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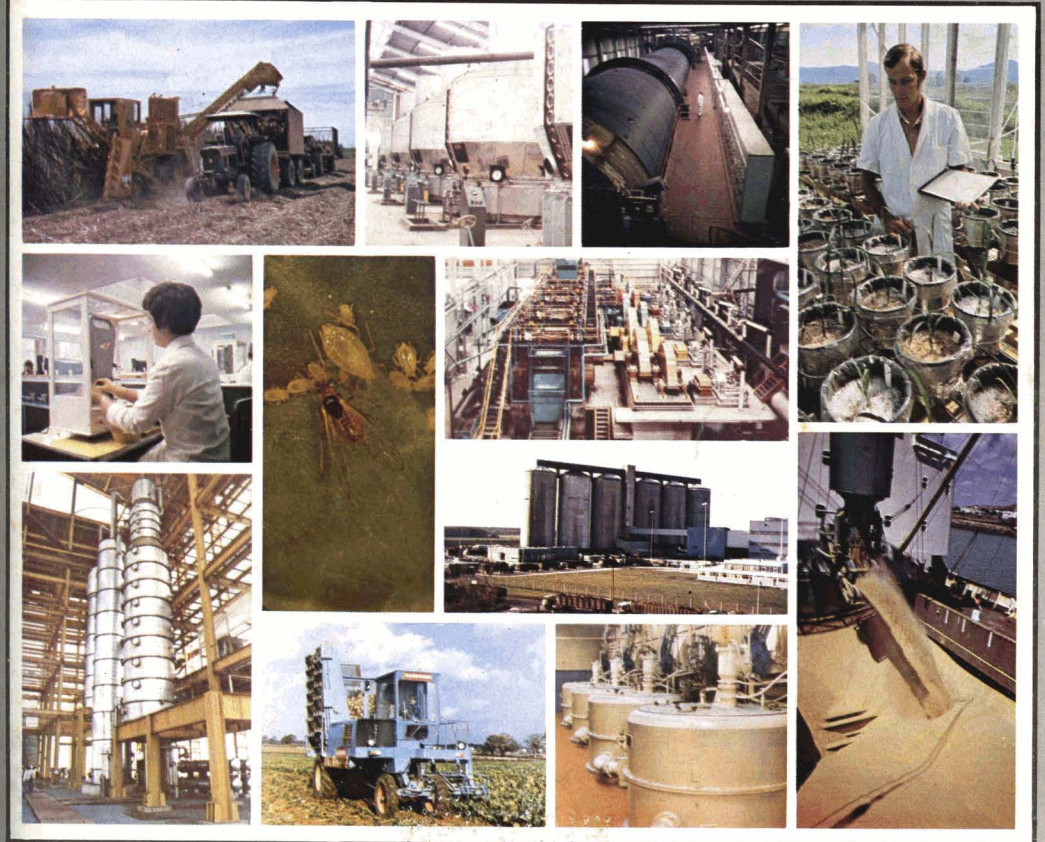

APRIL 1979

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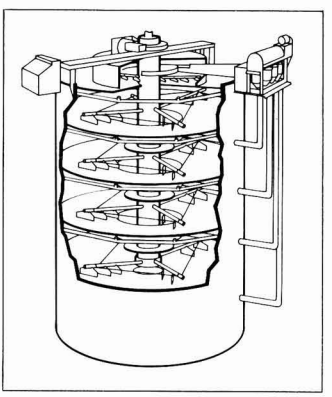

