigation plant was expanded to allow irrigation of all blocks and to cater for irrigation research requirements.

BUNDABERG

Although a soils laboratory and the administrative headquarters of the Experiment Stations had opened in Bundaberg in August 1901, it was not until late 1913 that the land for a district Experiment Station was acquired. In the meantime, the laboratory and office in that city had been closed in 1910, and the Bureau was without representation in the district.

The new site at Margam was a 45-acre cane farm with a large farm house, a ploughman's cottage, sheds and stables. The house was sold for removal in 1939 when a new residence was erected. The cottage still stands. The first combined office and juice laboratory, built in 1925, replaced the temporary accommodation in house and barn. Part of this building was later equipped as a soils laboratory, and considerable alterations and extensions were made in 1954 and 1966. In 1969, it became the headquarters of the Division of Mill Technology. The glasshouse erected in 1937 is still operative.

In 1972, the new two-storied office building was officially opened. The most recent addition is a complex of two controlled-climate glasshouses, an insectary and work space for Fiji disease research and resistance trials.

Shortage of water on the Station has always been a problem because of the relatively dry climate. Attempts to locate water for irrigation in the 1930s succeeded only in providing a limited supply from a shallow perched table in decomposed basalt. With improved drilling techniques, a good supply was located in 1965 at 240 feet, a depth not reached in previous drilling. This water opened the avenue for irrigation research on the Station. In 1974, a large storage dam was constructed, specifically to supply water for irrigation trials.

The original Margam property was too small for a satisfactory experiment station, even though it was nearly all excellent red basaltic loam. The Bureau was able to obtain an additional 35 acres in 1969 by purchasing the farm on the northern boundary.

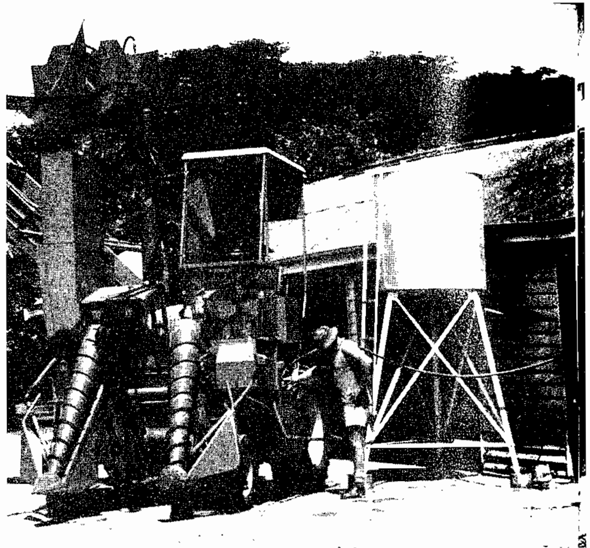
There are now 22 staff members at Bundaberg representing all Bureau Divisions. The Station was an important centre for early gumming disease trials and, more recently, research into Fiji disease and its leafhopper vector has been intensified. Control of the soldier fly pest with BHC was achieved in the late fifties. Variety selection trials have been carried out since 1930. Agronomic studies on the Station include fertilizer, trash conservation, deep ripping, irrigation and growth analysis trials.

MERINGA

In 1911, the first Bureau entomologist took up residence in Nelson (now Gordonvale) with a makeshift laboratory. The 1916 Annual Report recorded that a Bill was before Parliament for a levy to erect buildings on a new site at Meringa just north of Gordonvale. The Crown land for the site was ten acres forming part of Prison Reserve 502. The Bill was apparently not passed, but the buildings were erected anyhow.

There were three main buildings: the Entomologist's residence is still in use as principal residence; the residence for the Assistant Entomologist later became a soils laboratory and was sold for removal in 1969 to make way for the present two-storey offices; the laboratory became the ploughman's residence in 1935. It was remodelled 20 years later into the plant breeding laboratory and office. The buildings grouped across the railway line from the main road were known locally as "the grub station" in accordance with the original purpose of the Station.

At about the same time, a site at South Johnstone was acquired for plant breeding. This activity was transferred to Meringa in 1934 when about 42½ acres more Crown land were added to the original ten. A large glasshouse, a stable-barn and labourers' quarters were erected. The glasshouse was destroyed by cyclone "Agnes" in 1956 and replaced with a pre-fabricated structure. In 1958, a further 13 acres of land was purchased for expanding plant breeding activities.



Mechanical cane harvesters have been purchased for the Experiment Stations.

To cater for increased staff numbers, a single-storey brick building was erected in 1962, containing offices and a well-equipped laboratory. A two-storey brick building was added in 1969, with office accommodation and library on the top floor and workrooms and lecture theatre beneath. The two buildings are connected by a covered way. Special purpose structures include a juice laboratory, a tall controlled-climate room, a shade house for agronomy experiments and permanent cover over the cross-pollination and drying racks.

In addition to plant breeding work, Meringa is a regional centre for research staff in the fields of agronomy, entomology and mill technology and for an advisory group serving the Cairns-Babinda region. Two plaques at Meringa commemorate early scientific advances. In 1957, the Queensland Cane Growers' Council presented a plaque in recognition of the Bureau's work in controlling cane grubs. On the front wall of the new office building is a bas-relief of Henry Tryon with the famous Badila he introduced to Queensland from New Guinea in 1896.

AYR

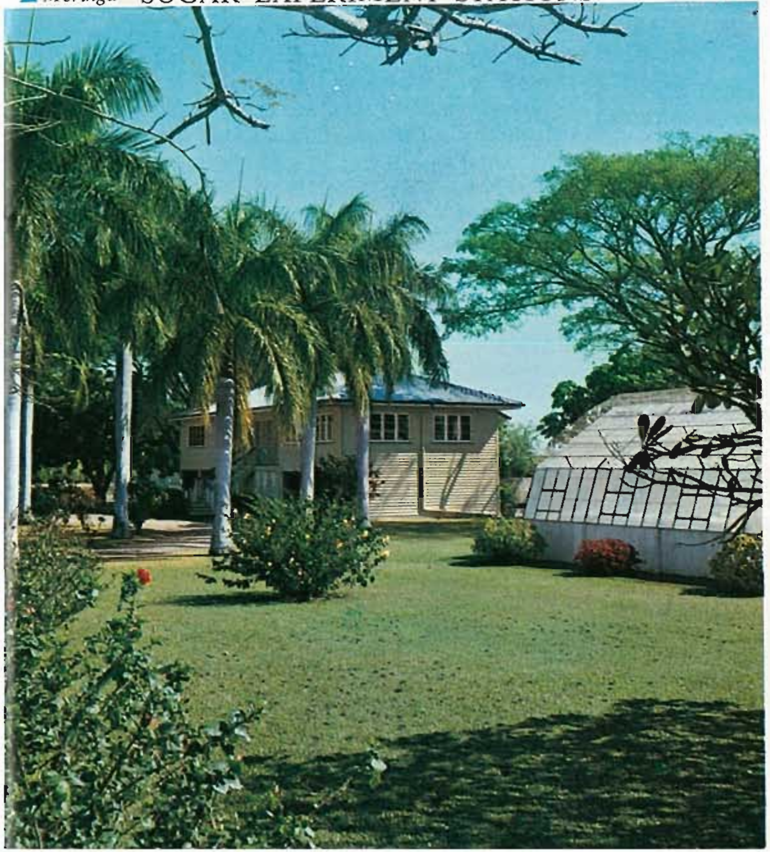
An Experiment Station for the irrigated delta lands of the Burdekin River was first advocated in 1945. A suitable site was difficult to find, but in 1948, 90 acres were purchased from Pioneer Sugar Mills Limited. The land is adjacent to the mill on the Bruce Highway some three miles north of Brandon. The site was amongst the first in the Burdekin district to grow cane in the 1880s, but, after 25 years, it was allowed to revert to cattle grazing. Although some trouble was experienced in establishing a suitable irrigation supply for the new land an excellent source was eventually obtained.

Despite post-war shortages of equipment and material, 1950 brought the first Station plantings and the creation of a residence and an implement shed. Two years later, a laboratory-office building was erected and a prefabricated glasshouse assembled for the raising of seedlings using fuzz supplied from Meringa. The Station was officially opened at a Field Day in 1954.

The original office building became inadequate for staff after the 1964 expansion, and more office space was added in 1966. The old water supply was supplemented by the installation of a turbine pump in 1969, when the underground water level dropped to a record low. This pump was connected into the existing underground reticulated mains.

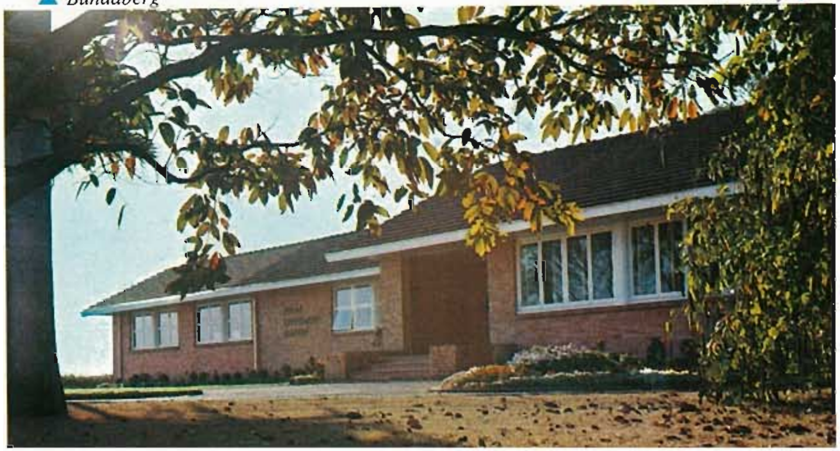
The present staff of the Station includes

▲ *Meringa* SUGAR EXPERIMENT STATIONS *Ayr* ▼



Head Office Brisbane

▲ *Bundaberg* *Mackay* ▼



Land clearing on the site of Tully Experiment Station

Laboratory and glasshouse at the Pathology Farm

members of the Advisory, Plant Breeding and Soils and Agronomy Divisions. The plant breeding programme has produced several useful varieties, including Q80 and Q85, which are important district varieties. The station was prominent in the development of control measures for ratoon stunting disease, pineapple disease and cane grubs. In agronomy studies, the value of ratoon crops to the district has been demonstrated, and the lysimeter installed in 1965 has provided useful data on irrigation requirements in the area.

PATHOLOGY FARM

When diseases were common and widespread, Bureau resistance trials were carried out on commercial farms. Research pathology was conducted in a small area excised from the public Domain in Brisbane at the back of the University. The position altered markedly following World War II; reduction in disease made trials on farms impossible, and the Domain became too small for the increased amount of experimental work.

Temporary relief was found in a short lease on the University Farm at Moggill, but this area was subject to frost and was required for University work.

The Bureau acquired its own farm in December 1951. It was a commercial small-crops farm at Eight Mile Plains about 11 miles from the centre of Brisbane. The soil on the farm is sandy and infertile, but satisfactory for crop growth with irrigation and fertilizers. The long, narrow block contains nearly 59 acres. This configuration is very useful in separating canes in propagation from disease trials and other plantings.

An old cottage, a bush-timber barn and an improvized sauna bath were the only usable buildings on the site. Improvements were slight until it was decided to make the Pathology Farm the headquarters for the Pathology Division. New buildings over the last decade include a house for the permanent farm hand, a large glasshouse, an office-laboratory and, recently, a controlled-climate glasshouse.

TULLY

This new Station in the "super-wet" zone is not yet fully developed. The site for the Station, on the Banyan Creek near Hewitt to the south of Tully, was formerly Crown land set aside as a camping and water reserve.

Although the Sugar Experiment Stations Board did not gain possession of the initial 40 hectares until November 1969, a general contour and soil survey had been carried out. Eight hectares were cleared and ready for planting in 1970.

The soils on the Station vary from loams, which were formerly covered by rainforest, to peats in a ti-tree swamp area. Drainage was initially poor, and the lower parts of the block were subject to regular inundation.

In 1973, a residence with office beneath and an implement shed were constructed and, in 1974, a further 16 hectares were cleared and planted to cane, major drainage works completed, and 15 hectares of additional land were acquired. The first agronomy trials were planted in 1974.

HEAD OFFICE

With the closure of the Bundaberg laboratory in 1910, the Bureau headquarters was transferred to Brisbane. Until 1930, soil analytical work was carried out in the Agricultural Laboratory, but in that year new administrative offices and laboratories were built for the Bureau in the main Agriculture and Stock Building. These buildings served until 1958, when the office was moved to a modern air-conditioned block on Gregory Terrace. The head office building has three stories, with two laboratories, a library and adequate office and storage space.

Head Office serves chiefly as an administrative centre. Initially, the laboratories were used by the Soils and Agronomy and Pathology Divisions, but in 1970 the Pathology Division transferred its laboratory work to the Pathology Farm. The main laboratory also contains a constant temperature room which is registered for metrology work.

Section of the chemistry laboratory, Brisbane

legislation

The Bureau could not exist, let alone operate, without the backing and compulsion of adequate legislation. The initial Act, 64 Vic. No. 17, "The Sugar Experiment Stations Act of 1900", provided for the establishment and control of sugar experiment stations. It was assented to on 14th December 1900.

The Act remained unchanged until 1923, when representatives of the canegrowers persuaded the Government to amend it to provide for the constitution of Cane Pest Boards following a request from a majority of canegrowers in a district. An assessment was to be levied equally on millowners and growers to the particular Cane Pest Board for the prevention and suppression of specified animal, bird and insect pests. This was the beginning of the present system of pest and disease control through Cane Pest and Disease Control Boards.

Meanwhile, in another Act, appeared the first indication of the limitation of varieties which a grower could plant. The Regulation of Sugar Cane Prices Act of 1915 allowed as one of four deductions in fixing a base price for cane "Varieties of sugar-cane, the growing of which has been disapproved by the Local Board with the sanction of the Central Board". This Act was amended in 1933 to force both Local Boards and the Central Board to publish each year a list of "approved" varieties which shall only contain all or any of such varieties as are set forth in the list as compiled and issued by the Director under the Sugar Experiment Stations Acts, 1900-1923.

A further eleven years elapsed before the Sugar Experiment Stations Act was again amended. In July 1933, a Sugar Advisory Committee had been set up to advise the Minister for Agriculture and Stock on the operation of the Bureau. The advice of this Committee, plus agitation from the sugar industry, led to the important amendments of 1934. They created the Sugar Experiment Stations Advisory Board, limited the amount of Government subsidy payable to a maximum in any one year of £7 000 (which still holds) and provided under certain circumstances for the making and levying of a special assessment in respect of the eradication of rats.

The Sugar Experiment Stations Advisory Board held its inaugural meeting on 13th March 1935. The Minister for Agriculture and Stock and the Director of Sugar Experiment Stations were the two Government representatives. The two representatives of the growers of sugar cane were nominated by the Queensland Cane Growers' Council—one representing mill areas north of Mackay, and the other mill areas from Mackay and south. The manufacturers of cane sugar were represented by one nominee from the Australian Sugar Producers' Association Limited, and one from the Queensland Society of Sugar Cane Technologists. The

Cane Pest and Disease Control Board employees inspecting and rogueing for Fiji Disease.

Advisory Board operated until it was replaced by the Sugar Experiment Stations Board in July 1951.

Despite the 1923 and 1934 Amendments to the Sugar Experiment Stations Act, it was largely "without teeth", and action generally had to be taken through "The Diseases in Plants Act of 1929" and amendments to that Act. So it was that in the early 1930s, Proclamation No. 14 of that Act declared nine sugar-cane quarantine districts (a tenth was cut off later) and a series of other Proclamations prohibited the movement of sugar cane into Queensland and also out of certain declared local quarantine areas.

The Sugar Experiment Station Act assumed its present general form with the major Amendment Act of 1938. The successes of the Bureau in controlling cane disease in Queensland would not have been possible without these amendments. The Amendment Act contained 28 sections, compared with the 11 of the original Act. They added 45 sections to the Act. Several of the additions had to do with such machinery matters as definitions, proclamations and regulations, and one inserted a Schedule of Sugar Cane Quarantine Districts. Most of the others were concerned with the institution on a sound basis of the approved variety system and the constitution of Cane Disease Control Boards which were to operate alongside the previously established Cane Pest Boards. A further Amendment Act in 1941 was to fuse these two types of Boards into what are now known as Cane Pest and Disease Control Boards. This same Act, incidentally, gave first official recognition to the Assistant Director (changed to Deputy Director in 1973).

Several minor amendments were made before the Amendment Act of 1951. This Act, like the original Act and the amendment Act of 1923, came about largely as a result of pressure from the industry. It should be noted that the 1938 amendments came from the administrators and not from the industry which, generally, would not be aware of the necessity for the drastic measures required to control disease.

B. T. Egan, Co-ordinator of Cane Pest and Disease Control Boards.

In 1950, sugar industry organizations expressed dissatisfaction with the lack of autonomy in the Bureau and requested that they be given control over the organization.

The concern was that, although the Government contributed little more than 10 per cent of the expenses of the Bureau, it made the final decision on expenditure from the Sugar Fund, and, in general, the Bureau was run as part of the State public service. Among other negations, the Public Service Commissioner would not permit additional remuneration to be paid to officers in key positions to retain their services.

The Government acceded to the request and, in 1951, the Sugar Experiment Stations Advisory Board was replaced by the Sugar Experiment Stations Board. This is a Crown instrumentality set up to administer "The Bureau of Sugar Experiment Stations".

The Experiment Stations Board consists of four members:

(a) The Minister for Primary Industries, *ex officio* a member and the Chairman of the Board.

(b) The Under Secretary, *ex officio* a member and deputy Chairman.

(c) A member representative of the growers of sugar cane who shall be a nominee of The Queensland Cane Growers' Council.

(d) A member representative of the manufacturers of cane sugar who shall be a nominee of The Australian Sugar Producers' Association.

