THE REVOLUTION IN SUGAR-CANE VARIETIES IN SOUTH AFRICA

H. H. DODDS, M.Sc., F.I.C.

A change in the variety or varieties of sugar cane commercially grown is a matter of considerable interest and importance in any cane-sugar industry. This is particularly the case where one variety has been firmly established for a very long time, like Uba in South Africa, or where the conditions are unusual, or specially exacting, so that only relatively few varieties can flourish. This is the case in South Africa. In few other countries is sugar-cane grown up to a latitude of nearly 31°, as it is here, and it is only possible here because of the Mozambique current bringing along the East African coast warm equatorial waters that moderate the severity of the winter season and confer on us in Natal a very equable and agreeable climate.

Climatic and Soil Limitations.

There is, however, a long period from April to October inclusive when the average atmospheric temperature is no more than 65.1°, and the average monthly rainfall only 2.13ins.—a period when sugar-cane cannot make appreciable new growth even under irrigation, because of the lack of heat. Sugar-cane, as we know it, does not make much vegetative growth at temperatures below 70° [1], though there are varieties recently discovered by Dr. E. W. Brandes in Central Asia that are said to be capable of active growth at much lower temperatures as well as a high degree of frost resistance[2].

What sugar-cane can do under cool conditions, however, is to develop sucrose, and it should be our aim therefore to establish varieties best able to exploit this long cool dry season by producing a high content of sugar and purity of juice, while resisting the effects of drought and the mild ground frosts that occur in some winters.

Our Queensland cousins have shown us the way in this, by introducing varieties that form an abnormally high sucrose content during their similar cool season. In a letter received recently, Dr. H. W. Kerr estimates for the past season's crop in Queensland a ratio of cane to 94 net titre sugar as low as 6.80.

Another important climatic disadvantage in this country is the rainfall which is deficient for sugar-cane. The annual average rainfall over the past nine years of 35 stations in the sugar belt is 42.44 ins. while the average rainfall at the Experiment Station for the past 12 years is only 36.42 ins., and 37.19 ins. over the past 51 years at Mount Edgecombe. Normally this is well distributed over the year, 60 per cent of it falling during the five active growing months of November to March when the mean atmospheric temperature is 72.6°. But droughts and almost equally disastrous floods are liable to occur at any time of the year so that any variety of cane to be widely adaptable in this country must have considerable powers of drought resistance and be economical in its demand for water, since irrigation is the exception rather than the rule.

According to Stubbs[3] sugar-cane should have an annual rainfall of about 60 inches of which three-quarters should fall during the growing season. But much depends of course on the humidity of the atmosphere and the rate of evaporation, also on the temperature, and on the porosity of the soil, as well as on mode of distribution of rainfall, so that any such estimate must be very approximate and conditional.

Another difficulty the sugar-cane meets with here to a degree almost peculiar to this country is the natural deficiency of phosphorus, characteristic of almost all our soils.

This is a deficiency that can of course be readily and relatively inexpensively supplied by artificials, such as superphosphate. It seems conceivable to me, however, that the application of phosphorus in this way, even in water-soluble form, may not have quite the same effect as phosphorus that is an integral part of the soil, so to speak, and thoroughly permeates it. We know that fixation of phosphorus takes place very rapidly in some of our soils[4] and besides the possibility of phosphates becoming more or less unavailable in this way, the difficulty in getting added phosphorus thoroughly incorporated in the soil, so that the plant roots can get at it readily, is considerable, especially where ratoon crops are concerned.

It may, therefore, be that a tolerance of an occasionally scanty or irregular supply of phosphorus on the part of a cane variety is also necessary under our conditions.

Disease Factors.

However that may be, a high degree of resistance and preferably also of tolerance to our little speciality in plant diseases, streak disease, is a necessity. Streak disease of sugar-cane appears to be peculiar to the African continent, and infection is in fact more virulent in sugar-cane in Egypt than at this end[5]. This virus disease has prevented several good varieties of cane from becoming established, and is probably the main factor in the deterioration of Uba. It is now generally believed by botanists that species of plants propagated vegetatively, that is from cuttings, do not necessarily deteriorate within any measurable period of time, provided they keep free of disease; but that sooner or later some disease factor usually supervenes[6]. As an example of this with sugar-cane, may be cited the variety Otaheite (Louzier) that has been in cultivation for over 150 years, and is still capable of giving excellent crops under favourable conditions, if kept free from disease infection.

Mosaic disease has always been much less prominent than streak disease in this country, because of the relative immunity of Uba from mosaic disease; but mosaic has persisted in this country for many years in spite of attempts to eliminate it, and is still a serious menace that must be taken into account in the introduction of new varieties. Some otherwise promising varieties have been rejected within recent years because of their susceptibility to mosaic disease.

Having thus broadly stated the conditions of the problem of selection of cane varieties for this country, I will outline recent attempts to solve it.

Uba Cane in Natal.

The almost accidental introduction of Uba in 1883 by the late Daniel de Pass[7] was undoubtedly the most important event that had ever occurred in the South African Sugar Industry, and if Uba had not been established it is very doubtful whether the industry would have survived.

Uba remained supreme as practically the only variety in cultivation for over fifty years. It was drought and frost resistant, resistant to mosaic and nearly all cane diseases, and tolerant of poor soil conditions and neglect of cultivation. On the other hand, it is a cane of poor quality for the sugar manufacturer, having only moderate sucrose content, high fibre, and colloid and waxy impurities which prove very refractory at the filtering and boiling stations of the sugar house. In the early twenties streak disease was first recorded in this variety, and spread rapidly during the ensuing years. Uba is fairly tolerant to streak disease, the loss in yield of cane being of the order of 11 per cent, but there appears to be a gradually accumulating loss of vegetative vigour as a further result[8]. It is now apparently difficult to grow it in this country without it becoming rapidly infected with streak disease.

Introduction of New Varieties.

One of the first and most important tasks therefore of the Experiment Station, founded in 1925, was to organise and accelerate the introduction of new varieties of cane from other countries.

I have already outlined the circumstances of previous importations by various organisations and private concerns[9]. Such of these as could still be found in this country were carefully collected and tried at the Experiment Station. Most of them had to be discarded because of infection with mosaic disease, but none of them promised to be of any permanent value greater than Uba.

At that time (1925) the range of known varieties in the world was very much less than it is now. Mosaic was a much greater problem, since very few seedlings had been produced showing any considerable degree of resistance, and at first the only varieties imported were those like Uba which were more or less immune.

We received in May, 1925, from the U.S. Bureau of Plant Industry in Washington, D.C., through the good offices of Dr. E. W. Brandes, Senior Pathologist in Charge of Sugar Plant Investigations, specimens of Toledo (Philippine Islands), Kassoer (Java), Oshima (Formosa) and Kavangire (India). None of these however, proved superior to Uba under our conditions.

This was the first of many varieties (47 in all to date) received from the same source. The South African Sugar Industry is very greatly indebted to the United States Department of Agriculture and to Dr. Brandes for the very generous way in which they have always acceded to our requests for cane specimens whenever they have been able to supply or to procure them for us. There have been very few cases in which they have not managed to obtain for us any variety for which we have asked, and the extent to which we have been able to reciprocate to their benefit is hitherto trivial.

Organisation and Equipment.

The systematic and safe introduction of varieties into this or any country really needs elaborate quarantine equipment and the supervision of a trained plant pathologist, as well as organised field trials at a later stage. It is usually found also that the official institutions or government departments that control the import of sugar cane specimens into most countries, and frequently the supply of specimens to other countries, will deal more freely with representative bodies than with private concerns.

