

SUGAR RESEARCH IN THE WEST INDIES

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Introduction.

In a sweeping curve from the eastern tip of Mexico to the mouth of the Orinoco lie the islands of the West Indies, which with Central America and the northern shores of South America enclose the Caribbean Sea, more than half a million square miles in extent. These lands are historically associated with Columbus, the Spanish *conquistadores*, pirates, Nelson and the French Wars, and with the varying fortunes of sugar during nearly three hundred years.

The islands of the British West Indies, comprising with others Jamaica, St. Kitts, Antigua, St. Lucia, Barbados, and Trinidad, with the mainland colony of British Guiana, have long been important producers of sugar and its satellite, rum. The last twenty years has seen great progress in the sugar industry there, with a total production in 1950 of nearly 850,000 long tons. During the same period the importance of the industry in the overall economy of the various territories has increased.

The development of air transport has played an important part in the closer linkage of island and mainland countries widely separated by sea in the Caribbean area. Frequent inter-territorial conferences are held, resulting in better understanding amongst the varied interests and the interchange of information in ways not formerly possible. The importance of this modern form of communication will more readily be appreciated by noting that the direct distance from Kingston, Jamaica, to Port of Spain, Trinidad, is 1,150 miles, approximately the same as from Cape Town to Lourenco Marques; and from Colon to Martinique in the French West Indies is 1,350 miles, equivalent to Cape Town to Beira. The islands of the British West Indies vary greatly in size and topography. They extend over 19 degrees of longitude and 8 degrees of latitude, entirely in the northern tropics. British Guiana is not a part of the British West Indies, but is included in most considerations affecting sugar.

Historical.

The progress of the cane sugar industry throughout the world has been influenced to a remarkable extent by research in which workers in the British countries of the Caribbean have played an important part. Although local investigations into problems of the sugar industry had been conducted prior to the establishment of the Imperial Department of Agriculture in 1897, it was not until then that the immense importance of organised agricultural experimentation in the British West Indies was officially recognised. This major development is related to the

searching inquiries of various commissions which from time to time reported and advised on measures for the advancement of the sugar industry.

1922 is an important date in British West Indies sugar research history, when the Imperial College of Tropical Agriculture was established in Trinidad. From its inception this institution has been engaged in research and teaching work for the cane sugar industry in all its phases. The model sugar factory, equipped by the generous gifts of manufacturers of sugar factory machinery, has enabled sugar technologists to receive an important part of their training under practical working conditions, and has provided facilities for applied research, the results of which have proved their value.

A few years later, in 1932, the British West Indies Central Sugar Cane Breeding Station was established in its present form in Barbados, where conditions favour the production of viable seed from controlled cross pollinations. Prior to that, several new commercial varieties of sugarcane had originated from seed in Barbados. British Guiana had also recognised the need for selecting new varieties of cane in the same manner.

Systematic breeding of new cane varieties has been carried on in Barbados since that time with great success for the whole of the British West Indies. Recently British Guiana has become a member of the scheme, which is financed by the Government of Barbados and the participating territories—that is the British colonies of the Caribbean. Contributions are made by certain other places which receive selected varieties produced at the Station.

The Departments of Agriculture of the various colonies carried out field experimental work on the inter-actions of the plant and soil under natural and induced conditions. These studies included comparisons of varieties, fertilizer responses, pest and disease control, and related matters, all of which continue to engage the attention of a large number of workers. A survey of the development of field experimental methods for sugarcane would in itself prove of absorbing interest, but cannot be included in this paper. The records however are available to show, amongst other things, the achievements of the past and the application of modern methods of investigation evolved from them.

Developments from 1937 to the present time have been rapid and extensive. They have been influenced by several important events and by independent economic factors. Noteworthy among these was the general undercurrent of uneasiness amongst the

peoples of the British West Indies area arising from depressed conditions, particularly in the sugar industry, which led to the appointment of a Royal Commission in 1938. The recommendations of that body dealt very largely with agricultural matters, including research, and powerfully stimulated applied research on the problems of the sugar industry.

The acquisition during this period of large sugar estates in Jamaica and Trinidad, with their factories and distilleries by Tate and Lyle, Ltd., the British sugar refiners, introduced a new outlook on cane sugar production, attended as it has been by the intensive application of modern methods backed by applied research conducted by specially appointed persons on the staff of the operating companies.

A regional sugar conference held in Jamaica in 1941, attended by representatives from all sugar producing territories in the British West Indies area resulted in the formation of the British West Indies Sugar Association (Incorporated) in the following year. This organisation attaches the highest importance to agricultural and technological research for the cane sugar industry, which is assisted by generous grants from association funds.