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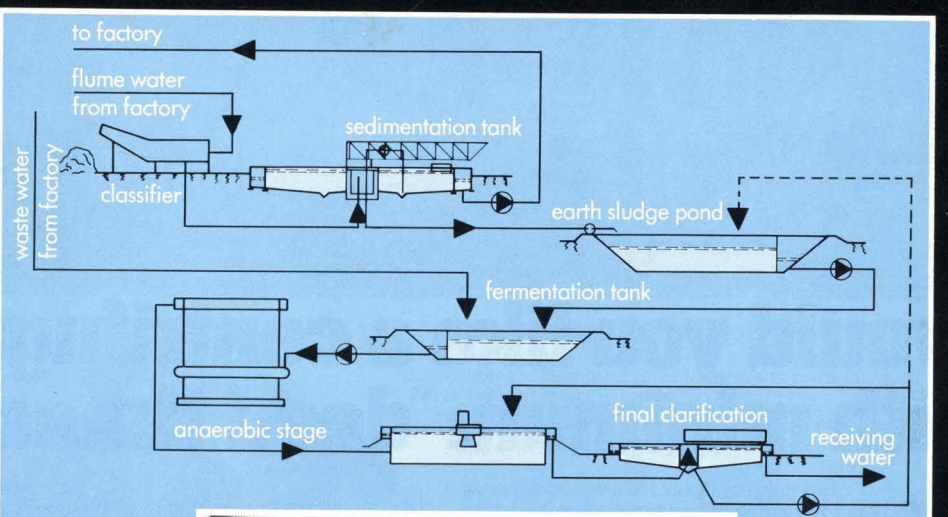

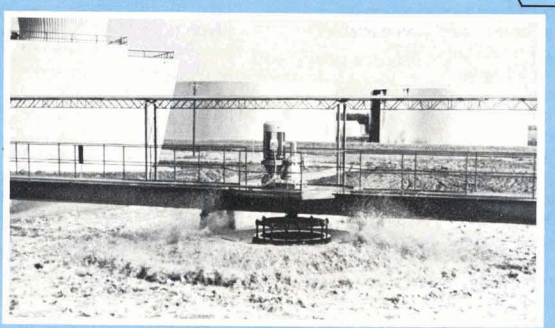

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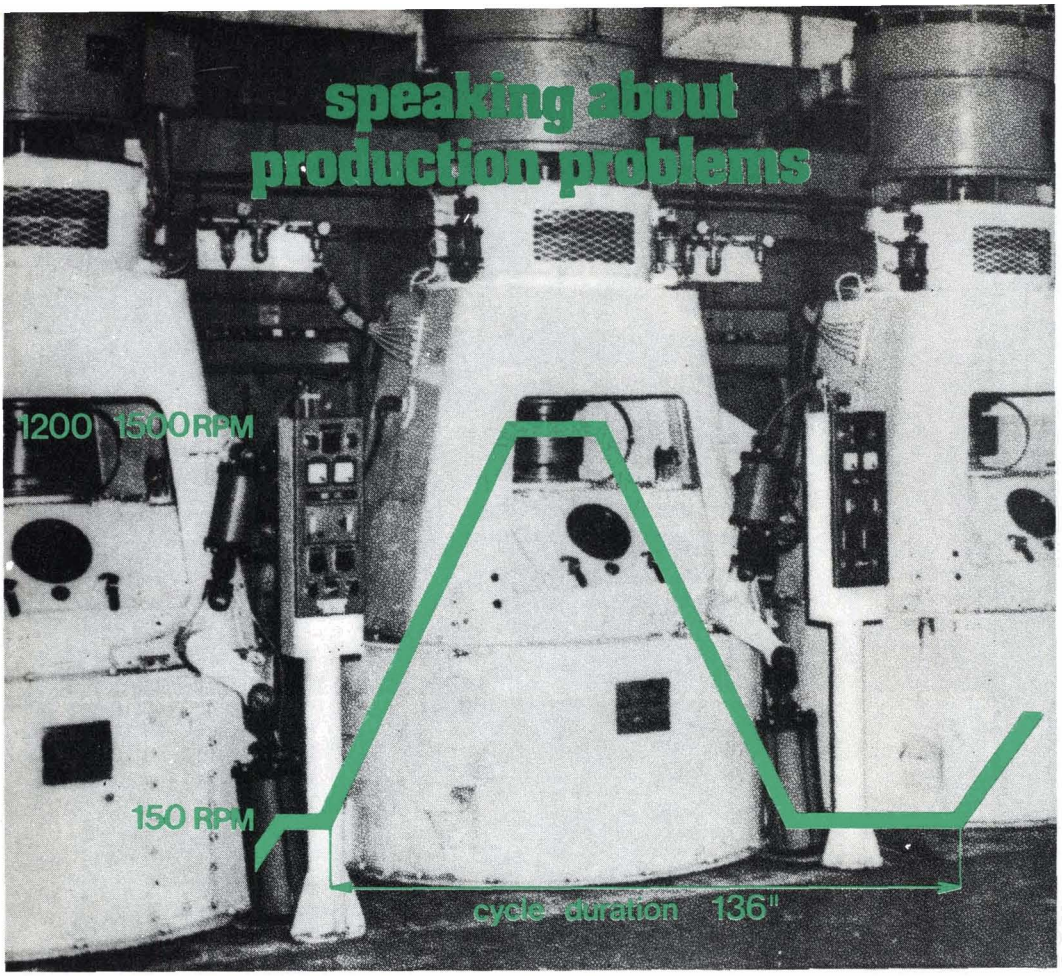