In any case the danger of importing sugar canes without elaborate quarantine precautions is very great, and many cases might be cited of destructive plant diseases and insect pests being introduced where they were previously unknown, through insufficiently controlled sugar cane introductions.

The quarantine station of the South African Sugar Association at the Natal Herbarium, Botanic Gardens, Durban, was officially opened in April, 1926, but was completed and immediately put into use nearly a year previously with the first importation of canes from overseas by the Experiment Station.

It was donated to the Sugar Association by the munificence of the late Messrs. David Fowler and Edmund Campbell of Durban at a cost of over £1,000.

It is an excellent building of its kind, and has served its purpose admirably. Upwards of 130 new variety canes have passed through it since its erection, including all the new varieties now widely grown. Although several of these importations were found to be harbouring sugar cane diseases or noxious insects, the greenhouse has always barred their further progress.

Varieties are kept in the greenhouse from one to two years, according to their source and their probable degree of freedom from disease and insect pest. This period of waiting often seems irksome enough, but is not always time entirely wasted. The rate of growth and general vigour of the stools in the greenhouse give a valuable indication of the ultimate performance of the cane in the field; and cuttings taken during this quarantine period have occasionally been used for export in exchange for other desired varieties, by arrangement with our friends overseas.

The greenhouse was first in charge of Dr. H. H. Storey, Government Mycologist, Durban, and in recent years under the care of his successor, Dr. A. P. D. McClean. The Industry is much indebted to these officials for their very valuable services in this and many other ways.

The selection of varieties for introduction in those days was made by the writer in collaboration with Dr. Storey. As stated the choice of varieties was very restricted and relatively little was known about such new canes as were available.

Mosaic Disease.

It was the accepted policy on the part of the Sugar Association in those days to eliminate mosaic disease if possible by having a close season for all varieties other than Uba, during which time it was believed that mosaic disease would die out through lack of any perennial foothold, Uba then being considered absolutely immune from mosaic disease. Since then however, Yoder in the U.S.A. has reported a few cases of mosaic in Uba and other highly resistant varieties[10].

This policy was not entirely successful, owing to the existence of a perennial grass, Setaria sulcata, capable of acquiring mosaic disease and transmitting it to sugar cane, and a slight degree of infection occurs to-day in many districts, at least.

Nevertheless, the policy was a very beneficial one, by giving the Association control of the variety position, so that an entirely new start could be made with imported canes or specially selected local material, and reducing the intensity of infection to a minimum.

Although mosaic disease still exists, it is no longer such a serious menace because many modern varieties are more or less highly resistant to it.

Coimbatore Varieties.

About 1925 the cane-breeding work of Dr. C. A. Barber at Coimbatore and his associates and successors came into world prominence and though comparatively little was then generally known of the Coimbatore canes we applied for our first selection of these varieties, Co.205, 210, 213, 214, and 281, and received specimens of each of these direct from Coimbatore in December, 1925.

All of these showed much promise under our conditions, but all exhibited serious faults eventually except Co.281. There was, however, a good deal of delay in getting this variety released by the South African Department of Agriculture because of the reputation it had gained meanwhile for susceptibility to mosaic disease in certain countries.

It was eventually released for commercial planting in 1933, and speedily proved one of the best canes ever grown in South Africa. It is a good germinating cane, vigorous rapid grower, develops high sucrose and purity, and is an excellent ratooner. Co.281 is also highly frost-resistant, and drought resistant, and is for all practical purposes immune from streak disease. So far there has not been recorded a single field case of streak or mosaic disease, so that it has at present a high degree of resistance to both these diseases under our conditions.

The only serious defect is a high fibre content, nearly as high as that of Uba.

It will grow well in soils with a stiff clay subsoil, which frequently occur in this country and which few canes will tolerate. Co.281 is not at its best, however, in a very light sandy soil, contrary to its early reputation in this respect. It is said to tolerate brak soil conditions very well, but we have had no experimental evidence of that in this country.

Our experiments show that on the whole Co.281 has yielded about 40 per cent more sucrose per acre than healthy Uba under the same conditions, and about 60 per cent more than streak-diseased Uba.

That first introduction of Coimbatore varieties has been followed by many more so that we now have in our collection 35 in all, of which three, Co.281, 290, and 301 have hitherto been released for commercial planting. I will have more to say of these later in this paper in their chronological sequence of introduction into the country.

Uba Hybrids.

In March, 1926, specimens of CH 64/21 were imported from the Cuban Government Sugar Experiment Station near Havana. This variety is practically immune from mosaic disease and is said to be a cross between Natal Uba and D74, formerly a standard variety in Louisiana. It resembles Uba very closely, however, and shows so little of D74 characteristics that it has been doubted whether it is an actual hybrid or a superior strain of Uba.

It proved on the whole superior to Uba in this country, and was in fact released for commercial planting in December, 1930, but became increasingly subject to streak disease, so that it has now almost entirely gone out of cultivation.

Another so-called Uba hybrid, U.D. 1, was obtained from Honolulu in July, 1927, through the courtesy of the Hawaiian Sugar Planters' Association. This was described as a hybrid of D1135 and Uba, produced in Hawaii, but on enquiry it was found that the Uba was not the Natal Uba we know but the so-called Japanese Uba, really the Formosan variety Zwinga. In any case U.D.1 proved susceptible to mosaic disease, and generally disappointing in this country; it is very sensitive to cold chlorosis like its D1135 parent.

P.O.J. Varieties.

Another well-known series of modern cane varieties is the world-famous P.O.J. canes containing many triumphs of the plant breeders' science. Some of the earlier numbers of that series such as P.O.J. 36, 100, 213 and 234 were used to combat mosaic disease, especially in Louisiana and the Argentine Republic but by a plan of campaign radically different to ours.

These varieties are all highly susceptible to mosaic disease, but very tolerant—that is to say they soon become totally infected, but appear to lose nothing thereby from a sugar producing standpoint, for many replantings at all events. The disadvantage of this simple course of planting up these tolerant varieties is that the range of the disease is extended and perpetuated, thus ruling out the re-instatement of desirable but susceptible varieties.

Consequently the early P.O.J. varieties were of no use to us under our policy towards mosaic disease. P.O.J.213 was in fact introduced by the Sugar Association in 1914 under the name of Argentine cane and was extensively planted for a time. It became completely infected with mosaic disease and was eventually eradicated except for one or two stools that had resisted or thrown off the infection, and formed the basis of a small mosaic-free stock of P.O.J. 213 at the Experiment Station.

In 1925 however, we heard of a new series of P.O.J. varieties numbered from 2714 onwards that were not only tolerant to mosaic disease if they happened to get it, but were also highly resistant. This was just the kind of cane we were looking for in our plan of campaign against mosaic disease and in June, 1926, we managed to get some specimens of P.O.J. 2714, and in March, 1927, more of P.O.J. 2714 and some P.O.J. 2725, also through the generosity of Dr. Brandes and the U.S. Bureau of Plant Industry.

In October, 1927, we became aware of quite a new possible source of cane specimens.

Incomati Estates, of Xinavane, Portuguese East Africa, through the enterprise and many personal visits to foreign countries of their general manager, Mr. C. J. Olivier, had built up a collection of valuable varieties remarkable for a private firm. We arranged a system of exchange of varieties with this firm that still exists to-day. In all we have received over 30 varieties through this source and returned about the same number in exchange.