Independently of these events, the Sugar Manufacturers' Association (of Jamaica) Limited decided in 1942 to establish and finance its own research organisation for the study of sugar estate problems of local importance including those of the field, factory and distillery. Reorganised in 1947 as the Sugar Research Department of that Association, it has assumed responsibility for all research work on the sugar industry which can be carried out within the island, including the introduction and testing of new varieties of cane. A civil engineering and hydraulics division carried out valuable work on problems of drainage, river and flood control, and irrigation during 1948-49. It was disbanded in 1949 together with the technological division, which had made most useful contributions to factory and distillery operation and control. The department now deals with investigations of a purely agricultural nature, with occasional attention to process matters of immediate local importance.

Sugar technology research and instruction have formed an important branch of the activities of the Imperial College of Tropical Agriculture, Trinidad. The need for a wider outlook on processing research for cane sugar was recognised some years ago, with the result that a new sugar research scheme for the British West Indies came into effect in 1947. Financed by the British Treasury, and by grants made by the British West Indies Sugar Association, the scheme is administered by the Imperial College. There is an advisory committee representative of the British West Indies Sugar Association and the

College, with the Principal as chairman. The Director of Research, who has professorial status, is a member.

Until the new laboratories on the College site were ready for use last year, work was carried out in the chemical laboratories at the University of Birmingham. The College sugar factory, to which reference has been made, is being fitted with new equipment and a pilot plant for the study of processes for the utilisation of by-products provided. Generous gifts of machinery and equipment have again been made.

Barbados has made notable and varied contributions to sugar research, and has now taken a further step whereby the industry is financing its own technology laboratory for the study of factory problems. Independent of the Department of Agriculture, and the Cane Breeding Station, this new establishment will supplement their work and provide the industry with technological service and advice.

The Present Position.

Having thus broadly sketched the recent history of sugar research in the West Indies, and indicated the present position, it will be of interest to discuss in greater detail some of the work accomplished and the principal lines of investigation now being pursued. It will be realised that the different territories are closely associated in economic and scientific matters regarding sugar in which the British West Indies Sugar Association plays a highly important part.

The author's association with Jamaica induces more prominence to investigations there, but the closer associations developed during recent years make it possible to deal with general progress within the area. It is convenient to discuss these matters under the main headings of field and factory.

Field.

Cane varieties.—The breeding, study, testing and distribution of new varieties is carried out at the British West Indies Central Sugar Cane Breeding Station in Barbados. The special needs of each territory are considered in the breeding programme, and as a general rule a limited number of selected varieties, regarded as being of promise for the particular conditions of each place, are released at the sixth year. It is realised that the method whereby selections are made in Barbados for other areas where climatic and soil conditions are different is not entirely satisfactory.

This is now to some extent overcome by distributing as many as fifty selections for testing and re-selection, though in the past less have been sent out in each batch.

Great success has attended this work. Barbados seedling canes now form a very high proportion of the commercial canes grown throughout the area.

In Jamaica the special characteristic of resistance to or immunity from mosaic disease is highly important. Most selections of commercial promise found to display immunity under Barbados conditions have proved highly susceptible to the disease in Jamaica. The principal cane now grown there is B.34104, susceptible but tolerant to mosaic. In order to provide a broader basis of selection in Jamaica some five hundred first-year seedlings from chosen crosses were brought in from Barbados in October, 1950, and a further similar number a year later. It is proposed to continue this programme for some time until the later development is fully effective whereby "fuzz" from special crossings is supplied by the Barbados station for growing at a nursery in Jamaica, where all the subsequent work of selection and testing will be done. The importation of a small number of seedlings proved in Barbados will continue each year as in the past.

Jamaica displays great differences in soil and climate amongst the sugar estates, which induce variations in the growth and behaviour of sugarcane, so that final selections have to be made from comparative trials against standard varieties on estates' land.

Soils and fertilizers.—Studies of soils in which sugarcane is grown, and the effects of organic and inorganic manures have been carried on for more than half a century. Modern methods of investigation involving the careful planning of field experiments in replicated plots of special design, and the statistical analysis of results are now in general use in the British West Indies.

Plant nutrient deficiencies and responses for sugarcane in Jamaica are studied by the method of foliar diagnosis—the analysis of the leaf. Field experiments of this type designed to test new varieties, fertilizer responses, and cultural treatment are carried out in large numbers on the estate lands in which cane is commercially grown, and not at central stations. Laboratory examination of samples from these experiments, and the statistical analysis of the results are conducted at the Research Station.