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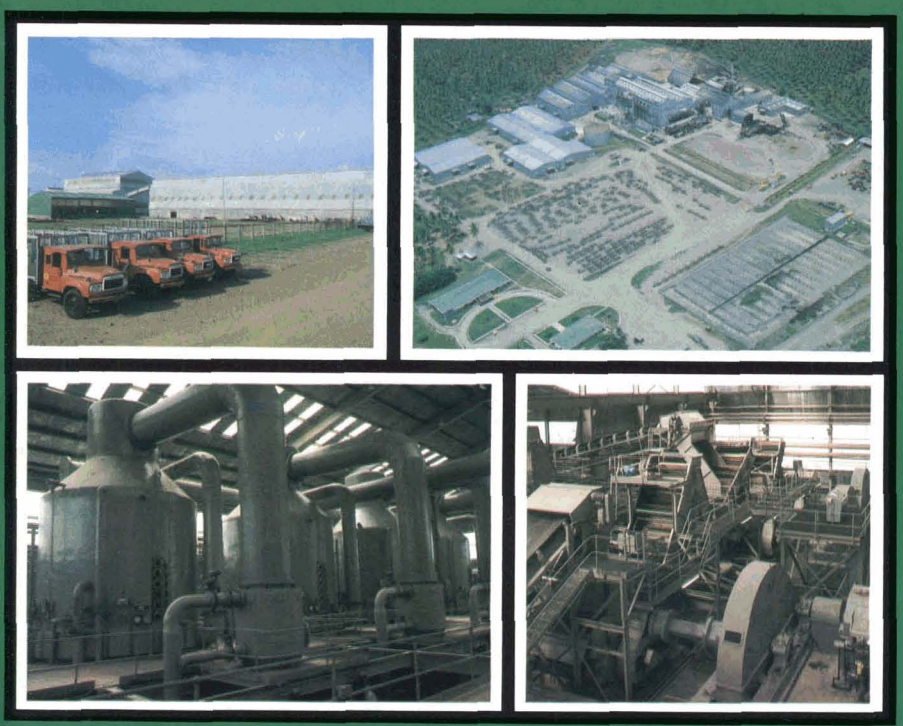
adjoining areas of the island, and despite the hazards has emerged with a first class record of operating efficiency.

Closely following the Davao factory FS was awarded a contract by the Bicolandia Sugar Development Corporation to build a 4,000 tonnes of cane per day raw sugar factory close to Naga City on the island of Luzon.

FS has recently completed a third turnkey project, the Northern Cotabato sugar factory sited on Mindanao island. Like the previous two factories Cotabato has a design capacity of 4,000 t.c.p.d. with provision for expansion to 5,500 t.c.p.d. at a later date.

This project, which is under the guidance of the Philippine Sugar Commission (Philsucom), is part of an extensive programme of rationalisation which is geared to increasing the efficiency of its existing plant and equipment in order to benefit both its home and export markets. Most recently FS has been awarded a contract to build a refinery at Batangas on the island of Luzon to produce 550 tons of high quality refined sugar per day. The Batangas refinery will play an important role in the strategy for improving the quality of sugar in the Philippines so as to promote the further development of local industries such as fruit canning and soft drinks without the need for importing the special grades required by these users.