We obtained from them in the first consignment specimens of P.O.J.2722, 2727, 2878, and more material of P.O.J.2725, at a time when some of these varieties were at a premium all over the world, and were said to be changing hands in Cuba at prices up to two dollars a bud, and armed guards for cane nurseries were necessary in some places.

In order to build up material as rapidly as possible of these varieties we used a method of rapid propagation first devised in Java and published by Brandes[11]. This consists in dividing young stools of cane into smaller units, each portion containing at least one sprout and a modicum of rhizome and roots. These are then planted in a specially prepared soil bed and carefully watered and tended. By this means the supply of material for planting can be multiplied ten to twenty fold within a few months' time given suitable growing weather and regular abundant watering.

This method was very effectual here during the summer months of 1929 and 1930 in building up stocks of P.O.J. canes but has not been used since, partly because there has not been the urgency for it and partly because of the considerable quantity of water required, hitherto a rather scarce commodity at the Experiment Station.

P.O.J. 2725 and 2878 were released for commercial planting in 1930 and P.O.J. 2714 and 2727 in 1931.

Of these P.O.J. 2714 proved disappointing because of its poor ratooning qualities, and has now largely gone out of cultivation. It develops under favourable conditions a magnificent stand of plant cane, of excellent quality. It is a handsome purple red cane, becoming brownish-red when mature.

P.O.J. 2725 is by far the most successful of this series and has revolutionised the industry in the northern part of Zululand, especially in the Umfolozi and Umhlatuzi alluvial flats. But it is capable of growing to perfection in similar terrain in the sugar belt anywhere, for example on the Umkomaas river flats on the South Coast, or under irrigation in suitable rich deep heavy soil, adequately drained.

In our experiments in Zululand P.O.J. 2725 has on the average shown a superiority in yield of sugar per acre over Uba of from 75 to 100 per cent in both plant cane and first and second ratoons[11]. Yields of 100 tons per acre of P.O.J. 2725 at Umfolozi are not uncommon. The sucrose content of the cane is usually two per cent or more above that of Uba grown under the same conditions, with corresponding increase in purity of juice, and a much lower fibre content.

P.O.J. 2725 is not at all suited to poor or sandy soils or to drought conditions. It will maintain a green and healthy appearance through a fairly severe drought, but appears to receive a prolonged check to its growth. P.O.J. 2725 has a distinct propensity to flower and in unfavourable circumstances may do this prematurely before it has made sufficient growth for the mill, in which case it can only be used profitably for planting. If it has made sufficient growth to mill, however, it can safely be left to mature even after flowering. In one instance at the Experiment Station a field of P.O.J. 2725 flowered in March, its sucrose content then being 13 per cent. This steadily increased month by month until in September the same field yielded 18 per cent of sucrose and was then harvested.

P.O.J. 2725 has a slight susceptibility to streak disease, but the rate of infection is so slow that it can easily be kept in check by discarding infected material for replanting. The loss in yield of cane due to streak disease is about 12 per cent, or about the same as with Uba.

Like all the released varieties, we have never yet had a single field case of mosaic disease recorded in P.O.J. 2725 anywhere in this country.

P.O.J. 2725 is very susceptible to the effects of the light frosts that occasionally occur and should not be grown in fields most liable to such frosts.

P.O.J. 2727 turned out somewhat disappointing mainly on account of its low sucrose content in many cases, in spite of many excellent qualities; it has now practically gone out of cultivation.

P.O.J. 2878, the wonder-cane of Java I believe would have been widely planted in certain districts with very good results if it had not been overshadowed by P.O.J.2725, which did even better in nearly every case where P.O.J. 2878 did well. In general it behaves similarly to P.O.J. 2725, but is even more exacting in its soil and moisture requirements, especially in the ratoon crops and is now but little cultivated. Like P.O.J. 2714 and 2727, there has never been a field case of streak disease reported in P.O.J. 2878.

Since these original introductions of the later P.O.J. varieties we have received several others from time to time, but none of them appear to be of any promise for us, with the possible exception of P.O.J. 2883 which we received fromWashington in April, 1936.

This was the only variety that was growing commercially in Java besides P.O.J. 2878 at the time of my visit there in 1935, and was reserved for specially wet and swampy lands. It might therefore have possibilities at Umfolozi. It is rather remarkable that P.O.J. 2714, 2725, 2878, and 2883 are all derived from the same cross, P.O.J. 2364 x EK 28.

Other Varieties.

Other well-known Javan varieties such as EK 28, B247, SW 499, Tjepering 23, and others that have been introduced from time to time have never shown any adaptability to our somewhat severe conditions; although Green Natal, formerly grown widely in this country is really Light Preanger, a Javan cane that has been cultivated on a very large scale in many countries under various local names, Crystalina, White Transparent, Rose Bamboo, etc. At one time it must have been producing half of the cane sugar in the world, at the height of Cuban production.

We have had similar experiences with several excellent West Indian varieties such as BH 10/12, SC 12/4, B 726, etc., that have been introduced and found lacking, though SC 12/4 showed some promise at first. BH 10/12, one of the best varieties ever known, both in field and factory usually headed the lists in our sucrose tests, but seldom made satisfactory growth. Both these canes were originally due to Bovell in Barbados, one of the pioneer cane breeders whose work has been of the greatest value to the world.

H 109, an excellent irrigation cane in Hawaii, that appears to have succeeded nowhere else, is one of the few varieties that seem unable to survive the long journey to South Africa.

Co. 290 and Co. 301.

Among the first consignment of variety canes we obtained through Incomati Estates was Co. 290, a cane that has proved one of the most valuable of all, both at Incomati and in this country. It was released for commercial planting in 1931.

Co. 290 is a heavy-yielding fast-growing cane like Co.281, but somewhat less hardy than that variety in most respects. The yield of sucrose per acre is about 30 or 40 per cent more than Uba under average conditions, more so in the most suitable soils or under irrigation.

It is not quite such a vigorous ratooner as Co. 281 but tends to give a better plant cane crop.

The quality of the cane is very good, sucrose content and purity of juice usually being high, and fibre content low.

It is slightly susceptible to streak disease, but infection spreads slowly, and there is evidently a high degree of tolerance. The yield of plant cane and first ratoons at the Experiment Station from streak diseased cane is not appreciably less than from healthy canes in the same field.

Co. 290 shows early signs of distress in drought, but it takes very severe drought to kill it, and its rate of recovery and subsequent growth after rain is remarkable. The same may be said of its recovery after locust attack.

It prefers light well-drained soils, and does remarkably well under irrigation in soils too light or too shallow for the P.O.J. canes. It is rather more exacting than Co. 281 in its planting requirements, a warm, well-drained, moist soil.

Of the later Coimbatore varieties imported either direct or via Incomati Estates Co.301 that we received direct from Coimbatore in October 1930, has been able to fulfil the necessary exacting requirements for release for commercial cultivation.

Co.301 is a green cane that resembles Uba in appearance. In variety trials against Co. 281 and Co. 290 it has usually taken the lead in yield of cane while maintaining an equal sucrose content and purity over a wide range of soils; the fibre content is low.

It is very highly resistant to streak disease, only two field cases ever having been recorded.

We do not know much about its resistance to drought under our conditions, but in India it has the reputation of being more resistant than either Co. 290 or Co. 281.

Co. 301 requires a well-drained soil bed for planting, otherwise an uneven stand of cane may result. It is probably better planted early in the season before the weather has become very warm, according to Indian experience.

Co. 301 was released to the Industry in 1935, and has proved a very popular variety since, though little has yet come to the factory, most of the product being used for replanting.