It came into being on 1st July 1951 as a body corporate with power to sue and be sued and to hold title to land. All property previously acquired through the Sugar Fund was transferred into the name of the Board, the Fund was closed and the balance from it transferred to the Board's bank account. The Bureau of Sugar Experiment Stations was at last a separate entity and no longer a branch of a Government Department.

Only a few minor amendments were made until an important amendment Act was passed in 1973 when the Bureau for the first time was given direct representation on every Cane Pest and Disease Control Board.

The Fauna Conservation Act of 1974 has forced the deletion of wallabies, rats, mice, kangaroo rats, coots and sulphur-crested cockatoos from the Schedule of Pests under the Sugar Experiment Stations Act. Licences are now required for the control of these pests.

The Act will continue to be amended to fit in with changing requirements in the Sugar industry.

reproduction of original act

Queensland.

64 Vic. No. 17.

THE SUGAR EXPERIMENT STATIONS ACT OF 1900.

An Act to Provide for the Establishment and Control of Sugar Experiment Stations.

[ASSENTED TO 14TH DECEMBER, 1900.]

BE it enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Legislative Council and Legislative Assembly of Queensland in Parliament assembled, and by the authority of the same, as follows:—

Short title.

1. This Act may be cited as "*The Sugar Experiment Stations Act of* 1900."

Interpretation.

2. In this Act, unless the context otherwise indicates, the following terms have the meanings set against them respectively, that is to say—

"Minister"—The Secretary for Agriculture or other Minister of the Crown charged for the time being with the administration of this Act;

"Sugar Works"—Any mill for the extraction of sugar-cane juice;

"Sugar-cane received"—Sugar-cane delivered at a sugar works and accepted;

"Owner"—The owner, whether jointly or severally, of any sugar works, or the authorised agent of the owner, or the manager or person in charge of the works;

"Fund"—The Sugar Fund established under the provisions of this Act;

"Director"—The Director of Sugar Experiment Stations appointed under the provisions of this Act.

Power to establish Sugar Experiment Stations.

3. The Minister may from time to time establish, maintain, and manage such and so many Sugar Experiment Stations as in his opinion are necessary, and may provide and equip the same with all buildings, laboratories, machinery, instruments, apparatus, and all other matters and things necessary or proper for conducting experiments in connection with sugar-cane and sugar and the by-products thereof, and for preventing the spread of disease in cane, and otherwise for promoting the well-being of the sugar industry.

Appointment of Director and officers.

4. The Governor in Council may from time to time appoint a Director of Sugar Experiment Stations, and may out of the Fund pay to such Director such salary and allowances as he thinks fit.

The Director may, with the consent of the Minister, from time to time appoint such inspectors and other officers as may be necessary for the effectual execution of the provisions of this Act, and may out of the Fund pay to such inspectors and officers such salaries and allowances as he thinks fit.

Powers and duties of Director.

5. The Director shall have the general direction, care, and control of all such Sugar Experiment Stations.

The Director shall from time to time make or cause to be made such inquiries, researches, and investigations as are directed by the Governor in Council or the Minister, and also such other inquiries, researches, and investigations as he thinks fit in relation to any matters concerning the sugar industry.

reproduction of original act

Sugar Fund.

6. There shall be established at the Treasury a Fund, to be called "The Sugar Fund," out of which shall be paid all expenses incurred by the Governor in Council or the Minister or the Director in the execution of this Act.

All assessments levied and other moneys received under the provisions of this Act shall be paid into the Fund.

Assessment.

7. The Minister may, in each year, make and levy an assessment not exceeding one penny on every ton of sugar-cane received at a sugar works. Such assessment shall be paid to the Minister in the first instance by the owner of every sugar works upon the actual number of tons of sugar-cane received during the season with respect to which notice of assessment has been given as hereinafter provided.

But such assessment shall be paid and borne by the owner of the sugar works and the grower of the cane, respectively, in equal proportions of not exceeding one halfpenny for every ton of such sugar-cane so received.

Notice of such assessment shall be given to all owners of sugar works before the thirty-first day of May in each year, and such assessment shall be paid by them to the Minister on or before the thirty-first day of January following.

The amount of every such assessment shall be a debt due from the owner of the sugar works to the Minister, and may be recovered at the suit of the Minister or other person appointed by him in that behalf by action in any court of competent jurisdiction:

Provided that the owner of the sugar works shall be entitled to deduct from any moneys due by him to the grower of the cane the amount of such assessment payable by such grower, and such amount shall be and remain a charge upon such cane and the resulting sugar and by-products thereof, notwithstanding any change that may take place in the ownership of the same; or he may recover such amount from such grower by action in any court of competent jurisdiction.

Returns.

8. For the purpose of enabling the Minister to ascertain the amount of the assessment payable by owners of sugar works, each such owner shall once in each year furnish to the Director a return of the weight of all sugar-cane received at the sugar works whereof he is owner, and the names and addresses of the respective growers thereof. Every such return shall be certified to be correct under the hand of the owner of the sugar works.

Any officer of the Government authorised by the Director in that behalf shall be permitted at all reasonable times to examine and test any weighbridge or other weighing instrument at any sugar-mill, and to inspect the books of every such owner relating to the receipt or purchase of sugar-cane for the purpose of verifying such returns, and to make any copy or take any extract therefrom.

No such return or copy or extract from such books shall be made public without the sanction of the Governor in Council.

Endowment.

9. In every year there shall be paid by the Treasurer into the Fund from the Consolidated Revenue, which is hereby appropriated for the purpose, a sum equal to the amount of assessments levied in such year:

Provided that until the payment into the Fund of the first annual assessment to be levied under the provisions of this Act the Governor may, by warrant under his hand, authorise the Treasurer to pay into the Fund out of the Consolidated Revenue on account of the endowment to be payable under the foregoing provisions a sum sufficient for defraying the necessary expenses incurred in the execution of this Act, and credit shall be given to the Treasurer for any sum so advanced.

10. In every year the Director shall furnish a report to the Minister upon the Sugar Experiment Stations under his control, and the administration of the Fund, and generally upon the condition of the sugar industry in Queensland. Director to report annually.

Every such Report shall be laid before both Houses of Parliament.

11. The Governor in Council may from time to time make regulations for the purpose of carrying into effect the provisions of this Act. Regulations.

Such regulations may impose a penalty of not exceeding twenty pounds for any breach thereof, and all such penalties may be recovered in a summary way before any two justices.

All such regulations shall be published in the *Gazette*, and thereupon shall have the force of law. All such regulations shall also be published in one or more newspapers circulating in the districts in which an assessment is made.

All such regulations shall be laid before both Houses of Parliament not later than fourteen days after the publication thereof, if Parliament is then in session, or, if not, then not later than fourteen days after the next session of Parliament.

If either House of Parliament within the next subsequent forty days resolves that any such regulations ought to be annulled in whole or in part, such regulations or part thereof shall, after the date of such resolution, be of no effect, without prejudice to the validity of anything done in the meantime under the provisions of such regulations.

By Authority: ANTHONY JAMES CUMMING, Government Printer, Brisbane.

administration

THE SUGAR EXPERIMENT STATIONS BOARD

So that the industry could be fully represented at the policy-making level of the Bureau, an Advisory Committee of the Bureau of Sugar Experiment Stations was established. It held its first meeting on Wednesday, 24th July 1933 with the following representation—Chairman: the Minister for Agriculture and Stock; two canegrowers, one from the north and one from the south; one representative of the milling interests; one Q.S.S.C.T. member; and the Director of the Bureau.

Under the Amendment Act of 1934 the name was changed to the Advisory Board of the Bureau of Sugar Experiment Stations. This newly-named body first met on 13th March 1935. Representation on the Board was similar to that of the old Committee, and remained so until the major breakaway from Public Service control in 1951.

The amending legislation allowing this breakaway received Royal assent on 30th March 1951 and came into operation, by Proclamation, on 1st July of that year. This 1951 Amendment Act divorced the Bureau from government control and provided for future administration of the Bureau by a body known as the Sugar Experiment Stations Board. Its members were to be: the Minister for Agriculture and Stock as Chairman, the Under-Secretary for Agriculture and Stock as Deputy Chairman, a canegrowers' representative and a millowners' representative.

The original Board consisted of—

Hon. H. H. Collins, M.L.A., Minister
A. F. Bell, Under-Secretary for Agriculture and Stock
W. L. Poustie, canegrowers' representative
J. W. Inverarity, millowners' representative

The changes which have occurred on the Board since its formation are—

Chairman	
The Hon. H. H. Collins, M.L.A.	1951 to 1957
The Hon. O. O. Madsen, M.L.A.	1957 to 1963
The Hon. J. A. Row, M.L.A.	1963 to 1972
The Hon. V. B. Sullivan, M.L.A.	1972 to date
Deputy Chairman	
A. F. Bell	1951 to 1958
W. A. T. Summerville	1958 to 1964
W. J. S. Sloan	1964 to 1965
J. M. Harvey	1965 to date
Canegrowers' Member	
W. L. Poustie	1951 to 1953
L. G. Scotney	1953 to 1959
B. Foley	1959 to 1960
A. G. Mann	1960 to 1966
E. C. Row	1966 to 1972
J. T. Elliott	1972 to date
Millowners' Member	
J. W. Inverarity	1951 to 1968
J. H. Webster	1968 to date

DIRECTORS

During its first 25 years, the Bureau had four directors, and four more during its second 25 years. The eighth Director, N. J. King, was appointed in 1948, and for the next 24 years the Bureau gathered momentum and expanded its activities under a well-planned programme of service to the industry.

As Director, he represented the Bureau on two commissions of enquiry into the Queensland sugar industry, in 1950 and in 1963, and was chairman of the committee of investigation into cane analysis formed in 1958. Recognition of his expertise and impartiality in local industry matters by overseas industries led to invitations to open the South African Sugar Cane Technologists Conference in 1969, and to participate in industry enquiries in the Philippines (1956) and Puerto Rico (1970).

N. J. King's great interest in the sugar industry on both local and international planes was evidenced by his participation and leadership in the Queensland Society of Sugar Cane Technologists (President, 1953) and the International Society of Sugar Cane Technologists (General Vice-Chairman, 1956; Regional Division Vice-Chairman, 1959). Honorary life membership of both the ISSCT (1971) and QSSCT (1972) was conferred upon him for his valued services to these societies.

Perhaps the highlight of his career occurred in 1968 when he was created Officer of the Most Excellent Order of the British Empire for his contribution to the scientific advancement of the sugar industry.

The winds of change were felt towards the end of N. J. King's period with the assumption of more responsibility by O. W. Sturgess, the next director. O. W. Sturgess was well grounded for the position through his wide spectrum of activity within the Bureau prior to his appointment, having served as a research pathologist before transferring to the advisory section, where he was senior extension officer until becoming assistant to director, assistant director, then director, in 1972.

Bin-mounted weighing equipment used in association with mechanical harvesters in small experimental plots.

Information and experience gained from within the local industry and through overseas study tours provided the basis for several new concepts introduced around the time of his appointment as director. Administration underwent review and change; the advisory activities of the Bureau were restructured with the introduction of such fields as economic services, agricultural engineering and extension; and changes have occurred in research emphasis within several divisions.

BUREAU FINANCE

Although finance for the working of the Bureau has come from various sources over the years, the industry itself has made the major contribution. The milling and growing sides provide funds equally to meet a levy which is struck annually by the Board. It is interesting to note that the levy remained at one penny or less for 48 years from 1901 to 1948. This was not a reflection on the Bureau's attitude to progress and expansion but rather an indication of the lack of inflationary pressures as are known today. Several steep increases in levy over the next 17 years were generally associated with industry expansion in the early sixties, and an enlargement of staff numbers and activities in the post-war years. Since 1969, a high and increasing inflation rate has soared costs, particularly for salaries and wages, to levels almost beyond comprehension seven or eight years ago. It is with some pride that the Bureau can claim a levy rate increase much lower than the inflation rate and still maintain an expanding and viable organization. A summary of the levy rates since 1950 is given in Table 1.

In addition to the industry levy, the State Government up until 1972 provided $14 000 annually and, in 1972/73, following submissions by the Board, a special grant of $100 000 was provided for Bureau research into special projects. This was followed by further grants of $186 000 in 1973/74 and $286 000 in 1974/75, which have financed such projects as the development of the Tully Experiment Station, the provision of mechanical harvesters for Experiment Stations, study on irrigation at Ayr and in the northern areas, the design and construction of bin-mounted weighing equipment for small experimental plots, expansion in irrigation equipment on the Bundaberg and Mackay Experiment Stations, drainage trials in the far north, glasshouse construction for Fiji disease research at Bundaberg and the Pathology Farm, and in polysaccharide chemistry and continuous centrifugal investigations by the Mill Technology division.

Of additional note was the receipt of a Commonwealth Extension Services Grant totalling $94 703.96 over the period 1968 to 1972 for the specific purpose of preparing and testing a practical system of rural accounting for use in the Queensland sugar industry.

TABLE 1

Rates of assessment levied annually since 1950

Crushing season	*Assessment per ton of sugar cane*
1950	2.0 pence
1951	3.0 pence
1952	4.5 pence
1953	4.0 pence
1954	4.0 pence
1955	3.0 pence
1956	3.0 pence
1957	4.5 pence
1958	5.0 pence
1959	5.0 pence
1960	5.5 pence
1961	6.0 pence
1962	5.5 pence
1963	5.5 pence
1964	5.5 pence
1965	5.5 pence
1966	4.5 cents
1967	4.5 cents
1968	4.5 cents
1969	5.0 cents
1970	5.6 cents
1971	7.2 cents
1972	7.2 cents
1973	7.6 cents (per tonne)
1974	8.9 cents (per tonne)

BUILDING PROGRAMME

As staff numbers have increased, new research projects have been initiated and new advisory centres opened. The Bureau has maintained a healthy building programme to cater for present and, at times, for future requirements. In the past 23 years, new office-laboratory complexes have been constructed at all Experiment Stations, with the exception of Tully, for which plans are being drawn.

In addition to the new head office building opened in 1958, during the past 25 years office-laboratory facilities have been built at Ayr (1952), Mackay (1956), Meringa (1962), Pathology Farm (1970), Bundaberg (1972).

Residences were purchased at Ayr (1950 and 1964), Ingham (1953), Childers (1960), Maryborough (1964), Pathology Farm (1965), Proserpine (1966), Mossman (1967), Innisfail (1970). New glasshouses were constructed at the Pathology Farm (1965 and 1974) and Bundaberg (1974) and a climate house at Meringa (1965).

For the new Station at Tully, a residence was completed in 1973 and work is progressing on an office laboratory complex.

STAFF TRAINING

Assistance with education of staff members is an area in which the Bureau has been and remains active. Two members, Dr. J. C. Skinner and Dr. N. Berding, studied at Manchester and California Universities, respectively, on Bureau scholarships, and Miss G. J. Persley was given assistance to further her studies at East Malling Research Station, United Kingdom.

Students undertaking Bachelor, Masters and PhD degree and post-graduate courses at the University of Queensland have been granted financial assistance through scholarships, and the list of recipients below gives an indication of the interest shown by the Bureau in staff furthering their education.

University—Student Scholarships

Agriculture Bias

J. C. Skinner, D. M. Hogarth, A. MacQueen, T. D. Redhead, N. Berding, J. A. Woods, G. Kingston, P. E. Ledger, J. S. Pollock, D. R. Ridge.

Engineering Bias

L. R. Brain, A. G. Claire, C. B. Venton, N. J. Vallis, P. G. Atherton, K. W. Crouther, R. Deicke, J. D. Harland, C. B. Kelly, P. A. Miller, B. J. Rutherford, K. A. Stuart, D. B. Batstone, R. N. Johnson, R. J. McCulloch, K. J. Nix, K. J. Petersen, A. K. Rapson, A. Saranin.

Agricultural College—Student Scholarships

Present staff members—

H. L. Boyle, 1965; C. W. A. Chardon, 1965-67; E. F. Copley, 1964-66; J. A. Currie, 1964; R. J. Hampson, 1964-66; L. K. Izatt, 1964-65; J. F. Reimers, 1965-67; E. G. Spry, 1965-67; G. R. Cullen, 1968-70; J. G. Powell, 1968-69; W. A. C. Webb, 1968-69; T. G. Willcox, 1967-69.

As well as providing financial assistance direct to students, the Bureau from time to time has undertaken to support financially courses or projects being undertaken by Universities. A chemical engineering grant was made to the then University College of Townsville from 1969 to 1972 to enable Professor Richards to investigate methods of biochemical degradation of the dextran products of stale sugar cane and, from 1951 to 1963, the Board of the Bureau financed the Post Graduate course in Sugar Technology at the University of Queensland.

From 1964 to 1974, financial support was given to the Engineering Faculty of the University of Queensland so that sugar technology training be retained in the Chemical Engineering course.

The Bureau has always recognized that to keep pace with technological development a free exchange of ideas and techniques is vital both within our industry and with industry overseas. To this end, the Bureau has ensured that attendance at international conferences such as that of the I.S.S.C.T. and study tours to both sugar and non-sugar producing countries have been maintained at a high level.

The following list gives some indication of the amount of overseas contact made through such visits.

Sugar cane stockpile at mill—Sezela, South Africa, seen during XV ISSCT Congress.