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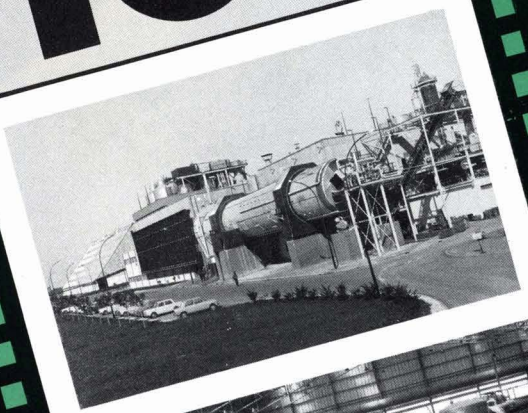
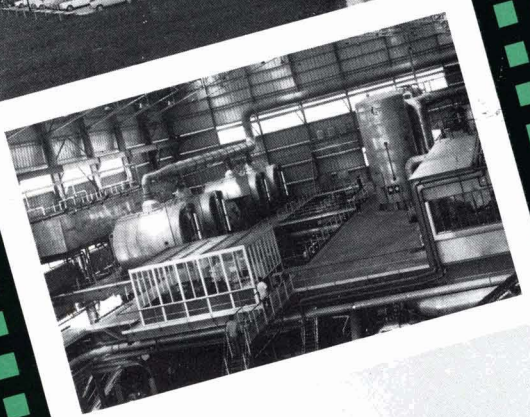
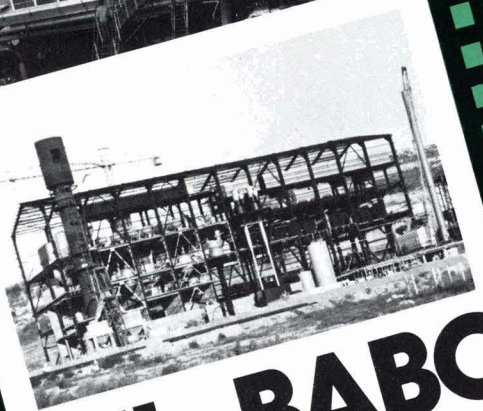


Beet sugar factories.



Cane sugar factories.



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NOTES AND COMMENTS

UK beet sugar production, 1978/79

The British Sugar Corporation produced more than a million tonnes of sugar for the first time since 1971/72, despite the serious problems caused by severe weather and national disputes outside the company. The beet processing campaign ended with a final sugar production figure of 1,022,420 tonnes of white sugar, an increase of more than 70,000 tonnes over last year. Production of animal feed, in the form of dried molassed beet pulp, was also increased from last year's 595,000 tonnes to 652,000 tonnes.

Had it not been for the road transport strike, fuel shortages caused by the tanker drivers' dispute, and the worst weather for sixteen years which affected harvesting, the production figures would have been slightly higher.

According to John Beckett, Chief Executive: "There was a fine crop and we were looking for rather higher sugar and animal feed production. But in the face of the problems we encountered during the campaign it is remarkable that the loss of production has been so slight. This is due to the initiative of growers in getting beet into the factories despite the transport strike, and to the resourcefulness of our management teams".

The crop was harvested from 204,000 hectares which produced an average beet yield of 34·72 tonnes per hectare (31·5 tonnes.ha^{-1} in 1977/78). Average sugar content was 16·75% (17·1%), giving a sugar yield of 5·81 tonnes per hectare (5·5 tonnes.ha^{-1}). More than seven million tonnes of beet were bought by the British Sugar Corporation Ltd. and growers will share a total payout estimated at £165 million.

The Corporation has so far accepted contracts for 217,000 hectares for the 1979/80 crop.

US sugar legislation and the ISA

With the Administration and various Congressmen working on bills with different objects and means to attain them, it is perhaps not surprising that sugar legislation appears to be getting nowhere, even though the US Dept. of Agriculture is reported to be optimistic about an early settlement of differences. Dr. Albert Viton, writing in early February[1], considers that "the chances are somewhat better than last year of evolving a reasonable long-term policy . . . The mainland beet economy and the cane industries of Hawaii and Florida have contributed much to scientific research and to raising productivity; it certainly would not be to the long-term world interests for these segments of the US agriculture economy to decline. Production costs of three-fourths of four-fifths of the industry are not excessive in comparison with those of other importing countries with high wage structures—and are, truth to tell, lower than many exporting countries. No sugar industry has as high man-hour productivity as Hawaii, and very few as high as the overwhelming part of Florida cane and mainland beet areas. Hawaii's productivity achievements have been due not to exceptionally favourable natural conditions but to years of intelligent research and extension". It is thus highly desirable, to say the least, that domestic legislation should soon be agreed which will allow profitable continuation of these innovative and efficient industries.