We have still 15 Coimbatore varieties numbered from Co. 331 upwards received during the past year or two awaiting preliminary and final trials. Of these Co.331, Co.419, Co.421, and Co.426 appear to be of special promise. The three latter belong to the new thick cane series of Coimbatore varieties, and are doing very well in many parts of India.

H. M. Varieties.

Another series of Indian varieties of which specimens were received here as a result of my visit to India in 1935 are the H.M. series from the Agricultural College at Hebbal near Bangalore, Mysore. We have received by the courtesy of Dr. V. K. Badami, Deputy-Director of Agriculture, Mysore State, 11 of these varieties which have been produced by an entirely novel method as applied to sugar cane, and quite distinct from the usual hybridising process.

Buds of a given variety of sugar cane are subjected to controlled exposure to X-rays; this has the property of destroying and eliminating some of the genes, resulting in each bud so treated becoming the forerunner of an entirely distinct and permanent variety. Some of these were giving excellent field results in Mysore.

Canal Point Station, U.S.A.

The U.S. Cane Breeding Station at Canal Point, Florida, U.S.A. has produced in recent years several new varieties of great interest to us[13].

Co. 281 and 290 became successfully established in Louisiana a few years ago, but after two or three years became seriously infected by mosaic disease with heavy losses in yield. As a result they are being largely replaced by recent C.P. seedlings mostly derived by crossing Co. 281 with local varieties so as to produce new hybrids of a high degree of resistance to mosaic disease while maintaining the excellent qualities of Co. 281. One or two of these such as C.P. 29/320 and C.P. 28/19 are showing considerable promise here. We would certainly be in a more satisfactory position with stocks established of these resistant varieties in the event of any recrudescence of mosaic disease.

Varieties from Puerto Rico.

Other series of recent varieties, produced in Puerto Rico, are of interest to us. They have been bred mainly at three stations in the island—the U.S. Federal Government station at Mayaguez (My series), the Insular Government station at Rio Piedras (P.R. series) and a private cane breeding station belonging to Central Fajardo (F.C. series). Nearly all of these varieties are hybrids of P.O.J. 2725 with S.C. 12/4, bred in an attempt to improve on P.O.J. 2725, especially by eliminating the early flowering tendency. However, the one which is showing most promise here at present is My 151 which is the only one we have not derived from P.O.J. 2725 but from P.O.J. 2364, a variety that has been of great value in cane breeding in Java, and is the mother of all our released P.O.J. cane varieties.

We obtained recently some extraordinarily high sucrose tests from one year old cane of some of these Puerto Rico varieties, several of over 17 per cent, and one of more than 19 per cent sucrose[14]. Some of these varieties have contracted mosaic disease here, however, which their P.O.J. 2725 parent has never done.

Other Countries.

It is rather surprising, in view of the somewhat similar climatic conditions between our sugar industry and that of Southern Queensland and New South Wales, that the Australian varieties have proved hitherto of so little promise under our conditions. That applies not only to those imported by Natal Estates, Ltd., about 15 years ago, of which D. 1135 (originally from British Guiana) and Badila (originally from New Guinea) showed some promise but did not survive permanently, but also to the more recent introduction in September, 1931 of S.J. 4, S.J. 7, Q. 831, and Pompey from the Queensland Bureau of Sugar Experiment Stations.

We have also imported a selection of varieties from British Guiana (Department of Agriculture) including the noted Diamond 10, but these have proved specially susceptible to mosaic disease, even under our mild conditions of infection.

Besides the countries already named, we have imported one or two varieties direct from Barbados (Department of Agriculture) and Philippine Islands (Philippine Sugar Association) to whom we are also indebted for their co-operation.

Seedling Work.

A more recent development of our variety work, and one which may be potentially more valuable, though no ultimate results in the form of new released varieties have yet been gained from it, is the germinating of seedling canes from imported fertilised seed tassels.

Sugar-cane, as in most sub-tropical countries, is not fertile here, but we can import fertilised cane flowers from countries able and willing to supply, and develop our own hybrid seedlings therefrom.

This method avoids almost entirely the risk of introducing disease or insect pest that is always present with imported cane setts. It also locates the procedure of selection to the country for which the cane is desired, so that the cane is selected to suit these conditions instead of the conditions of some other country. There is a better prospect, therefore, of getting eventually canes ideally suited to the country concerned.

The principal disadvantage is the time and skilled labour required in examining and discarding many hundreds or thousands of seedlings in the search for the potential few of real value.

(It should perhaps be explained for the benefit of my lay listeners that every separate seed of sugar cane is a distinct individual of incalculable characteristics and the forerunner of a potential new variety. Like brothers in the same family they are likely to have certain family likenesses, but may be almost anything within certain wide limits).

Nevertheless the possible rewards from cane breeding are so great that nearly every cane-sugar producing country has undertaken this kind of work, whether they maintain an exchange of established varieties with other countries or not.

We have experimented in a small way on these lines. Our first batch of imported seed was from Canal Point, Florida, U.S.A. from whence we received in March, 1930, seed tassels of five C.P. varieties. A fairly successful germination was attained, but only two varieties, N.F. 35 and N.F. 42 were considered worth keeping permanently in our collection and neither of them were considered worth releasing.

The next batch of seed was received from Mauritius in November, 1932, and was from a cross of the extremely vigorous and luxuriant growing variety Uba Marot with P.O.J. 2878 to give if possible canes of high sucrose and good milling qualities as well as prolific growth. 150 of these seedlings survived germination and transplanting and four were eventually selected to remain in our collection, but none were of outstanding merit though many combined the vegetative vigour of their Uba Marot parent with a vastly improved quality of juice.

This then was evidently on the right lines, as our friends in Mauritius had already found, and we have recently received from them (August, 1937) seed of Uba Marot crossed twice with high quality (so-called "noble") cane.

We have 751 seedlings of this latter series representing five different crosses of the type just mentioned now growing here and looking very well.

For these two importations of seed we are greatly indebted to the Sugar-Cane Research Station of the Department of Agriculture, Mauritius, and to Mr. N. Craig, biochemist in charge, as well as to his predecessor, Mr. A. Glendon Hill.

Some most promising seed tassels of crosses selected by ourselves were received from Coimbatore in January, 1936. There were three crosses, P.O.J. 2725 x Co. 214, P.O.J. 2725 x Co. 281, and P.O.J. 2725 x Co. 301, which were kindly made for us at the Coimbatore cane breeding station.

For this, as well as for numerous varieties, of which no less than three, Co. 281, 290 and 301, have already proved of the greatest value to this country, the South African Sugar Industry is very greatly indebted to Rao Bahadur T. S. Venkatraman, C.I.E., I.A.S., Government Sugar-Cane Expert, in charge of the Imperial Sugar cane Station at Coimbatore, and to his assistants, Messrs. R. Thomas and N. L. Dutt, M.Sc.

And since gratitude has been defined as a lively sense of favours yet to come, I may remark that we are looking forward now to the receipt of a promised further supply of variety specimens and fertilised tassels from Coimbatore.

The idea in selecting the above-named crosses of P.O.J. 2725 with Co. canes will be evident without much explanation. It is hoped to produce canes of rather thicker habit than the early Co. varieties, with higher sucrose and purity and lower fibre, while retaining their characteristic hardiness and adaptability and rapid growth.

Over 250 of these seedlings, representing the second selection based on growth and on hand refractometer tests of juice density have recently been replanted at the Experiment Station.

Time required to select and establish New Varieties.

Unfortunately the time taken to establish cane varieties new to this country, whether from seed or from setts, is very considerable.