1974	R. M. Bull	Papua/New Guinea	Study indigenous species cane leafhoppers and their parasites and predators.
1974	D. M. Hogarth	U.S.A. (Hawaii)	Exchange visit to assist with quantitative inheritance studies.
1974	K. C. Leverington	Russia, Canada, U.S.A. (Hawaii)	Study soils and pesticide research, trickle irrigation.
1974	L. K. Kirby	Europe, Britain and U.S.A. (Ohio, Connecticut, Iowa, Hawaii)	Discuss with manufacturers and users of equipment new developments and techniques applicable to Queensland raw sugar processing units.
1974	O. W. Sturgess P. G. Atherton	South Africa, Britain, Turkey, Europe, Mauritius, U.S.A. (California, Hawaii), Denmark, Germany.	Attend XII Session ICUMSA Conference at Ankara and XV ISSCT Conference at Durban.
1973	B. E. Hitchcock	New Zealand, U.S.A. (Hawaii, California, Philadelphia), United Kingdom, France, South Africa, Mauritius.	Inquiry into new pesticides and modern techniques of testing of biological and cultural control of pests.
1971	O. W. Sturgess J. C. Skinner P. N. Stewart	U.S.A. (Louisiana, Hawaii), Brazil, Barbados, Mexico, South Africa.	Attendance XIV ISSCT Congress.
1971	B. T. Egan	U.S.A. (Louisiana)	Attendance XIV ISSCT Congress.
1969	N. J. King	South Africa, Spain	Opening address to Congress of South African Sugar Technologists Association.
1968	K. C. Leverington	U.S.A. (Hawaii, California, North Carolina), Scotland, England, Holland, South Africa, Rhodesia, Canada.	Inspect developments in soil technology, irrigation, drainage, and crop nutrition.
1968	G. Wilson N. J. King P. G. Atherton	Taiwan, Philippines.	Attendance XIII Congress ISSCT.
1965	A. G. Clare O. W. D. Myatt N. J. King	Puerto Rico, Trinidad, U.S.A. (Louisiana, Hawaii), Barbados.	Attendance XII Congress ISSCT.
1965	O. W. Sturgess	Fiji, Jamaica, U.S.A. (Oregon, Louisiana, Hawaii).	Study of cultural management of cane crops, findings of research programmes and sources of finance for research and extension organizations.
1962	C. G. Hughes G. C. Bieske	Mauritius, South Africa, Nairobi, Madagascar.	Attendance XI Congress ISSCT.
1961	L. G. Vallance K. C. Leverington	U.S.A. (Hawaii).	Inquiry into sugar cane nutrition, fertilizer recommendations and experimental techniques.
1961	J. H. Nicklin.	Sweden, West Germany, Britain.	Study of techniques and equipment used in raw and refined sugar production.
1959	B. G. Adkins	U.S.A. (Hawaii).	Attend X Congress ISSCT.
1959	R. W. Mungomery	Taiwan, U.S.A. (Hawaii).	Study of Taiwan sugar industry and attend X Congress ISSCT.
1956	J. H. Nicklin N. J. King	India.	Attendance IX Congress ISSCT.
1955	C. G. Hughes	Canada, United Kingdom, Sweden, Holland, France, U.S.A. (Washington, New York, Florida, Louisiana, Hawaii).	Study at plant pathological centres and sugar cane experiment stations of latest techniques.
1955	J. H. Buzacott	India, South Africa, Philippines, Mauritius.	Study of modern techniques in sugar cane breeding techniques.
1954	L. R. Brain	South Africa, Mauritius.	Study milling techniques.
1953	D. R. L. Steindl	U.S.A. (California), British West Indies.	Study techniques for isolation R.S.D. virus. Attend VIII Congress ISSCT.
1953	N. J. King C. B. Venton	British West Indies, U.S.A. (Hawaii, Florida, Louisiana), South Africa, Fiji.	Attendance VIII Congress ISSCT.
1952	J. C. Skinner	U.S.A., United Kingdom.	Study of plant breeding techniques.
1951	J. H. Buzacott C. G. Hughes	Papua/New Guinea.	Collection of wild and native canes for future plant breeding.

Dr. J. C. Skinner (taking notes) with plant breeders during visit to Brazil.

The Bureau is proud to record the work carried out by staff members who have accepted positions on commissions investigating various aspects of sugar production in overseas countries. The very fact that these men have been offered these commissions emphasizes the high regard in which the Bureau is held by these countries.

The following is a list of those staff involved.

1956	N. J. King	Philippines	Advise on methods to improve productivity.
1961	B. T. Egan	Colombo	Report on diseases of sugar cane in Ceylon.
1964	C. G. Hughes	Venezuela	Report on diseases of sugar cane.
1965	C. G. Story	Malaysia	Advise on feasibility of establishing a sugar industry.
1967	J. C. Skinner	Mexico	Advise on improving plant breeding techniques
1970	N. J. King	Puerto Rico	Report on improving productivity.
1973	B. T. Egan	Argentina	Advise on diseases and cane deterioration.

CHANGES IN DIVISIONAL STRUCTURE AND ACTIVITIES

The previous publication *50 Years of Scientific Progress* details divisional and staff changes up to 1950. Since that time, marked changes have been made in the infrastructure of the Bureau, many of these being implemented in the past few years.

In 1964, the division of Entomology and Pathology was split into separate divisions following the appointment of R. W. Mungomery to the position of Assistant Director. G. Wilson assumed responsibility for Entomology and C. G. Hughes for Pathology. The vital role being played by the advisory staff was fully recognized when in 1968 a section, Advisory Services, under the control of the Chief Adviser, G. A. Christie, was created. With more emphasis being placed on the importance of economic considerations in farm decision making, the name of the division was changed in 1973 to Advisory and Economic Services.

Divisional Heads—1950-1975

Mill Technology—J. H. Nicklin (1950-1969); P. G. Atherton (1969-).

Entomology—R. W. Mungomery (1950-1964); G. Wilson (1964-1971); B. E. Hitchcock (1971-).

Pathology—R. W. Mungomery (1950-1964); C. G. Hughes (1964-).

Soils & Agronomy—L. G. Vallance (1950-1964); K. C. Leverington (1964-).

Plant Breeding—J. H. Buzacott (1950-1966); J. C. Skinner (1966-).

STAFF STRUCTURE

1950

ADMINISTRATION
Director
Assistant Director

SOILS and AGRICULTURE
Analyst (3)
Asst. Agronomist (1)

ENTOMOLOGY and PATHOLOGY
Entomologist (2)
Pathologist (2)

MILL TECHNOLOGY
Senior Technologist (1)
Mill Technologist (6)
Engineer (1)

PLANT BREEDING
Senior Plant Breeder (1)
Research Student (1)

FIELD STAFF
Senior Adviser (5)
Adviser (3)

STATIONS
Meringa, Mackay
Ayr, Bundaberg

1964

ENTOMOLOGY

PATHOLOGY

1975

ADMINISTRATION
Director
Deputy Director
Secretary
Co-ordinator C P & D C B
Accountant
Librarian

RESEARCH

AGRONOMY
Agronomist (5)

ENTOMOLOGY
Senior Entomologist (1)
Entomologist (2)
Technical Officer (1)

SOILS
Technologist (2)
Chemist (3)

PLANT BREEDING
Chief Plant Breeder (1)
Geneticist (1)
Plant Breeder (2)
Experimentalist (1)
Technical Officer (8)

MILL TECHNOLOGY
Chief Mill Technologist (1)
Technologist (8)
Metrologist (1)
Biochemist (1)

PATHOLOGY
Chief Pathologist (1)
Senior Pathologist (1)
Pathologist (3)
Experimentalist (1)
Technical Officer (1)

ADVISORY & ECONOMIC SERVICES

Co-ordinator
District Adviser (13)
Adviser (11)
Agricultural Economist (1)
Agricultural Engineer (1)
Extension Officer (2)

STATIONS

Meringa
Tully
Ayr
Mackay
Bundaberg

CENTRES

Mossman
Innisfail
Ingham
Proserpine
Childers
Maryborough
Nambour

Advisory Services—O. W. Sturgess (1968-1969); G. A. Christie (1969-1973).

Advisory & Economic Services—G. A. Christie (1973-1975); J. R. Burge (1975-).

The senior staff member of the Division of Advisory and Economic Services, the Extension Co-ordinator, now controls a wide scope of activities. An economist was appointed to the staff in 1969. His first duty was to develop a farm management accounting service for cane-growers. This was phased into commercial use in 1973. The need for improved farm drainage, irrigation, soil conservation and developments in the agricultural machinery field resulted in the addition of an agricultural engineer to the section in 1973.

Entry into new fields has not been restricted to the agricultural side, as evidenced by the appointment of a biochemist to the staff in 1974. His scope includes basic research in the field of polysaccharide chemistry and study of raw sugar quality.

The Bureau has been in the mainstream of the recent move to computerization in industrial and research organizations. Prior to 1973, use was made of commercial computer facilities to process some of the more involved trial data, and these are currently used for farm management data. In 1973, a desk computer was purchased to facilitate operations concerned with budgetary control of finances, biometrics, and checking of data for the farm management accounting scheme.

With the passing of a Bill amending the Sugar Experiment Stations Act in 1973, the Bureau gained representation on each Cane Pest and Disease Control Board. The Bureau appointee is the Co-ordinator of Cane Pest and Disease Control Boards, a new position created to provide better administrative control over Boards. The 1973 amendment was aimed at closing the technical gap between the Bureau and all Boards and ensures that the Bureau will be heard where it counts—at Board meetings.

Not only has there been entry into new fields but also withdrawal from fields which can now, after development by the Bureau, be left to commercial interests to foster: the fertilizer advisory service is an example. The former system of soil sampling and analysis for fertilizer advice has been replaced by an advisory service based on trial results and the prevailing economic conditions. Where required, soil analysis is offered to growers by fertilizer companies; and Bureau staff, apart from a watching brief, are no longer involved.

Some divisions have been reorganized as emphasis on priorities has changed, and staff numbers have increased considerably to keep pace with an increasing work-load and an encompassing of more disciplines. In 1950, total staff numbered 43, including five clerical staff and two laboratory assistants. Today, numbers have grown to 82, which includes 14 technical assistants and 20 clerical staff.

The foregoing gives an indication of the administrative changes which have occurred over the past 75 years within the Bureau. Through its realization of the need for change and by implementation of these changes, the organization has demonstrated its flexibility and the progressive attitude which has made it what it is today.

Analysing trial data by computer.

research and advisory activities

the early years

On taking up his appointment Dr. Maxwell set about correcting what he considered to be the main industry problem—impoverished soil. Although part of his original report to the Government dealt with pests and diseases no research was carried out in these important areas during his term.

As planned in the report, laboratory and administrative work was centred at Bundaberg. The existing experiment station at Mackay concentrated mainly on varietal testing and general agronomic trials. In the Bundaberg laboratory, intensive analysis of soil, water and other samples was commenced, and a peak of 13 000 analyses was reached in 1909. No time was wasted in setting out numerous field trials on the Mackay Experiment Station and on farms from Mossman to Nerang. These were concerned with "intensive cultivation" methods (which gave yields nearly double the State average), subsoiling, fertilizing, liming and green manuring, all with a commendable emphasis on the economics of the various operations.

The first two Bureau advisers, known as Agricultural Instructors, were appointed in 1912 and 1913. One advisory area extended from Rockhampton southward and the other from Proserpine northward. The Mackay region was supervised from the local Sugar Experiment Station. A survey in 1915 by these officers recorded operations on 654 farms: of these, 168 practised green manuring and 235 used fertilizers. After World War I, three officers served the whole State. Their areas extended from Ingham to Mossman; Rollingstone (just south of Ingham) to Rockhampton; and from Bundaberg south to the Queensland-New South Wales border. This situation continued until 1929, when a planned extension involving field demonstrations and farm experiments got under way.

Industry pressure led to the appointment of an entomologist in 1911 to work on the serious problem of white grub infestation of farms. He and subsequent appointees carried out meticulous studies of various insect species and their life cycles. The important publications which resulted from this work served as reference material for many years. Experimental work on the control of pests included trials with repellents, fumigants and other poisons, and attempts at biological control of the stem borer with the Tachinid fly parasite. In 1917, the division, then stationed at Meringa to concen-

Cutting green cane.

trate on grub work, had expanded to four members. A minor breakthrough in the fight against white grubs was achieved in 1923 when paradichlorbenzene was first used. This chemical was injected into the soil and became the standard commercial control measure on many grub-prone farms. The cost of this operation was high and the injection technique extremely arduous: the maximum area treated never exceeded 2 000 acres.

Although gumming disease was responsible for the demise of many canes from New Guinea and caused serious losses at Bundaberg, the importance of this and other diseases was not recognized for many years. It was not until 1924 that the first pathologist was appointed. In that and the following two years he carried out the first comprehensive survey of diseases in commercial cane crops. This formed the basis for much of the later disease control work. Following workers found the first Fiji disease in Queensland—at Maryborough and Beenleigh in 1926—and recommended that the elongated coastal strip of sugar land should be separated into quarantine districts in which only proved varieties should be grown.

Despite successful production of cane seedlings years previously by the Queensland Acclimatization Society and the Colonial Sugar Refining Company, the Bureau did not succeed in raising seedlings from local fuzz until 1921. In that year, some 736 seedlings were planted into the field on the new station at South Johnstone. During the first few years, the seedlings came from arrows naturally pollinated in the field, but a system of controlled pollination, with male arrows standing in a dilute solution of sulphurous acid, was introduced in 1926. Three well-known commercial canes—SJ2, SJ4 and SJ16—were produced during this period. The Bureau also continued to be a keen collector of overseas canes.

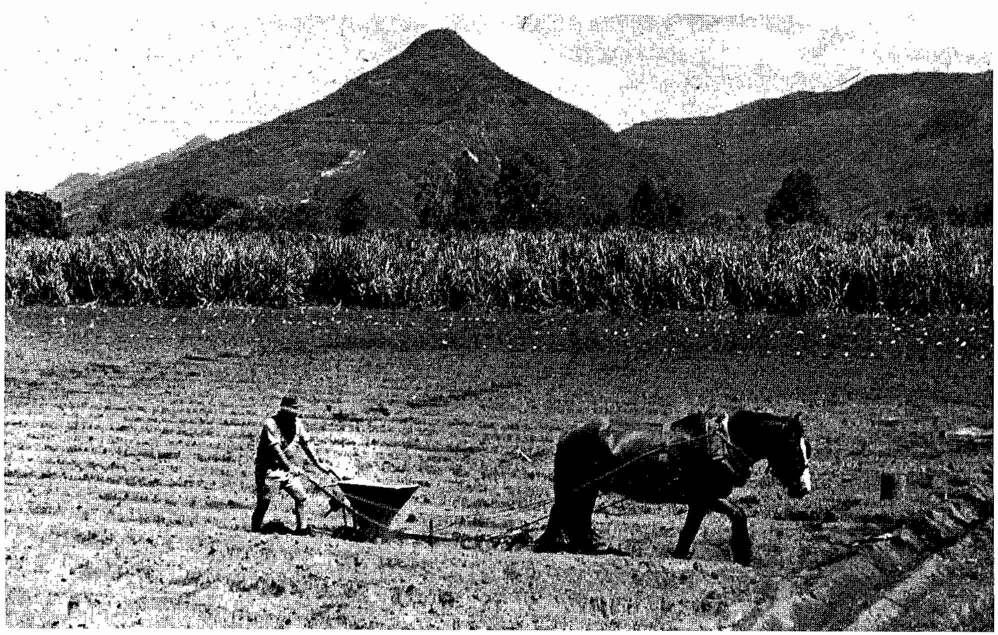
Development of the Bureau had been a gradual process, but at this stage entomology, pathology, soil science and plant breeding were established and set to mushroom into a vital service for the industry.

The Students Return

The impetus for development of this service came with the return of three scholarship holders from a period of overseas study. On their return in 1928 they took charge, respectively, of the Divisions of Soils and Agriculture, Pathology and Sugar Mill Technology. In this reorganization the heads of each division were responsible to the Director as administrative chief of the Bureau.

Soils and Agriculture was off to a sound start with a scheme of farm experimentation designed to find the fertilizer requirements of the wide range of sugar soils. The experimental plan was generally a 5 × 5 Latin Square, although there were some randomized block trials. This design was replaced in 1930 by a factorial layout (3 × 3 × 3) in which three levels of N, P and K were included. The results of these statistically-sound and markedly-refined techniques provided the basis for reliable fertilizer advice. They also gave a yardstick for evaluation of laboratory analytical methods of estimating fertilizer requirements. In 1934 it was reported that "studies of the relationship between field trial results and laboratory tests have been completed". This conclusion has remained valid since that time.

Soil and fertility surveys were initiated in 1930. These surveys helped to extend the range of soils for which fertilizer recommendations could be given, and were valuable for advice



Early method of BHC application in the cane drill during the acute fertilizer shortages of the 1939-45 War.

The advisory staff was expanded to assist with this work. Six advisory areas were defined: Mossman-Babinda, Innisfail-Ingham, Lower Burdekin, Mackay-Proserpine, Bundaberg and Maryborough-Nambour.

The embryonic Pathology Division turned its energies into many channels but, despite this dispersion, some important advances were made in the field and laboratory. Trials for testing reactions of varieties became a vital tool in the search for disease-resistant varieties. The first properly planned gumming resistance trial was planted on Bundaberg Sugar Experiment Station in 1928. Trials with leaf-scald, red-stripe, downy mildew and Fiji disease followed between 1930 and 1933. The last trial followed the discovery that Fiji disease is transmitted by cane leaf-hoppers.

The importation of varieties was stepped up to provide selection material for these trials, and two introduced varieties, POJ2878 and Co290, were important in eliminating gumming disease from southern Queensland. As a supplement to the programme of introducing resistant varieties, a clean-seed scheme was publicized and, to reinforce it, farms found disease-free in surveys were used as plant sources. Just prior to the widespread planting of gumming resistant varieties, more than 6 000 tons of clean seed had been provided in the Bundaberg area alone.

During this period, chlorotic streak was recognized in several districts, and basic studies of other diseases and allied fields were in progress. These included work on alternate hosts of gumming disease and downy mildew, top rot, a cane killing weed, *Striga*, and legume inoculation.