In association with this work, observations on varying cultural practices, such as land preparation, drainage, fertilizer placement, planting densities, trash disposal, weed control, and inter-row cultivation are sometimes included. The effects of applying factory and distillery residues to the land are being studied.

An important feature of all this work is the close association of the research officers with the staff of the estates. Experience has shown that this accel-

erates the application of experimental results to commercial practice. The estates are quick to seek and use the advice and help thus available from men who are highly trained observers, and whose duties enable them to move through the cane lands at frequent intervals.

Land management.—This includes the main features of agricultural practice in regard to all preparatory work up to the time of the plants becoming established, the treatment of the soil immediately after the reaping of the crop, trash disposal, crop cycles, fallowing and the use of cover crops, drainage and irrigation.

Mechanisation of field operations has been highly developed by the combined efforts of sugar estates and research workers. The British West Indies have been quick to try new and promising methods and to adopt those proved suitable to local conditions.

As a result of careful observations over many years, a system of soil classification into groups and sub-groups related to this subject has been worked out. The basic cultural requirements for each have been described, and the whole presented in such a manner that those in charge of field operations can make practical use of it.

In Jamaica nearly 45 per cent. of the sugar is obtained from cane grown in areas of deficient rainfall, using irrigation. Water is obtained from surface streams and wells. The expense of obtaining, distributing and applying water forms an important part of the total cost of sugar, and has led to careful inquiries into various aspects of irrigation, the object being to get the maximum economic return—which should not be confused with the greatest possible yield. The quality of the water used varies from time to time in some cases. Water from wells is regularly tested for chloride and total mineral content.

Harvesting and transport.—In 1947 enquiries were made into these operations with the object of getting information about details of expenditure of effort by workpeople; times occupied by loading, haulage, and discharge of vehicles; working and idle time of tractors; and related matters. It has been recognised that considerable losses of material and waste of time, and much misapplied effort can occur between the stages of standing cane in the field at the instant before it is cut and the arrival of that cane at the point of the first operation of milling.

Economic surveys.—Accurate costing is essential to good business management no less in the sugar industry than elsewhere. Some estates have annual records for many years so compiled as to show individual operation costs for cane and sugar. A close examination of methods in use on a group of

estates with their factories is in progress, to determine where savings in effort and cost can be made and improvements in field and factory practice effected.

General.—A recent development which promises to exercise important effects on agronomic research on sugarcane in the British West Indies is the constitution of a Sugarcane Investigation Committee under the auspices of the British West Indies Sugar Association (Inc.)

This body was appointed as a result of discussions at the annual meeting of the British West Indies Sugar Technologists held in Barbados in 1948, when it was recommended that action be taken to co-ordinate sugarcane investigation work. Among the important early decisions of the committee are the recognition of experimental results derived only from properly planned and statistically analysed work, the appointment of a working sub-committee on field experiments, and the necessity for using experimental plot designs and technique which will yield results of scientific and practical value. In this way the work of the Cane Breeding Station with its advisory committee, the investigations of the various territorial units, and the practical needs of the sugar estates will be further advanced.

Factory.—Though it may be asserted that a modern sugar factory can be rapidly adapted to the changing qualities and varieties of cane supplied, applied research, which has long been conducted on factory processes, is more than ever necessary. The records of the model factory at the Imperial College, Trinidad, describe work already done, and this with the devoted work of practising engineers and chemists has hitherto overcome most problems as they arose, but the urgent need for deeper inquiry into factors affecting the milling and related processes for extracting sugar from the cane is generally recognised. The procession of new varieties and changed field practices have introduced problems of clarification not formerly encountered, but above all the vital requirement of economic production of cane sugar has focussed attention on process research.

Under the new British West Indies Sugar Research Scheme these matters are being approached by studies of the cane itself, the products extracted or removed at various stages of the factory processes, and the changes which some of them undergo. Work of this nature is required for all varieties commercially grown. New analytical methods are being used, such for example as chromatography.

By-products of the cane are also under investigation, particularly bagasse, cane wax from filter muds, and molasses for the manufacture of chemical products.

Conclusion.

The studies thus briefly described are primarily directed to the examination of problems of particular local interest though much of the work is of wider application. Reports are issued to the industry as soon as possible after the completion of a stage of an enquiry has yielded useful information. Papers are presented to meetings of the various associations and are printed in their journals. Records of work, experimental results, observations and conclusions are published by Departments of Agriculture, the British West Indies Central Sugar Cane Breeding Station, the Imperial College of Agriculture, and other organisations.