In the case of P.O.J. 2725 and 2878 the varieties were released within less than four years of their first introduction, and nearly as rapidly in the case of CH. 64/21 and Co. 290.

Now that the matter of introducing new varieties is somewhat less urgent, and the competition they have to meet is more severe, it is most advisable to make the probationary period longer, if only to study the all-important ratooning powers more thoroughly. Certainly we now get much more detailed information from other countries than was available in the past concerning the performance of new varieties, but that is only an indication and by no means a certainty about what they will do here.

I regard at present six years as the minimum of time that must elapse between the introduction of a variety and its release in appreciable quantities, with sufficient information about it to justify its release.

Until a variety has passed out from the quarantine greenhouse stage the quantity of material of that variety remains very small, and never more than a few sticks of any cane, sometimes only one or two, are available for planting out at the Experiment Station.

So that even with the most rapid rate of propagation it takes time to build up stocks sufficient for variety trials, and much more for general distribution, especially without irrigation facilities at the Station.

Selection Procedure.

The hand refractometer is very useful, in enabling tests of juice density to be made from a few drops, and thereby avoiding the sacrifice of precious planting material in the crushing of sample canes for analysis.

Only a very small proportion of varieties pass the preliminary field tests and cane analyses to the stage of a complete variety trial (plant cane and ratoons) under conditions that give them a fair chance in competition with established varieties and other new rivals. In the past it has not been very easy to ensure this fair chance with our limited resources of experimental sites in representative soils; but I do not think that any potentially valuable variety has ever been over-looked in the hundred or so established varieties and many hundreds of seedlings that we have already dealt with, although there are many varieties, such as P.O.J. 2725, that do not show to best advantage in any conditions we can supply at the Experiment Station.

The development and adequate testing of a new variety needs the co-operation first of the botanist both in his role of plant breeder and plant pathologist; the agriculturist to gain an accurate idea of the productive capacity of the variety under good treatment and fair comparison with known varieties; also the chemist to assess the value of the product in relation to the capability of the soil, and the statistician to measure the accuracy and reliability of the data gained. In other words there is required all the essential services of a modern experiment station.

Conclusion.

Sufficient has been said I think to show that the new cycle of change from the half-century of supremacy of Uba cane has well begun, but has by no means reached finality.

I believe the time is past when this country will depend on only one, or even two or three, varieties. The widely different conditions prevailing in various parts of our sugar belt demand different varieties best suited to each representative environment. Good examples of the kind of system I mean are to be found in Puerto Rico and in Queensland. There many varieties are each in more or less permanent occupation of a certain district, or perhaps share it with one or two competing varieties, or with varieties better adapted to certain different conditions of soil or of moisture supply within the same district, or to different purposes, such as harvesting earlier or later in the season.

With the ever-growing scientific knowledge and resources of the world at our disposal, we have in this country, notwithstanding its climatic limitations, given favourable economic and political conditions, possibilities of successful intensive and profitable production of sugar to a degree little realised at the present difficult times.

Summary.

An outline is given of the introduction of new varieties of sugar-cane and of sugar-cane seed into South Africa during the past 13 years.

The most successful varieties hitherto are shown to be Co. 281, 290 and 301 and P.O.J. 2725, which have largely supplanted Uba, formerly exclusively grown.

References.

(1) H. W. Kerr. "Some Important Factors in Cane Irrigation." Proc. Queensland Soc. of Sugar Cane Technol., 1936, p. 59.

(2) E. W. Brandes. "Possibilities of Further Progress in Breeding Sugarcane for Cold Resistance." Sugar Bulletin, New Orleans, 15, 12, March 15th 1937, p. 5.

(3) W. C. Stubbs. "The Cultivation of Sugar Cane," p. 29, New Orleans, 1900.

(4) B. E. Beater. "The Measurement of Phosphate Fixation in Soils." Soil Science, 44, 4, Oct., 1937, p. 277.

(5) A. H. Rosenfeld. "Notes on Varietal Resistance to Streak Disease in Egypt and Natal." Int. Sug. J., 40, 471, March, 1938, p. 99.

(6) J. Grainger. "Virus Diseases of Plants," pp. 2 and 12, London, 1933.

(7) A. W. Hill. "The Uba Cane. Some Further Evidence as to its Origin." Int. Sug. J., 33, 392, Aug., 1931, p. 379.

(8) A. P. D. McClean and R. H. Halse. "Streak Disease of Sugar Cane: Its Economic Importance in South Africa." Proc. of 10th Ann. Congr. S. Af. Sug. Technol. Assn., 1936, p. 107.

(9) H. H. Dodds. "Outline of Scientific Progress in the South African Sugar Industry." S. Af. Sug. J., 20, 1, Jan., 1936, p. 33.

(10) P. A. Yoder. "Rare Cases of Mosaic Disease in highly resistant Varieties of Sugar Cane." U.S. Dept. of Agr., Bul. 392 (1926).

(11) E. W. Brandes. "A Rapid Method for Propagating Seed Cane." Facts About Sugar, 21, April 10, 1926, p. 348.

(12) Anon (H.H.D.). "Average Comparative Yields of Sucrose per Acre of Certain Varieties." S. Af. Sug. J., 20, 12. Dec., 1936, p. 751.

(13) E. W. Brandes. "Sugarcane: Its Origin and Improvement." U.S. Yearbook of Agriculture, 1936, p. 591.

(14) "Sugar Experiment Station Report for December." S. Af. Sug. J., 22, 1, Jan., 1938, p. 13.

Experiment Station,
South African Sugar Association,
Mount Edgecombe, Natal

South African Sugar Association.

Experiment Station, Mount Edgecombe.

CANE VARIETIES IN THE COLLECTION IN JANUARY, 1938.

A. At the Experiment Station.

Variety.	Parentage.	Country of Origin.
Agaul		India
B.247	Black Cheribon x Red Fiji	Java
B.726		Barbados
Badila		New Guinea
BH.10/12	B.6835 (B.1379 open cross) open cross	Barbados (1910)
Black Innes (Mauritius 189)		Mauritius
Black Tanna		New Hebrides
Booth's Selection		?(Found in S. Afr.).
CH.64/21	Uba x D.74 (Light Preanger open cross)	Cuba (1921)
Clarke's Seedling		Australia
Co.205	Vellai x S. spontaneum	India
Co.210	P.O.J.213 x Madras 2	,,
Co.213	P.O.J.213 x Kansar	,,
Co.214	Striped Mauritius x M.4600 (Saretha x S. spontaneum)	,,
Co.223	Chittan x M.1515 (Naanal x S. spontaneum)	,,
Co.237	P.O.J.213 x Red Fiji	,,
Co.243	A.2 x Co.206 (Ashy Mauritius x S. spontaneum)	,,
Co.244	P.O.J.213 x Co.205	,,
Co.270	B.3747 x Co.206	,,
Co.281	P.O.J.213 x Co.206	,,
Co.284	P.O.J.213 x Co.206	,,
Co.285	Green sport of Striped Mauritius	,,
Co.290	Co.221 (P.O.J.213 x Co.291) x D.74	,,
Co.301	Co.213 x P.O.J.1499 (P.O.J.385 x P.O.J.181)	,,
Co.303	Co.221 x P.O.J.1507 (P.O.J.213 x P.O.J.369)	,,
Co.312	Co.213 x Co.244	,,
Co.313	Co.213 x Co.244	,,
Co.317	Selfed Co.229 (Selfed Co.205)	,,
Co.331	Co.213 x Co.214	,,
Co.351	P.O.J.2725 x Sorghum durra Stapf	,,
Co.354	,, ,, ,, ,,	,,
Co.355	,, ,, ,, ,,	,,
Co.356	,, ,, ,, ,,	,,
Co.413	Co.290 x B.247	,,
Co.419	P.O.J.2878 x Co.290	,,
Co.421	P.O.J.2878 x B.3412 (D.74 open cross)	,,
Co.426	P.519 x Co.360 (P.O.J.2725 x Q.116)	,,
Co.432	P.O.J.2727 x Co.285	,,
Co.434	P.O.J.2878 x (probably) E.K.28	,,
Co.508	Selfed Co.214	,,
C.P.177		U.S.A.
C.P.807	Selfed U.S.1643 (probably selfed P.O.J.213)	,,
C.P.28/11	Co.281 x U.S.1694 (P.O.J.213 x ?)	,,
C.P.28/19	,, ,, ,, ,,	,,
C.P.29/320	Co.281 x C.P.27/34 (D.74 x U.S.1694)	,,
Cuban Selection	Probably indentical with CH 64/21	Cuba
D.1135	Unknown	British Guiana
D.207/20	D.145 open cross	British Guiana
D.666/13	D.625 (open cross of Dyer) open cross	,,