The new Sugar Mill Technology Division was responsible for the meeting convened in Mackay which decided to constitute the Queensland Society of Sugar Cane Technologists. After a shaky start, the Society gained status as a valuable cog in the technological machinery of the industry. It has always had the active support of the Bureau, and has provided valuable liaison between the Bureau and the cane industry. It was also responsible for the introduction of the Mutual Control Scheme which now disseminates weekly operating data between all 27 contributing mills. The first Mutual Control Synopsis was published in 1932.

Divisional work in the mills was responsible for a new scientific boiling technique to replace the old intuition and rule of thumb. The widespread adoption of the three-massecuite system was a result of Bureau recommendations. The Sugar Bureau pH meter for the continuous measurement of pH under factory conditions was also a pioneering product of the pre-war era. Another important contribution was the *Laboratory Manual for Queensland Sugar Mills*. It appeared in 1934, with a second edition in 1939. The mill technology News Letter first appeared in 1940.

Between 1925 and 1928, three new entomologists were appointed to the Division, and this led to the first major breakthrough in pest control. At Bundaberg, it was found that long ratooning contributed to the build up of cane grubs and fewer ratoons, in conjunction with use of a rotary hoe in fallow soil, reduced grub numbers. The wireworm problem at Mackay was reduced by measures such as drainage and late planting. In 1935, rat studies were begun at Mackay, and machine-packeted thallium sulphate wheat baits were introduced for rat control. In the north, beetle borers rivalled grubs in importance as a cane pest, and control was finally achieved with improved field sanitation combined with pre-harvest burning.

Although plant breeding was not given divisional status, seedling work expanded, with the production of seedlings on Mackay and Bundaberg Stations in 1930 using fuzz from South Johnstone. This coincided with the first use as parents of the newly-introduced POJ canes from Java and the Co canes from Coimbatore in India. The production of fuzz at South Johnstone was not reliable and, in 1930, plantings of parental canes were tried on a farm at Freshwater, north of Cairns. Crosses made there in 1931 proved the new site to be superior to the old, especially with regard to the reliability of arrowing. By 1935, when breeding work was transferred to Meringa Experiment Station, all crossing was being done at Freshwater.

Within the next few years, a wide range of crosses was made, a large number of parents synthesized, cold-resistant spontaneum from Turkmenistan and robustums from New Guinea were incorporated in breeding lines, the storage of fuzz from one season to another became commonplace, the solution crossing technique was standardized, and reasonably satisfactory selection techniques were developed. Many "Q" canes were in trials, but the era of important "Q" canes did not start until after World War II.

Legislative changes introduced soon after the students' return were essential to Bureau work during this period, especially in disease control. These changes were a result of behind-the-scenes pressure generated by the Bureau and others.

This section has dealt briefly with Bureau activities prior to World War II. More details of this period can be found in a previous publication, *Fifty Years of Scientific Progress*, published in 1950. Post-war work in different fields is covered in succeeding sections.

soils and agronomy

INTRODUCTION

The fertilizer advisory service established during the 1930s proved invaluable during World War II as a guide for efficient use of limited fertilizer supplies. During and after the war the service was supported by a programme of trials and fertility surveys to ensure that results remained valid with changing soil fertility. Work in other fields was not neglected, and details of important investigations during this period can be found in the previous publication in this series. Since 1950, the scope of research has broadened considerably to include such matters as trace element deficiency, chemical weed control, drainage and irrigation.

FERTILITY STUDIES

Lime Trials

Responses to lime were demonstrated in the earliest experimental work, and lime trials have been conducted intermittently until the present day. Some promising responses were obtained in trials commenced in 1946, but these were unreplicated and results were not consistent in later years. Trials conducted since 1968 have shown no consistent response to lime, despite a rise of upwards of one unit in soil pH following treatment. It appears that modern cane varieties which have been selected on acid soils will tolerate the acid conditions.

Minor Elements

Poor cane growth due to minor element deficiencies was not recognized for several years, and factors such as nematodes, insect pests and diseases were considered as possible causes of poor growth. When these factors had been eliminated, various minor element treatments were applied and, in 1948, the first response to copper was observed in a "droopy top" area. Later, this response was confirmed in a replicated trial at Mackay, and the practice of applying regular dressings of copper sulphate has since been adopted on marginal sandy soils which exhibit droopy top symptoms. Recently, modern analytical techniques were used in an endeavour to establish tissue or soil tests for copper deficiency but, because of the patchy nature of this problem, satisfactory results were not obtained.

Another prominent nutrient deficiency is responsible for so-called "orange freckling" of cane in the far northern areas. The degree of freckling depends on the variety and seasonal conditions. This problem appears to be associated with low magnesium levels in cane tissue, but no definite responses to magnesium have yet been obtained. Research on orange freckle is continuing because one of the current popular varieties in the wet belt exhibits strong symptoms and apparent yield losses.

Recent expansions onto marginal sandy areas have produced nutritional problems which may be related to minor element deficiency or toxicity. On some of these soils, spectacular responses were obtained to heavy broadcast applications of superphosphate in addition to conventional fertilizer treatments. This response is similar to that obtained in recent trials with broadcast applications of calcium metasilicate (or cement). Soils which respond to silicate

R. B. Moller, Agronomist

materials appear to fall into two groups—sandy soils low in soluble silicon, and volcanic soils having a high anion exchange capacity and strong phosphate fixation properties. Research into silicate responses is continuing, as the economics of treatment are favourable on responsive soils.

Recent Research with the Major Nutrients

Post-war soil fertility surveys in several areas showed a decline in soil fertility, which was attributed to the fertilizer shortages during the war. In particular, potash deficiency was noted, and nitrogen and potash gave greater responses than phosphorus in nutritional trials.

Between 1956 and 1961, strong emphasis was placed on potash research. Widespread responses were obtained in potash trials, particularly in ratoon crops. When the Bureau fertilizer mixtures were modified in 1962 to adjust for changing fertility and varietal requirements, a high potash mixture was introduced for use on deficient soils.

Following a study visit to Hawaii by two officers in 1961, increased emphasis was placed on the use of tissue analysis and small plot techniques in fertilizer trial work.

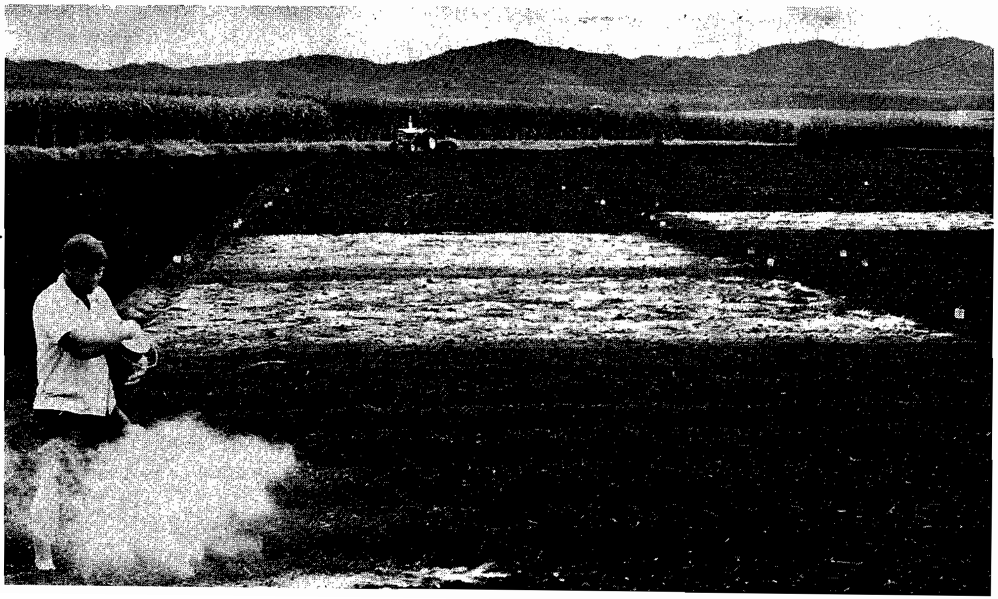
Much of the recent nutritional research has been concentrated in the Mackay area, and trial results have been subjected to detailed computer analysis. Data from phosphorus × potassium trials and nitrogen trials have been analyzed using multiple regression techniques and response curves calculated for each nutrient. An economic analysis of the responses showed that both the rate and composition of fertilizers should be modified with changes in the ratio of fertilizer costs to sugar prices. The major response is to nitrogen, a lesser response from phosphorus, and the least return from potassium fertilizer.

More recently, results from a series of 30 soil test calibration trials with various combinations of nitrogen, phosphorus and potassium have been analyzed. In these trials, factors other than soil tests were found to be most important in determining yield response. The factors include crop class, the level of available soil moisture, depth of topsoil and, for nitrogen, the size of the crop.

The decline in the value of soil tests is probably associated with the long history of fertilizer use on most farms, and it is now felt that these tests have value mainly on new land. Priorities have changed in fertilizer advisory work, and the customary free soil testing service to growers has been replaced by more accurate advice based on trial results and the current economics of fertilizer use. Calibration trials will be continued on a regular basis, and a series of soil fertility monitoring stations will be established to ensure that recommendations retain their present standard of accuracy.

In addition to fertilizer calibration trials, various new fertilizer materials such as urea, aqua ammonia, calcined iron and aluminium phosphate, biosuper and controlled release fertilizers are tested as they become available. Experiments have also been carried out to determine the optimum time of application of fertilizers, particularly nitrogen. Over the years, no advantage has been demonstrated for split applications of nitrogen over single applications. On the Mackay Station, current and past trials have been concerned with the long-term effects of nitrogen, phosphorus and potassium fertilizers. Recently, a programme of monitoring of levels of nitrate, phosphorus and potassium levels in underground waters was commenced to determine whether continued use of fertilizers is having an effect on water composition.

Establishing a field trial with calcium silicate



Agronomic Practices

Space allows mention of only a few of the numerous agronomic trials, apart from nutritional trials, carried out in the past 25 years.

Length of fallow

Long-term trials to evaluate benefits from long and short fallow periods, with grass or legumes as a fallow crop, were carried out on both the Mackay and Bundaberg Stations. While some improvements in individual crop yields were demonstrated for long fallows, the total yield for the trial period was highest in the short fallow treatments. Due to a steady increase in the proportion of the farm gross assignment harvested, a similar crop cycle experiment was established on Tully Station in 1974 to measure yields for various simulated nett harvest areas. Treatments include varying numbers of ratoon crops followed by the normal short fallow and also ploughout-replant without a fallow period.

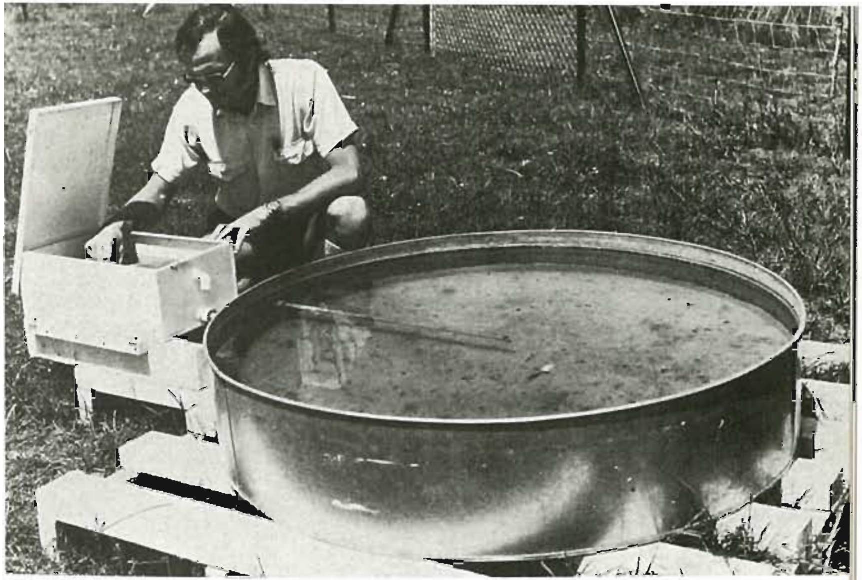
Long-Term Ratooning

A high proportion of plant cane has always been harvested in the Burdekin area because growers have felt that ratoon yields are unsatisfactory. In 1956, a long-term trial was established on the Ayr Station to compare plant and first and second ratoon yields for crops harvested in the same year. This trial continued until 1967 and demonstrated convincingly that at least two ratoon crops could be grown with a better return than plant crops alone. The increased ratio of ratoon crops to plant crops from 0.98:1 in 1956-7 to 1.60:1 in 1972-3 reflects grower acceptance of these findings.

A similar trial with four varieties on the Mackay Station, running from 1963 to 1971, compared yields for plant to sixth ratoon crops in the one year. Considerable differences in ratooning ability were noted for different varieties, but the dominant district variety, NCo310, yielded satisfactorily to the sixth ratoon.

Growth Analysis

Apart from these differences in ratooning ability, there are obvious differences in growth and maturation characteristics of different varieties. These differences are being studied in current growth analysis trials on Bundaberg, Mackay, Ayr and Tully Experiment Stations. Treatments include several times of planting and early, mid- and late-season harvesting. The trials, commenced at Bundaberg in 1970, have already shown some interesting results. To date, it is evident that late planting and late harvest both reduce yields of the subsequent crop. Time of harvest should also be adjusted to make most use of combinations of early and late maturing varieties.



Inspection of recorded readings from evaporation tank at an automated meteorological site.

Weed and Pest Control

Since the earliest trials with various chemicals (mainly arsenicals) in 1915, the Bureau has maintained a testing programme for new herbicides. There was a resurgence of interest in weedicides in 1947 when plant hormones first became available and these were tested extensively as pre-emergent and contact weedicides. One of the hormones, 2,4 dichlorophenoxyacetic acid (2,4-D), has been the most widely used herbicide since that time. Extensive testing of chemicals and other weed control measures has continued, and research findings were summarized in a special issue of the *Cane Growers' Quarterly Bulletin* in 1962.

Chemical treatment of soil was attempted to prevent restriction of cane growth by nematodes, but the treatment costs proved too high for commercial use of these control measures.

In the late fifties, the Division was involved in the initial development of control measures for soldier fly at Bundaberg, and this work was completed by the Entomology Division. The two Divisions have co-operated since then in measuring the persistence of insecticides in the field and monitoring of river waters and sugar products for possible pesticide residues.

IRRIGATION AND SOIL PHYSICS

Irrigation

Recent Bureau irrigation research has been concerned with water quality, responses to irrigation and water requirements of cane.

The water quality studies have led to the development of quality standards suitable for use in local high summer rainfall conditions and have established the levels of soil salinity which restrict cane growth.

Yield responses to irrigation have been studied at Bundaberg and Mackay. In both areas it was found that cane can be subjected to moderate stress without loss in sugar yields. These studies also established that pan evaporation

Installation of sub-surface irrigation pipes in trickle irrigation trial

has not been obtained with measures to improve inherently poor soil physical properties. Several trials have been carried out using various mill by-products such as molasses, bagasse and mill mud as soil ameliorants.

These treatments produced temporary improvements in water infiltration rates and other soil physical properties, but the effects were short-lived, and it has been difficult to demonstrate yield benefits, particularly in wet years. Chemical ameliorants such as gypsum, lime and sulphur, together with deep ripping, were included in some trials, but with limited success. In the Burdekin region, poor soil physical properties are responsible for uneven watering on some farms, and research is continuing into methods of overcoming this problem.

provides an effective means of scheduling irrigation.

The water requirements of cane were measured in a lysimeter at Ayr and in the field at Bundaberg.

Allied studies include measurements of furrow infiltration rates at Ayr and Bundaberg and the collection of data on soil water storage capacities for each irrigation district.

Irrigation provides a much-needed stabilization of yields under Queensland conditions, and research is continuing in several areas to provide basic information for design of the most economic irrigation systems and advice on watering schedules.

DRAINAGE

In the high rainfall region between Tully and Babinda, poor sugar levels in cane have always been a problem. The first attempt to identify the causes of poor c.c.s. was a detailed chemical analysis of cane leaves in 1954. Later trials showed that the shading in this area could contribute to lower c.c.s. levels. In recent years, study of this problem has been intensified, and computer analysis has been used to determine the major factors responsible for low sugar levels. One of the important factors identified was poor drainage, and a three-year study of watertable levels in relation to yields on several farms was recently completed. Waterlogging was found to play an important part in restricting yields, and it appears that general area drainage must be improved if individual farms are to benefit. Further trials to determine the potential yield response from drainage are in progress.

SOIL AMELIORATION

Although known chemical deficiencies in sugar soils can be corrected, the same success

Measuring hydraulic conductivity

disease control

INTRODUCTION

Research into disease control measures was brought to an abrupt halt by the 1939-45 war, and pathological activities were restricted to supervision of control measures for disease outbreaks. After the war, research studies and the programme of routine testing of new varieties for disease resistance were again taken up. The scope of the research work included the important virus, bacterial and fungal diseases, and limited investigation of problems such as parasitic plants, copper deficiency, and deterioration in harvested cane.

DISEASE INVESTIGATIONS

Pineapple Disease

Poor germinations due to rotting of setts by the soil fungus, *Ceratocystis paradoxa* are always likely when cane is planted during the cooler months, and serious losses occurred, particularly in the Burdekin area, before control measures were developed. With pineapple disease, the Bureau provided the fungicide for control and cane farmers developed the equipment for practical application.

Control was achieved by dipping setts in methoxy ethyl mercuric chloride solution (commonly known as "Aretan") which proved efficient in delaying entry of the fungus into setts and also stimulated germination. The practical application of seed cane treatment has gone from hand-dipping to sprays and dipping tanks on cutter planters. There has never been any difficulty in getting the idea of treatment accepted by farmers, for poor germinations in untreated areas can lead to the need for expensive and often unsatisfactory replantings.

With restrictions on the use of mercurial fungicides in other crops, alternative fungicides have been tested as they became available, and chemicals such as benomyl and thiabendazole have been found effective. These provide a more expensive alternative and lack the stimulating effect of mercurials.