No reference has been made to the names of past or present research workers. A list of them would be very long, and would include men who have become famous for their contributions to the knowledge and progress of the cane sugar industry.

It will be realised that sugar research in the British West Indies is intensely active, progressive, and practical in outlook. It is associated with unrestricted exchange of information, and is well co-ordinated by various advisory committees, while the research workers themselves enjoy the greatest freedom possible within the scope of defined policies of investigation.

The President said Mr. Barnes had for many years been Director of Sugar Research in Jamaica and his address was of particular interest to South African technologists. It seemed to be accepted that no one organisation was sufficient to cover the various aspects of the work done in the South African Sugar Industry, a point which seemed clearer after Mr. Barnes' paper. It was unnecessary to emphasise the important part the West Indies had played in research work, where the lead had been taken in cane breeding. One interesting point was that there was no centralised research station such as in Natal, but more use was made of station work.

Dr. Dodds said he could endorse much of what Mr. Barnes had said. He had been impressed by the number of publications received from the West Indies showing the vast amount of research being done and the highly organised skill behind it.

The President said he gathered that in Jamaica the bulk of the cane was produced by the miller-cum-planter. He asked how new varieties produced by the breeding station got into circulation. In Natal it was necessary to satisfy the needs not only of the large miller-cum-planter but the small growers, all of whom could claim a quota.

Mr. Barnes said the difference between production in Jamaica and Natal was that in Jamaica the factory estates themselves produced two-thirds of the cane and bought one-third, contrary to Natal practice. There were few large farmers in Jamaica. A majority of them supplied not more than one or two thousand tons a year and a large number supplied not more than a hundred tons or so. Farmers were registered and were not permitted to supply to a factory other than the one to which they were registered.

Regarding the introduction and testing of new varieties, all breeding work was conducted in Barbados, special crossings being made for Jamaica conditions. Selections were made in Barbados and varieties which promised to suit Jamaica conditions were sent by air freight each year. These underwent preliminary sorting in a nursery and those which grew well and showed resistance to mosaic disease were sent out to the twenty-three estates for further trial. They were under the care of the estates' staff and were inspected from time to time by officers of the Research Department. Final selection for commercial planting was made after comparative yield trials. Because of the impossibility of making final selections in one country for use in another with certainty, it was decided to introduce about five hundred seedlings annually in addition to those chosen after protracted trial in Barbados. This was begun in 1949, since when arrangements had been made to grow large numbers of seedlings as well as continuing the methods described. Farmers got new canes suited to their conditions from the estates to which they supplied—the miller-cum-planter.

Mr. Rault said that arising out of the paper it might be possible to follow the example of the West Indies and instead of criticising the excellent work done at the Experiment Station as "garden work," confirm it by field experiments on a plantation scale under the guidance of the technical staff of the Experiment Station, but with all the limitations of sugar plantation labour. He felt sure The Natal Estates would welcome investigations of this kind

to be carried out on their irrigation scheme to determine its economic limits. He asked whether the new factories erected in the West Indies were also designed as a result of research findings on labour economy—a problem common to all sugar industries.

Mr. Barnes referred to the importance of field experiments conducted on the estates and said the West Indies had started that way before the present research department was established. The Department of Agriculture itself carried out its variety fertiliser test work on the sugar estates. An annual cane and sugar survey was made for the estates, representing two-thirds of the production of the islands, and there were accumulated figures for seventeen years.

Dr. Dodds asked whether Mr. Barnes could deal with the method of paying small planters.

Mr. Barnes said the basis arrived at after many trials had been agreed upon by the Sugar Association on the one hand and cane farmers on the other and accepted by Government. The Government had the power to fix the price paid for cane, but with the exception of one year when a formula was applied and found unworkable this had been done by mutual agreement. Each factory was given a definite rating with regard to the percentage of raw sugar extracted, in which the planter shared. Each factory paid a proportion of the percentage based on the amount of sugar got from the cane. There was no general figure for overall recovery; the result was that different factories not only paid different prices because of their percentage rating but also paid a different rate dependent on the efficiency of their working and the quantity of sugar they could extract from the cane. The basic figure for the calculation was the value of the "naked" sugar. The bags, bagging cost, transport and shipping charges were deducted from the price the manufacturer received when calculating farmers' prices. At some factories the farmers were not all paid at the same rate because their cane differed in quality. The cane was tested at the factory by individual or group deliveries, depending upon quantity.