Variety.	Parentage.	Country of Origin.
Diamond 10	Diamond 185 (unknown) x D.145 (open cross of Striped Preanger)	British Guiana
E.K.28	P.O.J.100 (Black Borneo x Loethers) x E.K.2 (Lahaina x Red Fiji)	Java
F.C.915	P.O.J.2725 x SC.12/4	Puerto Rico
Gilbert's Selection		?(Found in S. Afr.).
Gingor (Goru or Mauritius Gingham)		Australia
Glagah (Saccharum spontaneum)		Java
H.M.609		India
H.M.619		"
Hind's Special		Philippine Islands
Horne		Mauritius
H.Q.694 (?)		Australia
Kavangire		India
Kassoer	Black Cheribon x Glagah	Java
La Mercy Red		Mauritius (?)
La Mercy Yellow		"
M.1900		"
M.P.55		"
Mayaguez 3	P.O.J.2725 x SC.12/4	Puerto Rico
Mayaguez 7	" "	"
Mayaguez 28	" "	"
Mayaguez 42	" "	"
Mayaguez 49	" "	"
Mayaguez 61	" "	"
Mayaguez 63	" "	"
Mayaguez 151	P.O.J.2364 x My.9 (Selfed SC.12/4)	"
N.F.35	(Selfed P.O.J.213)	S.Africa (Seed ex Florida, U.S.A.).
N.F. 42	"	"
N.M.98	Uba Marot x P.O.J.2878	South Africa (seed ex Mauritius)
N.M.105	" " "	"
N.M.134	" " "	"
N.M.139	" " "	"
Merthi		India
Ogle's Selection		?(Found in S. Afr.).
Oshima		Japan (Formosa)
Otaheite		Society Islands
P.O.J.36M	Bud Selection of P.O.J.36 (P.O.J.105?)	Japan (Formosa)
P.O.J.36	Striped Preanger x Chunni	Java
P.O.J.100	Black Borneo x Loethers	"
P.O.J.213	Black Cheribon x Chunni	"
P.O.J.234	" "	"
P.O.J.2714	P.O.J.2364 (P.O.J.100 x Kassoer) x E.K.28 (P.O.J. 100 x E.K.2)	"
P.O.J.2722	" " "	"
P.O.J.2725	" " "	"
P.O.J.2727	P.O.J.2364 x Batjan	"
P.O.J.2753	P.O.J.2364 x P.O.J.1507	"
P.O.J.2803	P.O.J.2703 [P.O.J.2354 (P.O.J.100 x Kassoer) x E.K. 28] x P.O.J.2713 [P.O.J.2364 x P.O.J.2571 (Cheribon x Fiji)]	"
P.O.J.2822	P.O.J.2526 (Cheribon x Kassoer) x Tjoekir 154	"
P.O.J.2878	P.O.J.2364 x E.K.28	"
P.O.J.2883	P.O.J.2364 x E.K.28	"
P.O.J.2946	P.O.J.2875 x S.W.111	"
P.O.J.2947	P.O.J.2875 x S.W.3	"
P.O.J.2952	P.O.J.2722 x S.W.499	"
P.R.803	P.O.J.2725 x SC.12/4	Puerto Rico

Variety.	Parentage.	Country of Origin.
P.R.809	P.O.J.2725 x SC.12/4	Puerto Rico
Pompey		Australia
Light Preanger ..		Java
Q.813		Australia
Rapson's Selection ..		Mauritius
Rouillard's Selection		"
R.P.8		"
S.C.12/4	B.6835 (B.1379 open cross) open cross	Barbados
Sin Nombre (probably Saretha)		India
*Striped Co.281	P.O.J.213 x Co.206	South Africa
Striped Co.290	Co.221 x D.74	"
Striped P.O.J.2725 ..	P.O.J.2364 x E.K.28	"
Striped Uba		"
S.J.4	Badila open cross	Australia
S.J.7	" " "	"
S.W.499	(Black Cheribon x Batjan)	Java
Tjepering 24		"
Toledo		Philippine Islands
Townsend's Selection (formerly known locally as "China" cane)		?(Found in S. Afr.).
Transkei Selection ..		"
Tucuman 451		Argentine
Tucuman 454		"
Tucuman 472		"
Tucuman 544		"
Tucuman 1406	Co.243 x Co.244	"
Uba		India
Uba Marot		Mauritius
U.D.1	Zwinga x D.1135	Hawaii
Yellow Caledonia ..		New Hebrides
Yon-tan-san		Japan (Formosa)
Zwinga		China
U.S.663		U.S.A.

255 Seedlings from Coimbatore (150 P.O.J. 2725 x Co. 301; 80 P.O.J. 2725 x Co. 281; 25 P.O.J. 2725 x Co. 214).

751 Seedlings from Mauritius (18 Uba Marot x P.O.J.2878; 345 Selangor seedling x M196/31; 178 Selangor seedling x M.108/30; 144 M.109/26 x M.108/30; 66 M.109/26 x M.196/31).

*Several other field sports of Co. varieties have occurred in South Africa and are under observation here.

B. In the Quarantine Greenhouse in Durban:

Variety.	Parentage.	Country of Origin.
Black Cheribon ..		Java
Co.299	Co.213 x P.O.J.1410	India
Co.300	" "	"
Co.360	P.O.J.2725 x Q.116	"
Co.402	Vellai x Co.243	"
Co.433	P.O.J.2878 x E.K.28 (?)	"
C.P.29/103	P.O.J.2725 x CP.1165	U.S.A.
C.P.29/116	" "	"
C.P.29/291	Co.281 x U.S.1694	"
H.M.89		India
H.M.320		"
H.M.606		"
H.M.608		"
H.M.613		"
H.M.617		"