Ratoon Stunting

The first record of ratoon stunting appeared in the Bureau Annual Report of 1945. The disease was recognized when the variety Q28 was introduced at Mackay, and was later identified in other districts and other varieties. Trials showed substantial yield losses due to ratoon stunting disease, particularly in conditions of drought stress. At the time, it was considered as a possible cause of "running out" of varieties.

Research findings led to the development of two avenues for control of the disease: sterilization of the knives at planting and harvest to prevent transmission, and hot water treatment of cane prior to planting to remove the disease from planting material. In the spring of 1953, the first hot-water treatment campaign was carried out in several districts. Cane is soaked for three hours at 50°C in large treatment tanks which have been established in each mill area. Several disinfectants were tried as knife sterilants, and a quaternary ammonium compound marketed under the trade name "Mirrol" became the standard knife sterilant.

C. G. Hughes, Chief Pathologist

Since the establishment of control measures, the main problem in containing the disease has been apathy towards their use.

Fiji Disease

Since 1926, when it was first recognized, Fiji disease has been present at varying levels of infection in the southern districts of the State. Complete control was apparently achieved in the Bundaberg area in the early 1950s, but the disease broke out again in 1969. The rogueing and quarantine techniques used in the past have not proved successful in containing the spread of the disease, but they have limited tonnage losses in the district. The main difference be-

tween the present and previous outbreaks is the build-up of the leafhopper vector of the disease to plague proportions.

An intensive research programme aimed at control of the vector, and development of disease-resistant varieties to replace the susceptible NCo310, is in progress. This programme includes study of population dynamics and host-parasite interaction for the leafhopper; testing of resistance of seedlings at an early stage of selection; study of the inheritance of resistance; and observation of the actual effect of the disease on different varieties.

Leaf Scald

Serious leaf-scald infection in the high sugar, high yielding variety Q63, which started in the early 1960s at Mackay and Bundaberg, sparked a wide-ranging research programme aimed at getting as much further information as possible about this old-time disease. A quick stop to commercial planting of Q63 at Bundaberg led to the apparent disappearance of the disease from the district. At Mackay, it was a different story, with Q63 giving excellent returns for more than a decade before increasingly widespread infection caused its discard. The research at the Pathology Farm and in field and laboratory has shown that

D. R. L. Steindl,
Senior Pathologist

- strains of the pathogen occur,
- at least three grasses, including the ubiquitous blady grass, may act as alternate natural hosts,
- stress in the autumn seems to be largely responsible for the widespread development of the acute stage of the disease and consequent losses, and
- setts may be rendered disease-free by a long soak in cold water followed by the standard three hours in water at 50°C. The ability of the disease to remain masked for long periods and the difficulty of relating behaviour in resistance trials to behaviour on farms has again been painfully confirmed.

Yellow Spot

The fungal, yellow-spot disease needs the right environment to develop but, when it does, losses can be severe in susceptible varieties. The 1971 epidemic provided the opportunity to estimate these, since the fungicide benomyl, could be used to give some measure of control in replicated trials. The outbreak was well documented as to varieties and areas affected using both ground and aerial surveys. In the 1971 outbreak, losses in the mills north of Townsville were estimated at over 30 000 tonnes of sugar. In the same year, Mackay and neighbouring mill areas had their first serious outbreak of the disease.

Chlorotic Streak

Extensive studies of chlorotic streak were carried out at Meringa and Brisbane in early sixties. The important findings concerned the role of water in transmitting the disease. They led to the development of an efficient transmission technique (by using waterlogged gravel) and a new understanding of the interaction of the disease and soil water in commercial fields. The recommended practice for control of chlorotic streak is to improve drainage, but yield losses can occur in spite of this in susceptible varieties in wet years, particularly in the far north.

Striate Mosaic

Like bacterial mottle, striate mosaic is apparently a Queensland-only disease. It was discovered when Pindar and Q57 showed poor growth patches on several farms in the Lower Burdekin district. The disease, named because of the very small striations which go to make up the mosaic-like pattern on the leaves, has been found in other canes on diseased farms, but has not occurred outside the Burdekin mill areas. Bureau research has established that it can be transmitted by pin-prick inoculation into the spindle, but only with difficulty, so this technique cannot be used for resistance trials. They are merely plantings on diseased farms which do, however, usually become infected in the plots of susceptible varieties. With the demise of Pindar and Q57 in the district, the disease ceased to be of commercial importance, although, behind the scenes, it does cause the discard of some promising seedlings. The work on striate mosaic rather interestingly revealed a similar disease in the variety Trojan. It has been named Trojan mottle. It could have been important had not Trojan also been abandoned as a commercial cane.

Bacterial Mottle

Bacterial mottle was named and first described in 1957, although it had been known for some years in the Ingham district under the guise of "root disease". It has recently been found at Rocky Point, but generally it is worse from Mackay north. It is found naturally on many grasses in badly-drained and flood-prone areas, where susceptible varieties of cane also get the disease. The causal agent, *Pectobacterium carotovorum* var. *graminarum,* is a soil-borne bacterium. It occurs in the diseased plants in immense numbers. The disease has not been reported from anywhere outside Queensland. Control is not difficult because there are several resistant varieties for planting in disease-prone situations.

Sclerophthora

Sclerophthora disease was first found in 1941 in a cane specimen sent from the Broadwater mill area of New South Wales, in the belief that it might be dwarf disease. It is due to a fungus which, like the causal agent of bacterial mottle, infects in wet places. It was subsequently found throughout most of the Queensland industry. In general, it has remained a disease of minor importance, although occasionally it causes fairly heavy localized infections. The disease has been found in Peru, Louisiana, Mauritius and South Africa, and some suggest that it had been around for quite a long time in each country.

OTHER RESEARCH STUDIES

Post-Harvest Deterioration

Investigation of the problem of post-harvest deterioration of chopper-harvested cane has been a joint project of the Mill Technology and Pathology Divisions. The work started in 1958, with the first appearance of the choppers. Indications were that deterioration would not be any worse than with cane sent to the mill as whole stalks. But this was a laboratory study that did not translate directly to the field. In the hot field conditions, with billets often crushed by blunt knives, cane was found to deteriorate rapidly.

The problem was approached from many angles with the full co-operation of all sections of the industry. Work ranged from counts of the spoiling *Leuconostoc* bacteria in cut billets in the laboratory to full-scale field trials, followed from burning through harvesting, transport to the mill and crushing, to crystallization of the sugars. The final solution lies in clean, sharp cutting of the billets and a minimum cutting to crushing time.

Copper Deficiency

Droopy top disease of sugar cane appeared first as a serious stunting trouble, most apparent on newly-cleared sandy country from Rocky Point to Mossman. At the time, the nutrient deficiency was not recognized as such, and the Division was handed the problem. It turned out to be acute copper deficiency, now routinely controlled by the application of about 40 kg per hectare of copper sulphate as a curative measure, and 20 kg per year as a preventative on suspect country.

Thesium Cane-Killing Weed

Cane-killing weeds of the *Striga* genus have been known in Queensland for at least 60 years, but a new one was found in 1953. It was identified as *Thesium australe* and, until this finding, had not been known as a parasite of cane or any other plant. It has never been a serious problem.

DISEASE CONTROL

A basic tenet of the Bureau's approach to control of cane diseases has always been: "Eradicate if possible, if not, eliminate commercial losses".

The policy of eradication appears to have worked in Queensland with two formerly very serious diseases of sugar cane.

Gumming disease nearly wiped out the Bundaberg industry in the 1890s, and was still serious there in the early 1930s. It seemed to crop up anywhere in Queensland where susceptible varieties were grown. It has not been seen in commercial plantings since a diseased block of SJ4 was ploughed out in Mossman in 1950 The gumming resistant trials were continued for a few years at the Pathology Farm, when all cultures of the causal bacterium were destroyed.

Downy mildew has a similar tale, and a similar hope that it too is gone. Downy mildew was one of the scourges (Fiji was the other) of the gumming resistant POJ2878, the "wonder cane" of southern Queensland. It also infected other susceptible varieties from Bundaberg to Mossman. As early as 1948, some forecasts of its possible eradication were made. A single diseased stool was rogued in 1958 at Bundaberg; none has been found since. What is hoped to be the very last downy mildew in Queensland was destroyed in 1972 when the resistance trial at the Farm was ploughed out.

Control to the point of minimal commercial loss has been achieved in several potentially disastrous diseases. Any grower who discovers pineapple disease, for instance, has failed to treat his setts effectively with mercurial. Losses from ratoon stunting are inexcusable with present knowledge. Post harvest deterioration can be minimized, provided seasonal conditions allow the necessary short delay between burning and crushing. Losses from leaf scald can be prevented—and they generally are— but, as with Q63, the benefits of a variety in the short-term sometimes outweigh the disadvantage of its susceptibility.

Fiji disease has been held in abeyance for years at a time in the various areas of southern Queensland, but at Bundaberg and now possibly at Rocky Point, it has surged back to threaten the popular NCo310. The attempts to control the disease at Bundaberg are only holding operations to keep the industry free from serious loss until NCo310 can be profitably replaced.

pest control

INTRODUCTION

During the war years, entomology work continued, although on a reduced scale. The beetle borer disappeared as a pest following the introduction of universal pre-harvest burns during the war, but grubs continued to be a major hazard to cane growing in the north. Various insecticides were screened against cane grubs, but with little success until benzene hexachloride became available in 1945. In 1946, field control of greyback grubs was achieved using BHC applied in the drill. Control of wireworms with a small amount of BHC added to the fertilizer at planting was demonstrated at Mackay in 1948.

The advent of BHC and other chlorinated hydrocarbons brought a profound change in the concepts and practice of pest control in the sugar industry. Other major changes in the practice of entomology took place between 1950 and 1975: the introduction of statistical methods in experimental procedures; the development of insect resistance to pesticides, with consequent ever-expanding research into new pesticides; the emergence of new pests, sometimes as a result of pesticide usage; and, finally, an increasing awareness of the effects on the environment of pesticides, with consequent legislative limitations on the use of persistent chemicals.

The Consolidation of Grub Control

The discovery of the efficacy of BHC for grub control in 1946 was one of the most significant events since the foundation of the Bureau, but much remained to be done before

B. E. Hitchcock, Senior Entomologist

the ravages of grubs could be alleviated in the industry generally. Firstly, the rates of BHC required to protect varying numbers of ratoons had to be determined, and this was found to vary according to whether greyback grubs or the various species of *Lepidiota* were involved. At the same time, the best method of placement in in the drill had to be determined and growers educated in the correct methods, because incorrect placement could lead not only to poor control but also to root stubbing due to the phytotoxic nature of the BHC. Later, various refined formulations came on the market. It was not until control failures had occurred that it was realized that only the crude BHC would persist and give protection to ratoon crops.

Trials in northern Queensland were conducted by entomologists, in other centres by members of the advisory staff. Of particular note were trials held at Bundaberg which showed that BHC broadcast and worked into the soil before planting would control the Childers grub, an important pest in that district. At Meringa, many new chemicals were screened against grubs and it was found that, whereas a number of the chlorinated hydrocarbons would kill greybacks, only BHC was effective against *Lepidiota* grubs. From 1969 onwards, research has been carried out on the control of *Antitrogus mussoni,* which has developed into a major pest species at Bundaberg and other southern districts.

THE POOR RATOONING PROBLEM

From about 1950 onwards, growers at Bundaberg were becoming increasingly concerned about the rising incidence of patches of ratoon failure in their fields. In 1952, a fungus, *Verticillium,* was found in association with stools that had failed to ratoon and, for a while, this was suspected as the cause of the ratoon failures, although various agronomic aspects were also investigated. At the same time, it was noted that the larvae of three insects, *Rhyparida,* margarodids and the soldier fly, *Inopus rubriceps,* were often associated with poor ratooning. In 1956, a survey showed that soldier fly larvae were present in 90 per cent of the poor ratoons examined. A trial, in which various insecticides were broadcast and worked into the soil before planting, was established in 1958. Following harvest in 1959, normal ratoons were obtained in plots treated with crude BHC, while untreated control plots remained heavily infested with soldier fly. Further trials in subsequent years showed that both BHC and dieldrin gave good control in ratoons and confirmed the status of soldier fly as a major cause of poor ratooning.

Rhyparida and margarodids both proved to be relatively restricted problems. The control of *Rhyparida* was achieved by the application of BHC in the half-open drill, or the broadcast applications used for soldier fly control, but margarodids proved resistant to all the chlorinated hydrocarbons. Their bionomics were studied for many years, and control was finally achieved by fumigation with EDB.

The elimination of crop losses from soldier fly did not follow quickly after the control methods were worked out in trials because, about the same time, there was a vast increase in the incidence of the pest. This occurred not only at Bundaberg and other southern districts, but also at Mackay. In trials at Mackay in 1965 and in 1966, it was found that in some instances crude BHC was not giving adequate control. Similar failures of control with BHC occurred subsequently on farms, so that dieldrin soon became the sole chemical used at Mackay for soldier fly control. Many Bundaberg growers persisted with BHC for soldier fly control because it also gave control of Childers grub, but, as more and more encountered control failures, virtually all growers changed to dieldrin.

In 1967, work began at Mackay on the bionomics of the soldier fly. It was found that the species common at Bundaberg, *I. rubriceps*, also occurred at Mackay, but another species, *I. flavus*, was almost equally prevalent, although it preferred the drier soils. In 1967, limited infestations of *I. rubriceps* were found at Innisfail and, in 1971, a third species of soldier fly was found on two farms in the Burdekin district. Both *I. rubriceps* and *I. flavus* have been reared from egg to adult to establish details of the life cycle.

Watering rearing jars to constant weight in soldier fly studies

CICADAS BECOME CANE PESTS

Cicadas *(Melampsalta puer)* were first found damaging ratoons in 1962 at Gordonvale. In subsequent years, they were found on various farms from Mossman to Tully, and, more recently, at Ingham. In some years, particularly at Tully, they caused extensive ratoon failure. In 1965, another species, *Parnkalla muelleri* damaged ratoons in the Burdekin, where it has been a sporadic pest ever since, causing extensive ratoon failure in 1973. Early work on the control of the *M. puer* achieved no great success, except to show that they were unaffected by chlorinated hydrocarbon pesticides. Studies since 1970 have shown that infestations are worst where heptachlor has been applied for funnel ant control. The life cycle and cultural control measures have been successfully determined. With the recent upsurge in the incidence of *P. muelleri*, this species is now receiving attention, and there is some evidence that it might be possible to control either species by means of soil fumigation.

LEAFHOPPERS AND FIJI DISEASE

In 1933, the leafhopper *Perkinsiella saccharicida* was found to be the vector of Fiji disease. From 1960 onwards, there was a great upsurge in numbers of the leafhopper in the Bundaberg district, with an accompanying expansion in the incidence of Fiji disease. Extensive studies on the ecology of the leafhopper were begun in 1971 with the objective of determining the reasons for its vast increase in numbers and, hopefully, means to reduce the population and thus the spread of Fiji disease. It has been shown that the variety NCo310, which is widely grown at Bundaberg, is much more favourable to hopper breeding than many other varieties, and this may be a major reason for hopper increase. Indigenous parasites and predators of *P. saccharicida*, propagate too slowly to prevent the usual summer population explosion of the leafhopper. In 1974, a survey of the parasites and predators of *Perkinsiella* in Papua-New Guinea was conducted with the ultimate objective of importing promising species. In the meantime, the artificial propagation of *Tytthus* egg predators is being investigated, and varieties unfavourable to hopper breeding will be favoured in selecting canes at Bundaberg.

MODERNIZING RAT CONTROL

The appointment of a zoologist to Meringa in 1968 marked the initiation of the first worthwhile studies on rats since before the war. Fundamental ecological and biological studies were begun on *Rattus conatus* and *Melomys littoralis* and cage and field evaluations of new attractants, poisons and bait formulations. From studies of aerial baiting, which had been the practice at Ingham since 1965, it was concluded that the standard techniques of trapping, tagging and release were inadequate as a measure of rat activity. Consequently, the current method of stalk counts was introduced. This has proved highly successful in subsequent trials.

milling research

P. G. Atherton, Chief Mill Technologist

Investigations into sugar manufacture lapsed completely during the war years, due to lack of staff. By 1950, staff members had increased to nine, and investigational work was again in full swing. Divisional responsibilities since then have been divided between advisory work and research projects. The latter have been concerned with improving the efficiency of different stages of the milling process, utilization of by-products, and loss of sugar due to bacterial action.

DETERIORATION OF SUGAR

One of the first major projects in the early 1950s was research into the deterioration of bagged sugar, prior to refining. An extensive study was carried out in several mill areas, frequently in collaboration with other research organizations. As is now a well-established practice, the solution lay in adequate drying of sugar at the mills.

In the late 1960s, tests were carried out on the dryer stations at several mills, and the question of using fluidized bed techniques for drying was considered. To investigate this new approach, a pilot scale unit was constructed and tested, but flow problems with sticky sugar proved to be a major source of difficulty. Development of this technique is continuing.

CLARIFICATION

The clarification process received considerable attention as new clarifying agents became available for testing. The first of these was magnesium oxide, which proved effective—but expensive. A co-operative study of bentonite with the Sugar Research Institute showed that this material produced no significant benefits.

During the early 1950s, synthetic polyelectrolytes became available for use as flocculating agents, and tests were carried out on such materials as Krilium and Lytron. Reaction to these early clarifier additives was lukewarm, and gave little indication of the extensive use to which they would be put in later years. Parallel tests with soda ash partially replacing lime did not show the benefits claimed of reduced scaling and improved boiling characteristics.

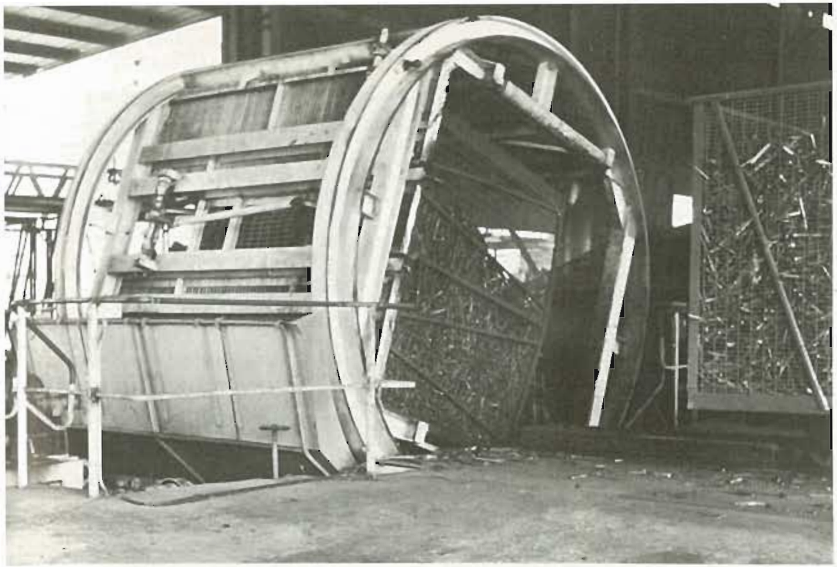
An allied project of particular interest was the checking of subsider residence time using a radioactive isotope. In conjunction with the Atomic Energy Commission, testing was carried out on a Bach subsider using bromine 82, a short-lived isotope. The results showed that considerable mixing occurred in the unit because juice containing isotope appeared in the overflows after only five or ten minutes, when the subsider had a theoretical residence time of one and a half hours.

The clarification studies lapsed until the latter half of the 1960s, when an investigation was carried out into mud concentrations and mud profiles within subsiders. These studies gave more detailed knowledge of flow patterns, and the effectiveness of deflector baffles was investigated. Tests were also made to compare the capacity and performance of commercial subsiders under operating conditions. Further investigation into subsider flow patterns was carried out using a model clarifier constructed for this purpose. The glass-sided unit was fitted with a feed well and mud rakes and enabled demonstration of many of the flow characteristics of factory units.

An investigation was also undertaken to evaluate the "cold" clarification process under Queensland conditions, but it was found that any potential gains would be more than offset by the considerable increases in the chemical costs.

CRYSTALLIZERS AND EVAPORATORS

The subject of heat transfer in crystallizers, which has been a continuing project of mill investigators over many years, was taken up again in the early fifties with the testing of different factory units. These and allied studies of circulation and steam distribution are a continuing project.



Chopped cane emptying from tippler

Evaporator tests were undertaken to investigate vapour bleeding, and the effect of superheat in exhaust steam fed to number one effet. The effect of superheat was found to be very small up to values of 80°F. but above this, a reduction in overall coefficient of heat transfer was recorded. The heat transfer coefficient found in this vessel under normal conditions was generally satisfactory, but there was considerable variation between mills.

To carry out controlled experiments on heat transfer coefficients in evaporator tubes, a single tube pilot plant was constructed and installed at Bundaberg. This plant gave heat transfer coefficients of the same magnitude as in mill tests, and proved to be a useful unit. In the late sixties, comparative tests were carried out with clean brass and stainless steel tubes containing scale.

Entrainment testing was done in several mills to check the efficiency of various types of separators. It was found that, where sufficient headroom is available, the best and simplest first step towards effective entrainment prevention is the installation of half-plate baffles in the body of the vessel.

FILTRATION

Research on filtration has to some extent parallel clarification studies. Clarifying chemicals such as magnesia, polyelectrolytes and lime have also been tested to determine whether they improve the filtration properties of mud.

In the early sixties, a new type of rotary filter, a cloth belt filter, was compared in performance with the commonly-used rotary screen filter. The results of the trials confirmed the higher retentions expected from this unit. Later in the decade, the operation of a newly-introduced solid bowl decanter centrifuge for the treatment of primary mud was investigated. The work was carried out in collaboration with the manufacturer. Results of the series of trials showed that acceptable performance, both for pol recovery and retention can be achieved. The unit has several advantages over rotary filters, including the need for less ancillary equipment, and ease of operation. An economic evaluation, based on machine capacity and cost, is in progress.

MILLING INVESTIGATIONS

From 1950 onwards, various milling studies were undertaken, including tests on the new crusher-feeder and number one mill at Babinda, and milling train tests at Pleystowe. The latter work was in collaboration with staff of Sugar Research and included testing of the new S.R.I. designed wet disintegrator for bagasse analysis. This apparatus, with very little modification, has become standard equipment for the analysis of cane and bagasse.

Recent studies include a series of load determinations on knife and shredder installations. These have given valuable information on the power required for cane preparation.

BY-PRODUCT UTILIZATION

Early investigations on by-products were concerned with the extraction of wax from cane mud, and a pilot plant was installed at Bundaberg for this work. Testing also began on the use of bagasse and molasses mixtures for stock-feeding, in co-operation with the Department of Agriculture and Stock and some private companies.

Later, a detailed investigation into the production of paper and hardboard from bagasse concluded that paper production carried no technical difficulties and it was purely a matter of economics. The hardboard project was carried forward to the production of some test hardboards, in collaboration with a chemical company. The boards produced were of high quality, and, as with paper, the question boiled down to one of economics.

Following an inspection in 1968 of the by-product industry of Taiwan by the present

Chief Mill Technologist, interest was renewed in the possibility of using bagasse for the production of paper pulp or hardboard. Subsequently, a cost survey and studies of bagasse storage and transport problems were carried out. A seminar convened in Mackay in 1970 gave rise to consideration of that centre for a paper pulp industry. The Bureau has been active in feasibility studies for this industry.

CONDENSERS

As with other mill units, condensers receive intermittent attention as problems arise. In the early fifties, a new rain type condenser installed at Fairymead, which operated at a much lower temperature than the tray-type unit, was investigated. This type of unit was reintroduced in the late 1960s, and is now almost exclusively installed in new condensers. At this time, comparative tests in the factory confirmed the superiority of the rain type condenser over the tray type. Tests under controlled conditions were also carried out using a model installed in parallel with a commercial condenser in a northern mill.

Work with the model showed that altering the size of holes in the sieve tray caused no significant change in performance, and that most condensation occurs near the outer wall of the unit.

CENTRIFUGALS

Continuous low grade centrifugals were introduced into the industry before 1960 and 1965. The original machines tested by the Bureau were found to have approximately twice the capacity of their batch counterparts, were cheaper to buy, and had a much steadier electrical load.

These tests were resumed later with comparisons of the performance of different types of machines. It became obvious that feeding arrangements played a big part in machine capacity and performance. Feed bell wear in centre-feed machines was also shown to have a very adverse effect on capacity, for the uneven gauze loading restricted the amount of massecuite that could be effectively handled. A study of feeding characteristics resulted in the design of a feed probe to stabilize the feed stream. This probe enabled a large increase in capacity in the BMA K1000 machine. A study of the effectiveness of the vertical gauze section in the bottom of these BMA machines led to the fitting of a similar system to Roberts machines. This led to increased capacity, coupled with good performance.

Investigations were also carried out into the performance of a new Italian centrifugal. A technique employed for the first time on centrifugal work was the use of an ultra-high speed movie camera, which enabled detailed studies of feeding and massecuite flow problems.

STEAM STUDIES

The first turbine mill drive in a Queensland factory was installed in the early 1950s. Water and/or impurities in the steam supply soon caused problems, and these highlighted the need for clean superheated steam for turbines and for adequate boiler feedwater control systems.

High speed cine photography of a centrifugal

Both aspects have received attention with the testing of conductivity meters for detecting contamination of feedwater and studies of steam utilization. Recently, a combined project with Sugar Research and IBM on steam demand and heat utilization was commenced. This involves computer modelling of sugar factory operations.

CANE ANALYSIS

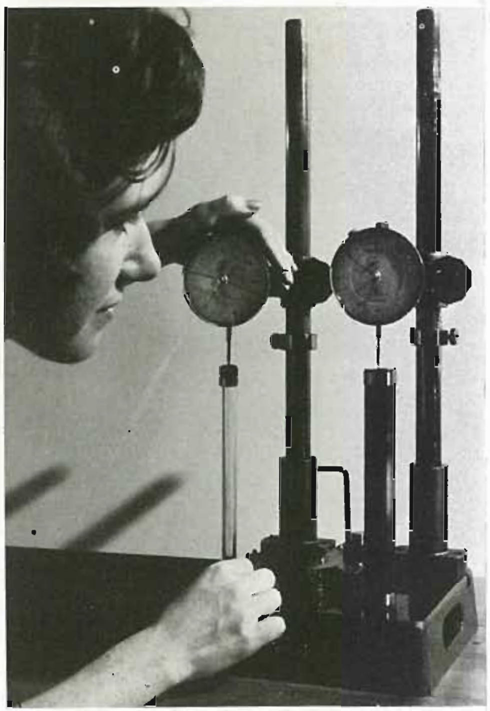
In the late fifties, the subject of cane payment was coming into prominence, and several mills installed juice scales for factory control. An investigation into cane payment was requested, and, initially, a committee consisting of staff of the Bureau and the Central Sugar Cane Prices Board was formed to consider the matter. Later, a Ministerial Committee was formed, and the Bureau was heavily committed to the ensuing investigations.

Fields of work included juice scale control of sugar mills, sampling of prepared cane and direct analysis using the wet distintegrator, the weighing of bagasse, the use of a hydraulic press for cane analysis, the introduction of the cutter grinder for preparation of samples, and others. This investigation gave staff excellent experience in this most exacting field, but it had the detrimental effect of removing them from the everyday working of the industry. No action was taken on the matter after the final report, and the status quo was maintained on cane payments.

In the latter half of the 1960s work on rapid methods for fibre determination in seedling canes and participation in a programme for the direct analysis of canes was undertaken at a northern mill. In this latter project, the sampling of prepared cane was the major hurdle to be overcome. A Bureau suggestion for a moving chute under the rotating sub-sampling table helped solve the problem.

DETERIORATION OF CHOPPED CANE

With the move to chopper harvesters, deterioration of chopped cane became a problem, and co-operative studies were carried out with Bureau pathologists. In the late sixties, an extensive series of tests was carried out at a southern mill to compare the deterioration of chopped and whole stalk cane. The accelerated deterioration rate of chopped cane, and the consequent fall off in all aspects of juice quality, was convincingly demonstrated. Similar studies were later carried out at a Mackay mill, resulting in major improvements to its harvesting and transport arrangements to minimize deterioration. A recent study of cane quality throughout the industry illustrated the need for adequate control of burning, harvesting and cane transport, if sugar of an acceptable standard is to be produced.



Checking the length of a saccharimeter tube with a dual comparator

ADVISORY SERVICES

Apart from the major projects, advisory work has covered almost every section of the industry, including electricity generation and distribution, boiler testing and evaluation, effet capacity testing, sugar quality problems, and many other fields.

The Metrology Section has continued to serve the industry in standardizing factory analytical equipment. Mutual Control figures, Plant Data and Mill Statistics have been produced and Newsletters concerning items of interest circulated. Two revisions of the *Laboratory Manual for Queensland Sugar Mills* were published.

The statistics collected for the past 25 years show an enormous increase in output by the Queensland sugar industry. Sugar production has increased from some 600 000 tonnes to more than two million tonnes, with increases in average crushing rates by mills from 70 tonnes per hour to over 220 tonnes per hour to cope with the expanded production. The increased crushing rates were initially accompanied by a fall in extraction percentages, but these were restored by increases in factory plant and improved milling and cane preparation techniques. The present efficiency of about 88 is very creditable.

varietal production

Since the war, Bureau plant breeding has advanced both in methodology and in the output of commercial canes. The proven cross system has given a gradual improvement in the quality of seedlings, methods of selection have been refined, and the end product, the "Q" cane, now provides some 60 per cent of the Queensland crop.

Q CANES

Varieties produced by the Bureau receive a "Q" number, whereas those produced in Queensland by CSR Limited receive names from classical mythology. The most successful of these varieties are Trojan and Pindar.

By 1950, 54 canes had received "Q" numbers, of which only 14 were grown commercially. The most notable of these was Q50, which first produced over one million tonnes of cane in the 1950 crop, and continued above this level until 1964. From 1951 to 1975, 47 new Q varieties were produced, and all except one (the fodder cane Q60) were grown commercially. Of these varieties, over one million tonnes of cane per year have been produced by Q57, Q58, Q63, Q68, Q80, Q83 and Q90.

Queensland varieties (Bureau plus CSR Limited) produced only 20 per cent of the crop in 1940, rising substantially to 64 per cent in 1950, reaching a peak of 84 per cent in 1961, but declining to 70 per cent in 1973. This decline was due to the South African variety NCo310, which was introduced in 1951 and became the main variety in Queensland by 1966. It is dominant in southern and central Queensland, but Q varieties have continued to increase in importance further north. The increases have been largely at the expense of Trojan in the Lower Burdekin and Pindar in the wetter regions of the north. The contribution of Bureau varieties increased from 32 per cent in 1950 to 61 per cent in 1973. Considerable progress is still being made, but new varieties, such as Q90 in northern Queensland, are mainly replacing older Bureau varieties. With additional requirements for leaf-scald resistance in central Queensland and Fiji resistance in southern Queensland it may be sometime before NCo310 can be replaced in these areas.

Dr. J. C. Skinner, Chief Plant Breeder

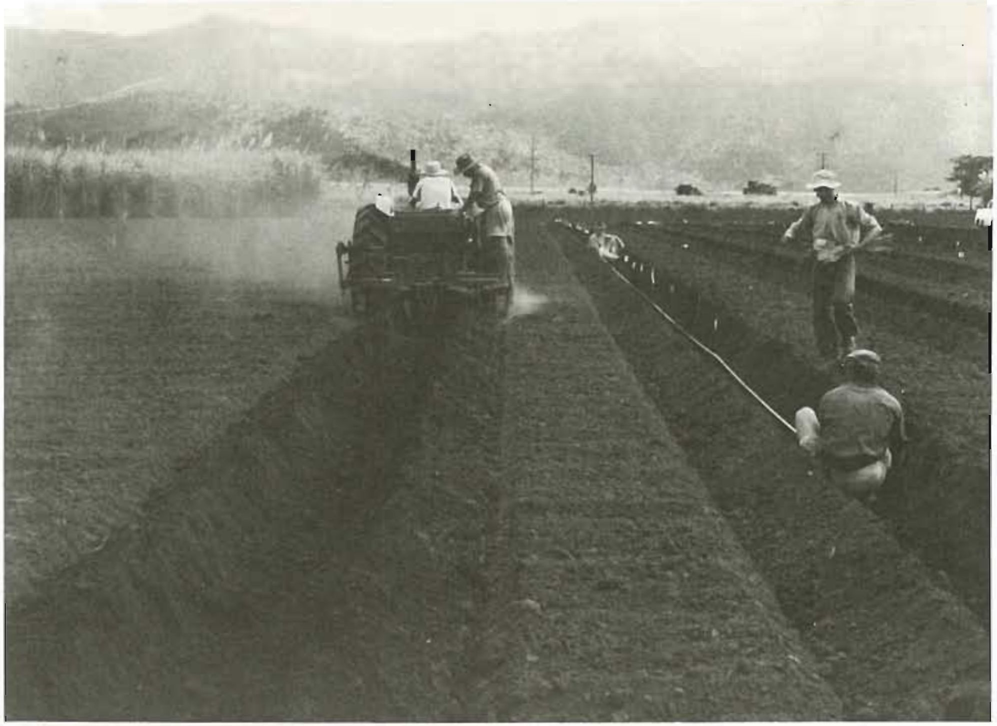
SELECTION

An intensification of research into variety selection and other aspects of plant breeding followed World War II. The selection procedure was already organized and effective, but it still involved some arbitrary decisions.

These were largely eliminated by the development of a grading system to evaluate varieties at all stages of selections. The scale finally adopted (one very poor to 20 excellent with the standard variety 10) was the same as that used previously for 40-sett plots, but otherwise the system was changed. The new grading system is subjective, with the emphasis given to each character dependent on its economic importance, the extent to which it is influenced by heredity and environment in small plots, and the extent to which it is correlated with other characters.

Following theoretical studies of the influence of heredity and environment on performance of sugar cane seedlings, experiments showed that more original seedlings should be selected. The best two per cent are now planted in 30-sett plots (comparable with the previous 40-sett plots) and 10 to 20 per cent more are planted in a new 4-sett plot stage, selections from the 4-sett plots being planted in 30-sett plots the following year.

A study of competition and gains from selection resulted in the use of smaller 3-row plots for replicated variety trials. Starting in 1955, the last two stages of selection on the experiment stations (unreplicated 0.01 hectare plots and five replications of 0.02 hectare plots) were



Drilling, fertilizing and measuring a varietal trial site

replaced by a single stage using two or three replicates of 0.004 hectare plots. This enabled testing of about 30 times as many varieties in replicated trials, the number of Meringa rising from four in 1954 to a peak of 219 in 1968.

The Hawaiian system of bunch planting of original seedlings was found to be effective, but inferior to the Bureau system of single planting, which continues as the standard method. The exception is the Ayr Station, where bunch planting, combined with very liberal selection, fits in better with local irrigated conditions. Bunch planting is also used at Meringa for crosses involving wild canes.

It has been found beneficial to repeat borderline varieties from the 4-sett and 30-sett plots in these stages.