DIAGRAM OF DESCENT OF THE PRINCIPAL JAVAN CANES

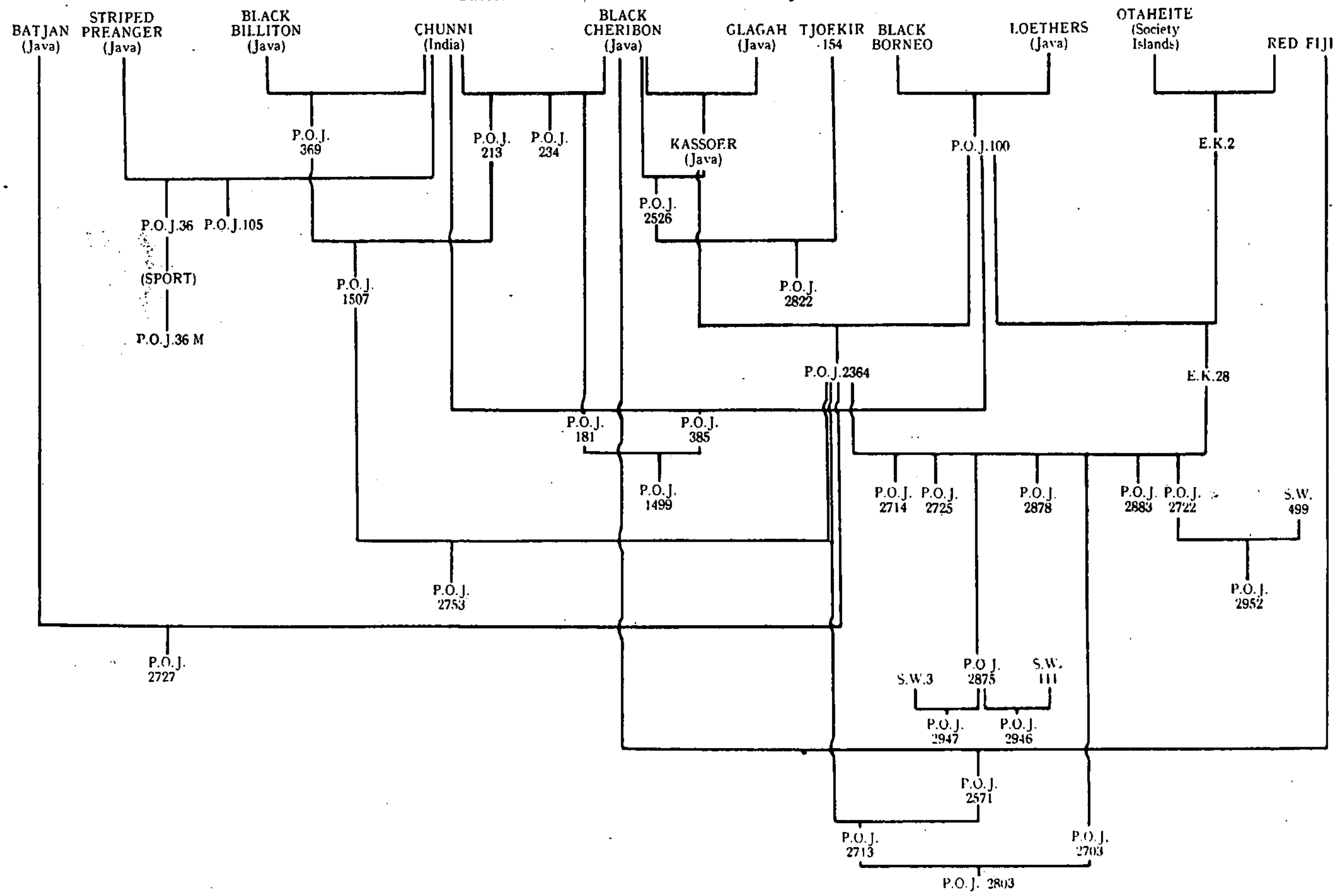


DIAGRAM OF DESCENT OF THE PRINCIPAL Co. VARIETIES

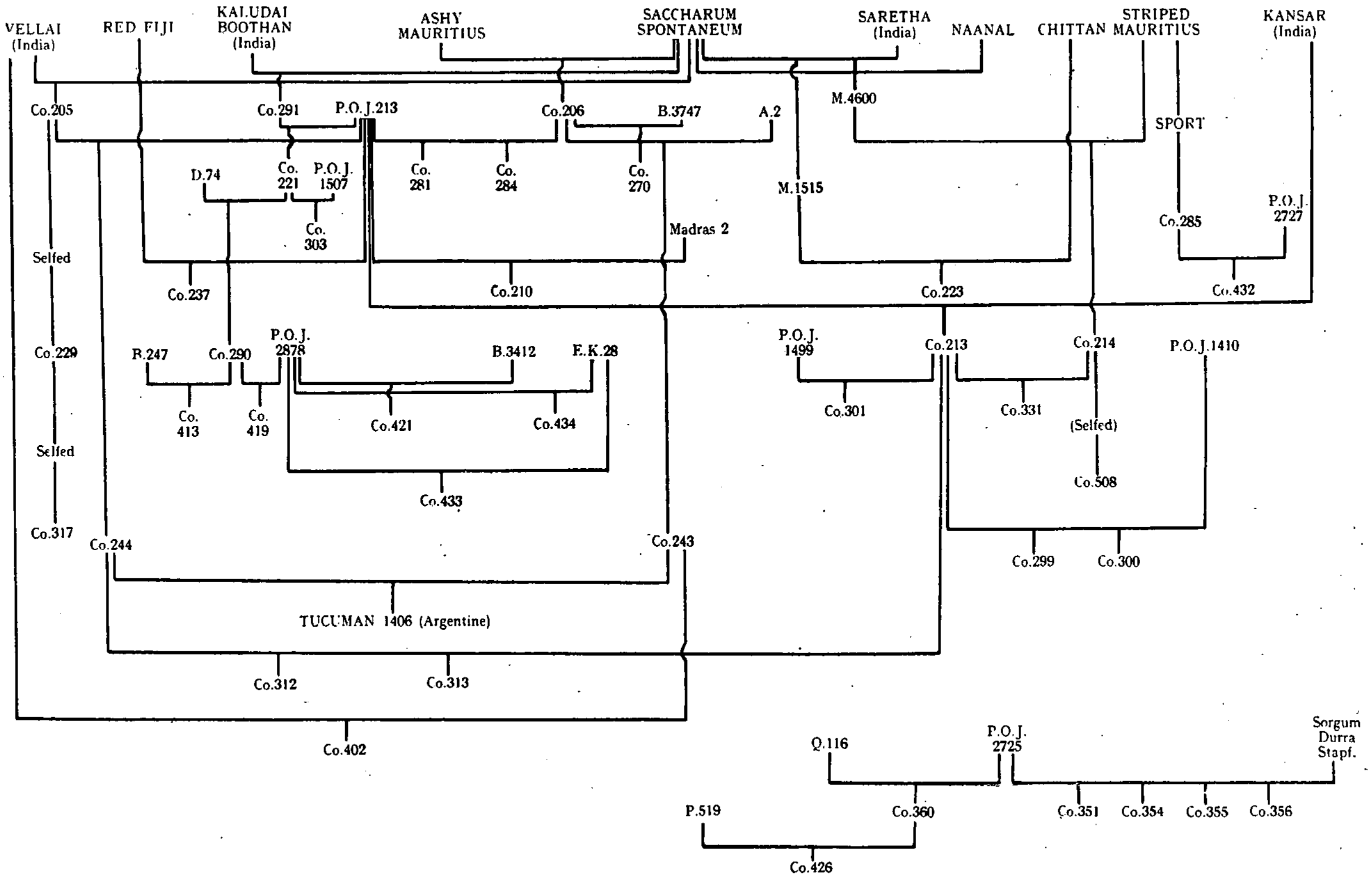
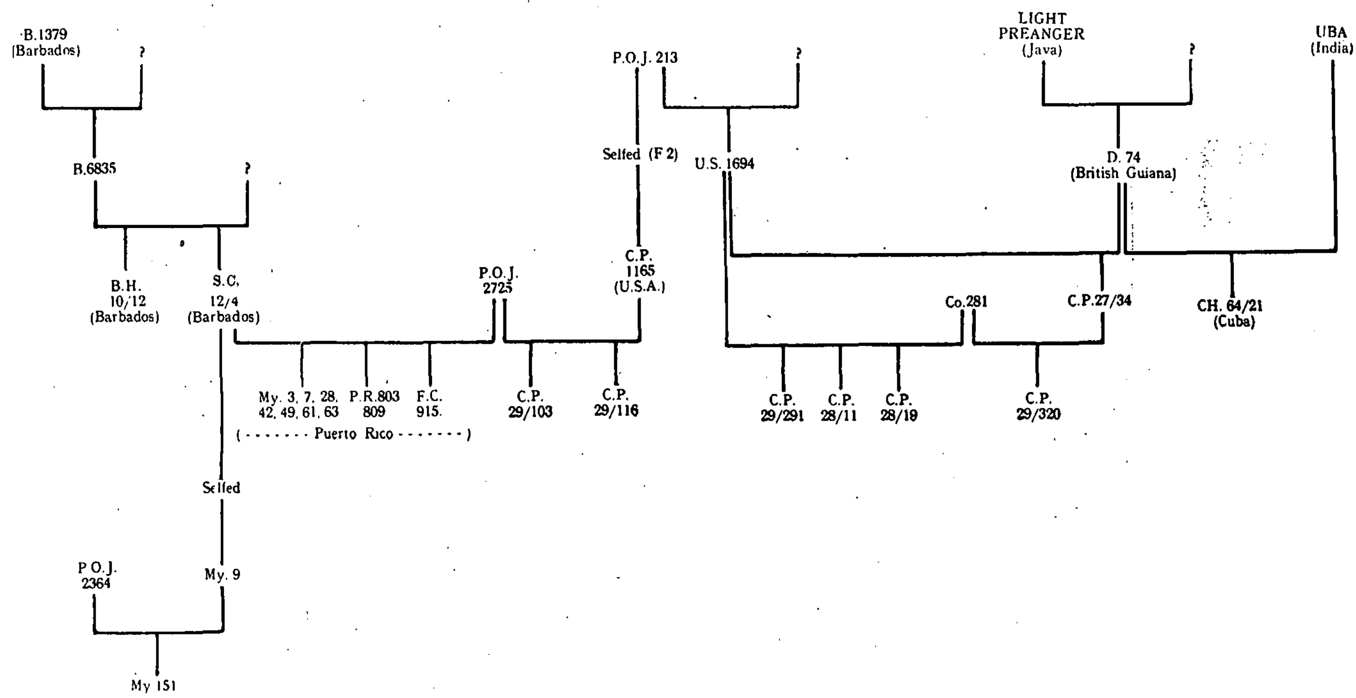