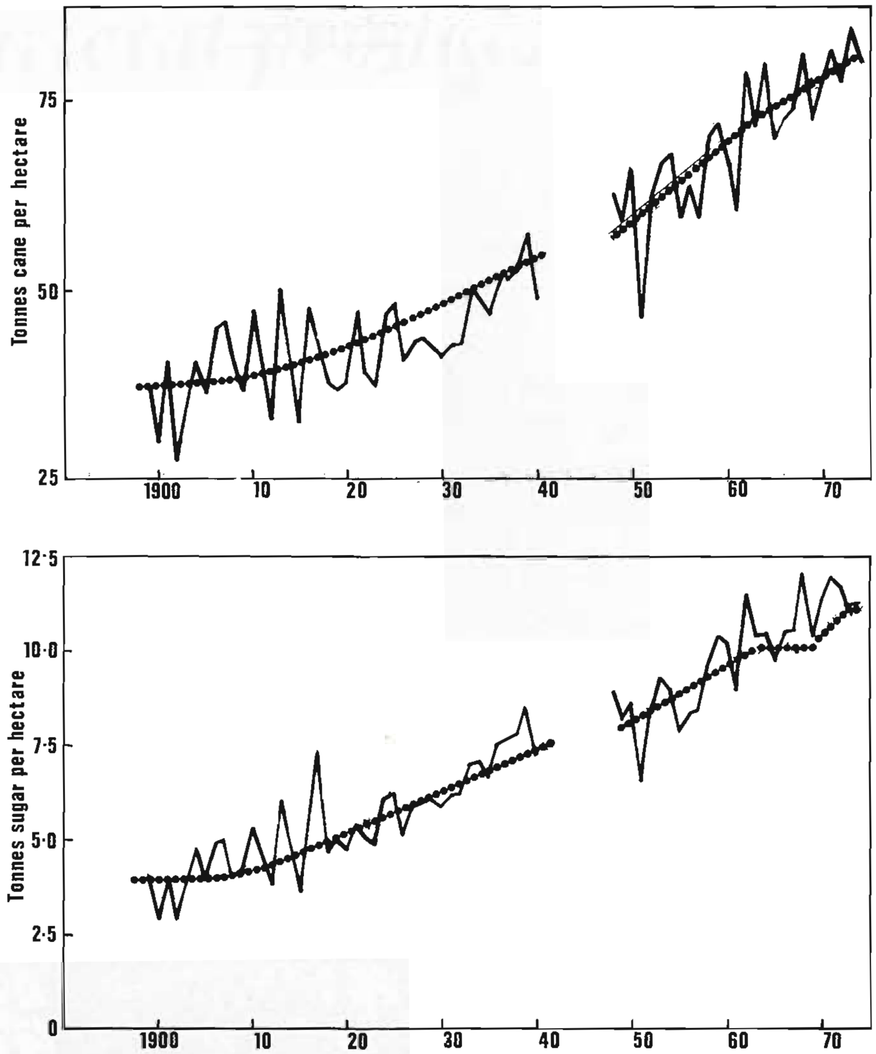
The combination of these changes in selection methods has resulted in a marked improvement in the standard of varieties in advanced stages of selection. In replicated trials planted between 1952-54 at Meringa, only one selection outyielded the standard variety Pindar, and the average yield was 80 per cent of the standard. The comparable trials for 1961-63 showed 92 selections outyielding Pindar and an average yield of 95 per cent of the standard. The standard has shown no decline during the intervening period.

The improved selection system on the experiment stations has resulted in substantial increases in the number and average quality of varieties reaching farm trials. The system adopted for farm trials involves planting them in 30-sett plots on several farms in different mill areas, selections from ratoon 30-sett plots being planted in replicated variety trials on different farms. A parallel propagation system is used to keep the planting material of selected varieties free from disease.

Seedling-raising instructions prior to 1950 were mainly concerned with seedling raising and selection on the experiment stations. These instructions were revised and expanded into a plant breeding manual describing all aspects of Bureau selection methods. The manual ensures that an efficient standard selection system is used in each district. The selectors include seedling officers and research staff on the experiment stations and advisory staff on farms. Substantial additions to advisory staff throughout the State have increased the capacity for testing varieties on farms and the chances of success in selection work.

CROSSING PROGRAMME

The programme for incorporation of the desirable characteristics of wild canes *(Saccharum spontaneum* and *S. robustum)* into seedlings met with success when the anti-lodging varieties Q66 and Q78 were approved in 1958 and 1964. Both these varieties had a *S. robustum* variety in their parentage. Crossing with a wider range of wild-cane varieties began in the 1950s and was intensified when a controlled-climate room was constructed in 1965. This allowed alteration of the natural flowering time of *S. spontaneum* varieties, so that they could be crossed with sugar cane. The early results have not been promising.



Production of tonnes of cane and tonnes of sugar per hectare since 1900

By 1959, some attractive varieties had been produced, but they were too low in sugar content. Selection for high Brix was then introduced and, in 1966, 30 per cent of the original seedling area was planted to seedlings from wild-cane parents which had been back-crossed to sugar cane. Many had good Brix but were poor in other characters, and the selection rate was below that from ordinary experimental crosses between sugar cane varieties. Subsequently, the size of the wild-cane programme was much reduced, but it is continuing as a long-term project.

The proven cross system has played an important part in the Bureau's plant breeding work by continually improving the quality of the original seedling populations. This can be seen by following the selection record of the important cross Trojan × Co475, which has produced several "Q" varieties since it was first planted as an experimental cross in 1954. This cross showed a consistently high selection percentage during the first few years, followed by a marked decline. Since crosses do not deteriorate, and varieties reaching the final yield trials pass through at least one selection stage where no selector is aware of their parentage, the decline of an old proven cross indicates that better new proven crosses are being selected.

Research on breeding systems has resulted in the development and adoption of a new crossing system for parent varieties, known as the factorial polycross. It provides the first new mating system in sugar cane since the polycross (or "melting pot") technique was developed in Hawaii over 30 years ago. Already it is playing a part in the Bureau programme.

EXPANSION OF PLANT BREEDING

The considerable expansion of cane breeding work during the 1960s was made possible by the appointment of more research staff, specialist technical officers, and an increase in advisory staff numbers. Substantial increases have occurred in cross-pollinations, selections on Experiment Stations and the number of varieties reaching the final stage of selection on farms.

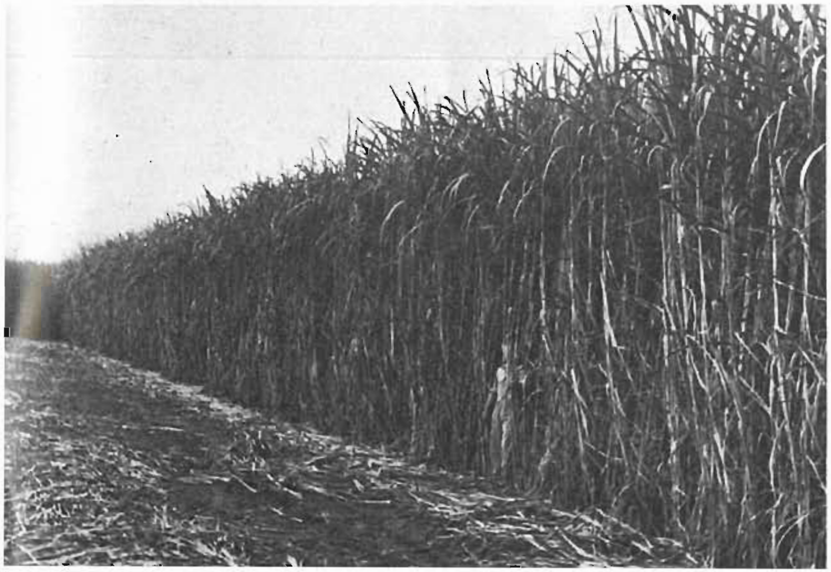
The number of districts taking part in varietal testing has also expanded. Selection programmes, based on the introduction of varieties from the Bundaberg Station, are now operating in the Childers, Maryborough and Nambour districts. There is a variety introduction and testing centre in the Ingham district, and sub-stations based on Meringa are operating in the Innisfail and Babinda districts in the north. The Innisfail sub-station, started in 1955, has played an important part in the selection of varieties for the wet belt. The commercial varieties Q78, Q83 and Q91 first gave outstanding results there, resulting in earlier approval for use by growers.

TECHNICAL ADVANCES

The most significant practical contribution of the research programme during the 1960s was the development of a sampling method for measuring the weight of varieties in replicated trials. With the rapid adoption of mechanical harvesting in Queensland, the previous system of weighing whole plots cut by hand can no longer be used. The sampling method enables valid statistical results to be made from trials that would otherwise be lost. In the 1967 season, 35 replicated variety trials were harvested throughout the State, 13 by sampling and 22 by weighing the whole plots. By 1973, the number of trials was 66, and 65 were processed by the sampling method.

In 1973 and 1974, all experiment stations changed from manual to mechanical harvesting, and a bin-mounted weighing machine was designed at Meringa for direct weighing of experimental plots. This has been successfully used for two harvesting seasons.

The crossing technique has undergone minor changes with the use of closely woven materials in lanterns to prevent contamination of crosses by stray pollen, and a switch to bulk supplies of crossing solutions to minimize labour requirements.



Q.90, currently a major variety in northern Queensland

COWPEA BREEDING

A cowpea bulk hybrid breeding programme was initiated in 1955 to produce high yielding varieties with a longer growing season than the existing varieties. These flowered early and did not give cover throughout the wet season.

The selections were very successful, and a series of long-season varieties (Meringa, Aloomba, Mulgrave, Pyramid, Brandon and Kalkie) were produced. The demand for cowpeas has tended to decline in recent years because of the reduced amount of land being fallowed and the high cost of cowpea seed.

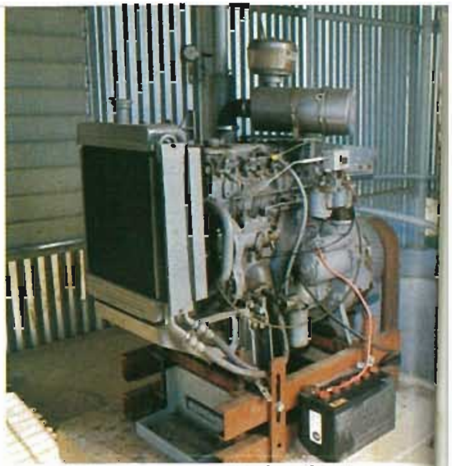
FUTURE PROSPECTS

Since 1950, Bureau varieties have contributed substantially to the continued improvements in productivity achieved through new varieties. In the early 1950s, Pindar was outstanding in the north, and many people felt that it could not be outyielded by new varieties. Recently, Q90 has drastically reduced the size of selection programmes in the far north because of its outstanding performance as a standard. There could be a temptation to conclude that Q90 has reached a physiological limit. However, the experience of the 1950-75 period, in which the development of improved selection systems was followed by the production of numerous varieties outyielding Pindar, suggests that Q90 will be replaced by superior selections.

Several avenues exist for future improvement in the cane breeding programme: an increase in the number and types of parent varieties available for crossing; the provision of more favourable conditions for flowering and crossing; a reduction in the generation interval (at present this is 15 to 18 years); better methods of testing varieties for disease resistance; and further studies of quantitative inheritance to provide basic information for improved breeding and selection methods.

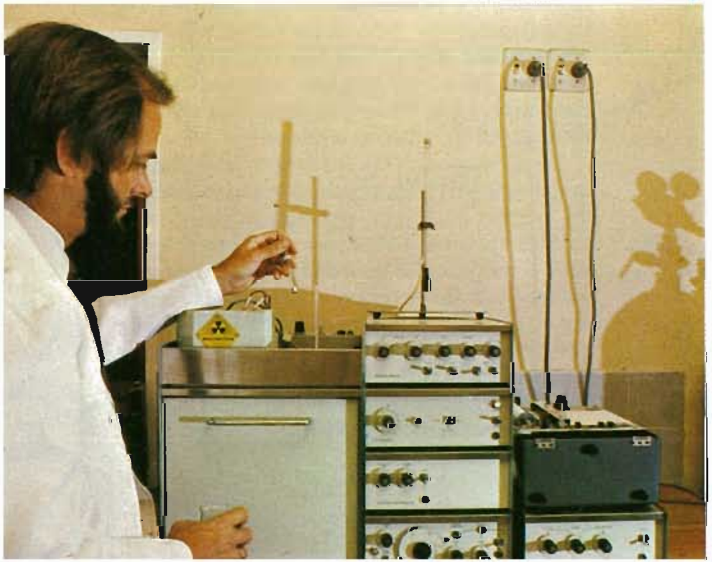
Hopper developed to weigh cane from trial plots in bins.

Intermediate dam for irrigation trials Bundaberg Station



Irrigation pump Mackay Station

Monitoring pesticide residues in environmental investigations.



Bundaberg glasshouse complex for Fiji disease studies.

advisory services

J. R. Burge, Extension Co-ordinator

Research within the sugar industry would have limited effect if the achievements of specialists were not accurately collated and communicated to growers in practical terms. This vital intermediary role is only one of the functions of the Bureau advisory staff. At some time during every adviser's career he has worked in association with specialists in most disciplines, and is continually involved with some aspects of research projects.

Such involvement enables an adviser to call upon considerable personal experience in his general extension duties with cane growers.

Growth of the advisory services group has been one of planned development to keep pace with the industry's progress. At present, advisory centres have been established in 12 localities and are staffed as follows:—

Mossman (1), Cairns-Babinda (3), Innisfail (2), Tully (1), Ingham (2), Lower Burdekin (3), Proserpine (1), Mackay (6), Bundaberg-Gin Gin (4), Childers (1), Maryborough (1) and Nambour-Rocky Point (1).

In addition to this planned development, emphasis on extension themes has changed in accord with the ever-changing needs of the sugar industry.

For instance, advisory staff were deeply involved in fertilizer investigations prior to World War II, then the expansion of the plant breeding programme during the post-war period required the conduct of many varietal selection trials. More recently, as emphasis on the economics of production, drainage and irrigation has increased, specialists in these fields were added to the staff of the advisory and economic services division.

Fertilizer Advisory Service

During the industry's expansion, advisory services filled an important role in determining fertilizer requirements for newly-established farms. Between 1950 and 1974, some 43 500 soils were sampled and tested for phosphorus and potassium requirements.

These tests, combined with soil fertility surveys over the years, have built a comprehensive picture of the fertilizer requirements of the total range of soil types and crop conditions throughout the State. Having compiled such a record of information on cane-growing soils, the Bureau in 1974 was able to phase out its soil testing service and replace it in 1975 with an advisory service based on trial results in each district.

The new system is such that soil phosphorus and potassium requirements will be determined by district advisers from trial work and their intimate knowledge of the nutrient status of various soil types. Nitrogen recommendations will be made from trial results and will additionally take into account the price of both fertilizer and sugar. So that any changes of soil fertility over time can be monitored, a series of soil fertility monitoring sites has been established throughout the State. If any changes in fertility take place, recommendations for certain soil types will be modified accordingly.

Thus, the new fertilizer advisory service forms an integral segment in the activities of the advisory group, with the ultimate objective being improved overall farm management.

Plant Breeding

With the exception of trials on the experiment stations, advisory staff are responsible for the running of all varietal selection trials, with assistance from specialist staff at selection time. This has allowed testing of potential commercial varieties on farms throughout the State, ensuring that selections from the experiment stations perform well under farm conditions. The advisers are also responsible for propagation and release of new varieties in their area.

Pests and Diseases

As in the agronomy and varietal fields, advisory staff are kept well informed on new findings in pest and disease control through the conduct of trials. Disease resistance trials and trials to evaluate pest control measures are

Taking levels for drainage improvements

carried out under the supervision of specialist staff in thse fields.

The Cane Pest and Disease Control Boards are constituted and function under provisions and regulations of the Sugar Experiment Stations Act, but they are autonomous bodies. Contact with Boards is maintained through a Bureau officer on each Board and by day-to-day contact between advisory staff and Pest Board officers. The supply of clean planting material from plots is another important point of contact. The Bureau and the Boards also meet annually at a Conference which has technical and business sessions.

Economic Advice

The necessity for canegrowers to have available data and to be aware of both the yields and profits from individual fields and from the farm as a unit has made itself increasingly obvious. To help cater for this need, a Steering Committee on Farm Management Accounting was constituted by the Sugar Experiment Stations Board in 1968, and was empowered to prepare and test a practical system of rural accounting for use in the Queensland sugar industry. The Committee recommended the introduction of a "Managerial Service for Cane Growers" based on close co-operation between the Bureau, public accountants and their canegrowing clients. Over the following five years, pilot studies were tested at Mackay and Innisfail using finance provided under a Commonwealth Extension Services Grant.

An agricultural economist was appointed to the staff in 1969 so that this discipline could be developed in line with the growers' best interests and the Bureau could develop sufficient expertise to be in a position to advise growers. The "BSES System" of farm management accounting was phased into commercial use in 1973.

Agricultural Engineering

The recognition of the need for improved farm drainage, expanded irrigation and soil conservation and development in the agricultural machinery field, resulted in the addition of an agricultural engineer to the advisory division in 1973. He is providing the technical back-up for field staff in this aspect of extension work.

Traditional engineering services provided by advisory staff include running of levels for drainage, irrigation, farm reorganization and loading sidings. The Bureau also assists with applications for finance of drainage and irrigation projects.

Publications

Prior to 1933, what were known as Farm Bulletins, which dealt with various aspects of cane culture, were released at irregular intervals. Technical publications were in a separate series. Two examples of these which were widely used by the industry are *Notes on Insects Damaging Cane in Queensland,* published in 1916 and *A Key for the Field Identification of Sugar Cane Diseases*, published in 1929.

Informal discussion groups disseminate information

Weighing cane on a bipod in a trial area.

The first regular extension publication was the *Cane Growers' Quarterly Bulletin*. It appeared in July 1933 and, except for a break from April 1942 to April 1946 because of World War II, has been mailed regularly on the first of January, April, July and October every year since.

The important feature of the Bulletin is that a copy is posted to every Queensland cane farmer. By special arrangement, cane growers in New South Wales also receive the Quarterly Bulletin.

The first local text book on cane growing, *The Queensland Cane Growers' Handbook*, appeared in 1939. It was a Government production. Its successor was the first edition of the *Manual of Cane Growing*, published in 1953 by Angus and Robertson. The second edition appeared in 1965.

A Newsletter, now the Queensland Sugar Technology Newsletter, has served to keep mill technologists throughout the State aware of any new developments. The *Laboratory Manual for Queensland Sugar Mills*, now in its fifth edition, is a valuable handbook for use from the juice laboratory to the pan stage in every mill.

The *Proceedings of the Annual Conference of the Queensland Society of Sugar Cane Technologists* are edited by the Bureau.

In addition to these publications, the publication section of the division, consisting of a publications officer and an assistant, is responsible for the production of a varied range of printed material for Bureau and industry circulation.

Field Days

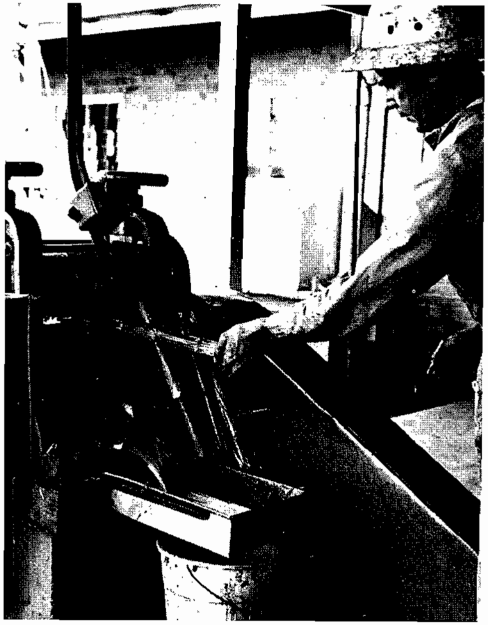
The first recorded Field Day was held on the Mackay Station in June 1914. The Field Days are now regular events on all the Stations, except the embryonic Tully Station. Bureau displays, farm machinery exhibits, a slide show, tours of the Station, a light lunch and informative addresses, now form the basis of the Days. The formula has definite appeal, since over 900 visitors have been recorded as attending this annual event on one of the Experiment Stations.

Roving Field Days, which take in several farms, have been successful in some areas.

Industry Conferences

The Annual Conference of the Queensland Society of Sugar Cane Technologists is an important point of contact between the Bureau and the industry. Bureau officers present papers and enter freely into the discussions. It is the largest regular gathering in the State of all those in the sugar industry or in the ancillary industries servicing it.

The contacts at the conferences of the Queensland Cane Growers' Association, the Australian Sugar Producers' Association and the Proprietary Sugar Millers' Association, are in a slightly different form. Senior officers of the Bureau attend these by invitation and participate in discussion on industry matters.



Small mill crushing cane for laboratory ccs determination

chronology

1950 Director appointed to Royal Commission established to prepare an orderly plan for development of the Queensland sugar industry. Seventh ISSCT Congress held in Brisbane. Last appearance of gumming disease in Queensland, at Mossman. Fifty-four canes had received "Q" numbers.

1951 Creation of the Sugar Experiment Stations Board. Bureau became an autonomous organization. Pathology Farm at Eight Mile Plains purchased. Bureau cane-collecting expedition to New Guinea.

1952 Industry expansion followed by nutritional problems on new land.

1953 *Manual of Cane Growing* first published. Ingham advisory centre opened. First commercial hot water treatment of cane for ratoon stunting disease. Q50 became leading variety in State, producing over two million tons.

1954 Ayr Experiment Station officially opened by the Chairman of the Sugar Experiment Stations Board.

1956 First plantings at Innisfail sub-station for wet belt selection of varieties.

1957 Queensland Cane Growers' Council presented a bronze plaque to the Bureau to commemorate control of the cane grub. Bacterial mottle disease first identified.

1958 Death of former Director, A. F. Bell. Bureau moved into new headquarters at 99 Gregory Terrace, Brisbane. Bureau represented on committee of investigation into cane analysis. Last reported cane infected with downy mildew ploughed out, Bundaberg.

1959 Control of soldier fly achieved using BHC. Area of Meringa Experiment Station increased. Leaf scald outbreak in Q63 at Bundaberg and Mackay.

1960 Childers advisory centre opened.

1961 Director presented evidence to Commonwealth Committee of Enquiry into the financial status of the sugar and canned fruit industries.

1962 Bureau investigations intensified into deterioration of cane after harvest. First finding of cicada damage, at Gordonvale.

1963 Director a member of the Gibbs Committee of Enquiry into industry expansion.

1964 Major expansion of industry; some 1 200 new cane farms created. Associated increase in Bureau staff in advisory, agronomy, plant breeding and entomology sections. Maryborough advisory centre opened.

1965 First failure of BHC in control of soldier fly noted; change to dieldrin. Lysimeter installed at Ayr for water use studies. Second edition of *Manual of Cane Growing* published.

1966 Proserpine advisory centre opened.

1967 Mossman advisory centre opened. Irrigation research commenced at Bundaberg.

1968 Advisory services became a separate division. Rat research recommenced. Commonwealth Grant received for development of a Farm Management Accounting Service.

1969 Recurrence of Fiji disease in Bundaberg. Farm Management Scheme commenced. Area of Bundaberg Experiment Station increased. Board acquired land for Tully Experiment Station to carry out wet land research.

1970 Study of cicadas intensified.

1971 Q63 was most important variety after NCo310.

1972 N. J. King retired; O. W. Sturgess appointed Director. State Government grant for research received for first time. Bundaberg Cane Pest and Disease Control Board abolished.

1973 Creation of three new Pest Boards—Fairymead, Millaquin-Qunaba and Bingera-Gin Gin to supervise Fiji disease control measures. Co-ordinator of Pest Boards appointed. Queensland seedling 58N1871 released as Q100. Leaf-scald outbreak at Mackay forced deletion of Q63 from approved variety list in two mill areas. Stations changed to mechanical harvesting. Q90 was third most important variety in State in its fourth year as a commercial variety.

1974 Soil analysis service for fertilizer recommendations phased out. Research into polysaccharide chemistry intensified.

bureau technical staff since 1950

Name	*Division*	*Service*
Adkins, B. G.	*Mill Technology*	1947–1966
Anderlini, T. A.	*Plant Breeding*	1970–
Anderson, G. A.	*Mill Technology*	1963–1966
Anderson, J.	*Advisory & Economic Services*	1950–1971
Arkadieff, L.	*Pathology*	1967–
Armstrong, E. T.	*Soils & Agronomy*	1969–1970
Arnold, P. G.	*Advisory & Economic Services*	1958–1965
Atherton, P. G.	*Mill Technology*	1965–
Barke, E. J. R.	*Administration*	1927–1961
Barnard, A. E.	*Plant Breeding*	1968–
Barnes, J. E.	*Plant Breeding*	1965–1969
Barrie, A. G.	*Soils & Agronomy*	1955–1964
Bates, G.	*Administration*	1923–1966
Batstone, D. B.	*Mill Technology*	1969–1972
Beak, D. A.	*Plant Breeding*	1959–1961
Beale, R. F.	*Mill Technology*	1958–1963
Berding, N.	*Plant Breeding*	1966–
Bieske, G. C.	*Soils & Agronomy*	1947–1966
Blogg, R. J.	*Mill Technology*	1967–1970
Booth, D. R. C.	*Plant Breeding*	1970–1972
Boyle, H. L.	*Advisory & Economic Services*	1966–
Brain, L. R.	*Mill Technology*	1947–1963
Braithwaite, M. J.	*Plant Breeding*	1966–
Brotherton, G.A.	*Mill Technology*	1973–
Bull, R. M.	*Entomology*	1968–
Burge, J. R.	*Soils & Agronomy*	1948–1968
	Advisory & Economic Services	1975–
Burman, N. J.	*Plant Breeding*	1959–1960
Buzacott, J. H.	*Plant Breeding*	1925–1970
Catip, V. A.	*Soils & Agronomy*	1965–1966
Chandler, K. J.	*Entomology*	1970–
Chapman, J. L.	*Soils & Agronomy*	1956
Chapman, L. S.	*Soils & Agronomy*	1955–
Chardon, C. W. A.	*Advisory & Economic Services*	1968–
Christie, G. A.	*Advisory & Economic Services*	1933–
Claire, A. G.	*Mill Technology*	1950–1967
Clayton, J. L.	*Mill Technology*	1938–1954
Cleary, D. J.	*Advisory & Economic Services*	1953–1954
Cook, J. M.	*Entomology*	1963–1967
Copley, E. F.	*Advisory & Economic Services*	1967–
Corkill, C. C.	*Plant Breeding*	1960–
Cox, J. I.	*Advisory & Economic Services*	1965–1966
Crouther, K. W.	*Mill Technology*	1962–1964
Cullen, G. R.	*Advisory & Economic Services*	1971–
Currie, J. A.	*Advisory & Economic Services*	1965–
Daniels, L. J.	*Advisory & Economic Services*	1952–1953
Davison, S. M.	*Soils & Agronomy*	1971–1973
Deicke, R.	*Mill Technology*	1955–1959
Doble, B. R.	*Pathology*	1964–1965
Doolan, A. D.	*Mill Technology*	1949–
Doolan, F. M.	*Administration*	1950–
Downs, P. R.	*Advisory & Economic Services*	1969–
Draper, W. J.	*Advisory & Economic Services*	1965–1969
Egan, B. T.	*Pathology & Administration*	1947–
Erbacher, J. P.	*Entomology*	1970–
Ferraris, R.	*Soils & Agronomy*	1964–1966

Name	Division	Period of Service
Fischer, K. S.	*Soils & Agronomy*	1965–1966
Fleming, M. E.	*Soils & Agronomy*	1966–1968
Ford, A. W.	*Advisory & Economic Services*	1965–
Freshwater, I. T.	*Advisory & Economic Services*	1953–
Fryer, L. J. R.	*Advisory & Economic Services*	1970–
Galetto, F. P.	*Mill Technology*	1958–1960
Garioch, D.	*Plant Breeding*	1961–
Gatt, J.	*Advisory & Economic Services*	1953
Gay, B. L.	*Advisory & Economic Services*	1969–1971
Glover, C. E.	*Advisory & Economic Services*	1959–1965
Graff, N. G.	*Advisory & Economic Services & Plant Breeding*	1949–1968
Graham, T. A.	*Pathology*	1971–
Hales, J. W.	*Advisory & Economic Services*	1960
Ham, G. J.	*Soils & Agronomy*	1967–
Hampson, R. J.	*Advisory & Economic Services*	1967–
Haskew, H. C.	*Soils & Agronomy*	1952–1954
Hakewe, H. C.	*Soils & Agronomy*	1952–1954
Haysom, M. B. C.	*Soils & Agronomy*	1966–
Henkel, C. R.	*Advisory & Economic Services*	1973–
Hetherington, M. A.	*Advisory & Economic Services*	1970–
Hilhorst, R. K.	*Plant Breeding*	1956–
Hillcoat, T. O.	*Administration*	1973–
Hinton, J. E.	*Mill Technology*	1968–1970
Hitchcock, B. E.	*Entomology*	1951–
Hogarth, D. M.	*Plant Breeding*	1964–
Horne, C. C.	*Administration*	1950–
Hucknall, J. N.	*Advisory & Economic Services*	1958–1963
Hughes, C. G.	*Pathology*	1934–
Humphry, E. V.	*Advisory & Economic Services*	1940–1954
Hurney, A. P.	*Soils & Agronomy*	1966–
Hutton, B. E. T.	*Mill Technology*	1974–
Izatt, L. K.	*Advisory & Economic Services*	1966–
Jenkins, R. J.	*Soils & Agronomy*	1959–1960
Jenkins, V. V.	*Advisory & Economic Services*	1957–1959
Jensen, E. D.	*Mill Technology*	1957–1965
Jones, C. D.	*Advisory & Economic Services*	1961–
Jones, P. A.	*Advisory & Economic Services*	1969–1974
Kerkwyk, R. E.	*Entomology*	1960–
King, N. J.	*Advisory & Economic Services & Administration*	1933–1972
Kingston, G.	*Soils & Agronomy*	1969–
Kirby, L. K.	*Mill Technology*	1966–
Knust, H. G.	*Advisory & Economic Services*	1937–1963
Lal, M. J.	*Soils & Agronomy*	1970–1973
LeBrocq, D. G.	*Soils & Agronomy*	1971–
Leddy, S. C.	*Administration*	1947–
Ledger, P. E.	*Pathology*	1971–
Leonard, G. J.	*Mill Technology*	1974–
Leverington, K. C.	*Soils & Agronomy & Administration*	1944–
Liehr, R.	*Soils & Agronomy*	1966–1970
Lindsay, F. C.	*Plant Breeding*	1940–
Linedale, A. I.	*Advisory & Economic Services*	1964–
Luxton, A. N.	*Soils & Agronomy*	1972–
Matthews, A. A.	*Advisory & Economic Services*	1950–
Milliken, J. E.	*Advisory & Economic Services*	1957–1959
Moller, R. B.	*Soils & Agronomy*	1954–

Name	Division	Period of Service
Morrison, R. P.	*Pathology*	1960–1961
Mulvena, T. C.	*Mill Technology*	1963–1970
Mungomery, R. W.	*Entomology & Administration*	1925–1968
Myatt, O. W. D.	*Advisory & Economic Services*	1946–
MacQueen, A.	*Entomology*	1966–1969
McAleese, C. M.	*Advisory & Economic Services*	1953–1960 } 1961– }
McAlloon, R. C.	*Soils & Agronomy*	1957–1959
McBryde, D. L.	*Mill Technology*	1934–1953
McGruddy, P. J.	*Plant Breeding*	1966–1969
McIntyre, R. J.	*Mill Technology*	1971–
McKay, J. H.	*Soils & Agronomy*	1965–
Nalder, C. R.	*Advisory & Economic Services*	1966–
Newman, K. E.	*Advisory & Economic Services*	1957
Nicklin, J. H.	*Mill Technology*	1945–1969
Nielsen, P. J.	*Advisory & Economic Services*	1965–
Nix, K. J.	*Mill Technology*	1965–1972
Noble, A. G.	*Mill Technology*	1970–
Olsen, M. J.	*Soils & Agronomy*	1973–
O'Sullivan, E. M.	*Mill Technology*	1958–1960
Owens, W. G.	*Plant Breeding*	1963–
Pembroke, E. A.	*Advisory & Economic Services*	1940–1957 } 1960– }
Persley, G. J.	*Pathology*	1970–
Phillips, G. F.	*Soils & Agronomy*	1953
Pollock, J. R.	*Pathology*	1955–1956
Pollock, J. S.	*Plant Breeding*	1969–
Powell, J. G.	*Entomology*	1970–
Pyne, H. G.	*Soils & Agronomy*	1970–1971
Rapson, A. K.	*Mill Technology*	1967–1969
Redhead, T. D.	*Entomology*	1968–1971
Rehbein, C. A.	*Administration*	1951–
Reimers, J. F.	*Advisory & Economic Services*	1968–
Ridge, D. R.	*Soils & Agronomy*	1966–
Rodman, L. E.	*Advisory & Economic Services*	1954–1960
Rudd, A. V.	*Advisory & Economic Services*	1965–
Ryan, C. C.	*Pathology*	1974–
Sedl, J. M.	*Soils & Agronomy*	1953–
Seymour, J. S.	*Advisory & Economic Services*	1965–67
Short, F. M.	*Soils & Agronomy*	1951–
Silcock, J. A.	*Soils & Agronomy*	1970–
Skinner, J. C.	*Plant Breeding*	1953–
Skinner, S. O.	*Administration*	1936–
Smith, J. A.	*Plant Breeding*	1973–
Smith, N. McD.	*Advisory & Economic Services*	1939–1965
Spry, E. G.	*Advisory & Economic Services*	1968–
Steindl, D. R. L.	*Pathology*	1935–
Stern, W. R.	*Soils & Agronomy*	1949–1951
Steward, J. M.	*Mill Technology*	1971–
Stewart, E. J.	*Mill Technology*	1968–
Stewart, I. J. V.	*Advisory & Economic Services*	1957–
Stewart, P. N.	*Mill Technology*	1960–
Stickley, B. D. A.	*Soils & Agronomy*	1968–
Story, C. G.	*Administration*	1935–
Sturgess, O. W.	*Pathology & Administration*	1956–
Sutton, J. A.	*Mill Technology*	1970–
Taylor, J.	*Soils & Agronomy*	1968–1971
Thomsen, R. G.	*Soils & Agronomy*	1968–1971
Tilley, L. G. W.	*Advisory & Economic Services*	1964–
Toohey, C. L.	*Advisory & Economic Services*	1951–
Usher, J. F.	*Advisory & Economic Services*	1964–
Vallance, L. G.	*Soils & Agronomy & Administration*	1945–1964
Vella, J. J.	*Soils & Agronomy*	1958–1960
Venton, C. B.	*Mill Technology*	1946–1954
Wallace, C. M.	*Soils & Agronomy*	1969–1970
Watson, J. D.	*Mill Technology*	1954–1958
Webb, W. A. C.	*Advisory & Economic Services*	1970–
Wesdorp, J.	*Soils & Agronomy*	1952–1965
Whittaker, G. H.	*Advisory & Economic Services*	1955–1967
Willcox, T. G.	*Plant Breeding*	1970–
Williams, A. R.	*Soils & Agronomy*	1971–1974
Wilson, G.	*Pathology & Entomology*	1926–1929 } 1948–1971 }
Woods, J. A.	*Entomology*	1965–1966
Wright, J.	*Advisory & Economic Services*	1964–
Yore, K. J.	*Mill Technology*	1950–1952
Young, H. E.	*Soils & Agronomy*	1957–1970

index