DIAGRAM OF DESCENT OF THE PRINCIPAL U.S. AND WEST INDIAN VARIETIES



The PRESIDENT: In opening the discussion stated that this paper which was much overdue could be regarded as a history of the introduction of new varieties at the Experiment Station. He drew attention to the amount of work and time involved before a variety was released to the planters. He asked Mr. Dodds if there had been many cases where cane increased in sucrose after flowering.

Mr. MORRIS: Congratulated the writer on an able report, and went on to say that the Experiment had saved the Sugar Industry. He shuddered to think what the Industry would be like to-day, had not the Experiment Station come into being when it did and brought new authority into the affairs of the Industry. Regarding the released varieties, it was remarkable that only four had been found which were of commercial value, and these four (P.O.J.2725, Co.281, Co.290 and Co.301) were not applicable to all sections of the Industry. The fact that certain varieties grew better in certain localities, proved the necessity for backing up the Experiment Station all one could. Everyone should support that Experiment Station, as it gave to the Industry its fundamental—a good commercial variety of cane. He wished to know something about the drought-resisting powers of Co.301, as on his estate it was suffering more than any other cane from the effects of drought.

Mr. COIGNET: Referred to the way in which imported varieties frequently deteriorated under new conditions. He said new varieties could be obtained to-day by X-ray treatment, which opened new possibilities.

Mr. WOUTERS: Asked Mr. Dodds if continually increasing the sucrose in the cane was going to be of advantage to the Industry.

Mr. W. A. CAMPBELL: Said that he was concerned to notice that Co.281 and Co.290 which had now spread throughout the Industry were seriously infected by mosaic in Louisiana. This made us realise that, as Mr. Morris said, we have to support the Experiment Station in every way to get other commercial varieties going, in case of such danger.

Mr. DE BEER: Expressed his great interest in the paper. He had heard of Umfolozi being referred to as the "Isle of Lost Ships" but to-day the situation was quite different. Umfolozi was on the map now and this was beyond doubt due to the Experiment Station. The situation at Umfolozi would have been entirely different without the released varities. He wished to convey to Mr. Dodds on behalf of Umfolozi, their very sincere thanks.

Mr. GARLAND: Asked whether it was necessary to apply phosphates where filter cake had been previously applied.

Mr. DYMOND: Remarked on the difficulty of ploughing out Co.281 ratoons compared with Uba and Co.290.

Mr. DODDS: Replying first to the President said that while most varieties deteriorated after flowering, P.O.J.2725 was not hindered in its development of sucrose at all by flowering. That was the experience of this country and Puerto Rico as well, where he first noticed it. Co.290 deteriorated rapidly after flowering, though fortunately it did not flower so very much. He appreciated Mr. Morris' kind remarks, and said he was sorry that Co.301 was apparently not as drought-resistant as he had hoped.

In reply to Mr. Coignet he said it was the general opinion amongst botanists that cane planted vegetatively only deteriorated when some disease factor came in. There was no inherent deterioration factor in cane planted vegetatively. The X-ray treatment referred to involved much expense and elaborate apparatus, but he hoped to do something along those lines.

Replying to Mr. Wouters he said he had repeatedly reminded the Industry of the danger of overproduction and the need for devoting at least some part of their land to other uses. The advantage of high yielding canes, under a properly regulated system of production, however, was very great.

Regarding mosaic, he said Louisiana was more subject to this disease than we in S. Africa. He thought in fact that the danger of a similar infection here was very remote and in any case would be very gradual. There has been no single case of mosaic disease reported in released Co canes, but since they can be artificially infected it would be advisable, as Mr. Campbell said, to have more strings to our bow. We were following the advice of Mr. E. P. Smith given this morning at the opening of our Congress, and we were not resting on our oars, but were looking to the future and endeavouring to provide for whatever may occur.

He was glad to have Mr. de Beer's first hand appreciation of the benefits received from the new varieties, especially P.O.J.2725 at Umfolozi.

In answer to Mr. Garland he thought it usually unnecessary to apply phosphate together with heavy applications of filter cake. Filter cake contains theoretically one seventh to one twentieth its weight of superphosphate. However, although he had found that the application of superphosphate with filter cake was not generally necessary, there had been instances in poorer soils where it had been of immediate additional benefit.

Referring to Mr. Dymond's remarks on the vitality of Co.281, he said that if we wanted to eradicate it we should perhaps find it a difficult task. In the case of disease, however, he thought this vitality would be lowered.

In conclusion he expressed his appreciation of the interest his paper had aroused.

The PRESIDENT: In according a vote of thanks to Mr. Dodds, commended him on the illuminating manner in which he had answered the various questions.

The Congress adjourned.