In its absence, however, as B. W. Dyer recently pointed out[2], Senator Church will probably continue to block US ratification of the International Sugar Agreement. "The success of the Agreement depends to a great extent on whether or not the US ratifies it. If it does not, unless member countries can strive to make the Agreement work without the US, a collapse of the Agreement would lead to prices lower than those currently prevailing. Such a price decline would hasten production cutbacks and probably result in higher world consumption, leading to a close balance between supply and consumption (thus drawing down world stocks of sugar) and higher prices in a few years. If the ISA holds together, production probably would stabilize and perhaps increase slightly. However, consumption would increase at a faster rate than production. A balance between supply and consumption would eventually occur, but would take longer than if the ISA fails".

India sugar production 1977/78[3]

The Indian Sugar Mills Association has recently released the final figures of sugar output during the season from October 1977 to September 1978. Production reached 6·47 million tonnes, white value, equivalent to approximately 7 million tonnes, raw value, and 33·67% more than in 1976/77. Consumption in the period also showed a healthy increase of 19·11% but, despite this, the season's final stocks were more than double those of the previous season. The stock level at the end of 1977/78 is an indication of the difficulties of the Indian sugar industry.

	1977/78	1976/77	1975/76
	tonnes, white value		
Initial stocks	1,575,300	836,800	1,221,000
Production	6,470,000	4,840,300	4,292,400
	8,045,300	5,677,100	5,513,400
Consumption ...	4,472,300	3,754,800	3,709,600
Exports	253,000	347,000	967,000
Final stocks	3,320,000	1,575,300	836,800

Australian cane sugar production, 1978/79[4]

According to the Australian Sugar Producers' Association, sugar output in 1978/79 totalled 2,900,000 tonnes 94 net titre, against 3,340,000 tonnes in 1977/78. This estimated outturn falls short of the total mill peaks of 2·94 million tonnes imposed because of ISA export limits. Officials have no doubts, however, that Australia will be able to ship its full quota of just under 2 million tonnes in 1979 despite the shortfall. The industry has set aside about 160,000 tonnes of raws to meet its obligation to hold special stocks under the Agreement; about 1·2 million tonnes of annual exports are sold under long-term contracts, and this leaves about 800,000 tonnes available for the free market.

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[1] F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 75.
[2] *News Matter*, January 30, 1979.
[3] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (32), 19.
[4] F.O. Licht, *International Sugar Rpt.*, 1979, **111**, (2), 36.

Meanwhile, flooding, heavy rains and high winds in the aftermath of cyclone Peter, which recently hit the Cape York peninsula, have flattened most of the cane stood-over from the 1978 harvest in North Queensland. The rains and floods affected 10 of Queensland's 30 mill areas, north of the Herbert River, containing nearly 2 million of the 3,150,000 tonnes of cane stood-over. No detailed assessment of crop losses is available but it was reported that all standover cane was down and there had been some breakage and some rotting of cane would occur. Advanced young cane is also flat and large areas have been inundated. Although cane can recover well from flooding it loses sugar content and, once flattened, stays down, requiring expensive adjustments to harvesting techniques.

Europe sugar production 1978/79

The International Association for Sugar Statistics carried out a survey in January of sugar production in member countries during the 1978/79 campaign and the results were reported by F. O. Licht in February, together with his own estimate of production in European countries not members of the Association[1]. The figures are as follows:

	1978/79	1977/78
I.A.S.S. members	*tonnes, raw value*	
Austria	357,000	495,000
Belgium	902,000	791,000
Denmark	441,000	566,000
Finland	102,000	70,000
France	4,060,000	4,268,000
Germany, West	2,998,000	3,076,000
Holland	1,033,000	905,000
Spain	1,196,000	1,198,000
Sweden	339,000	343,000
Switzerland	107,000	85,000
Turkey	1,103,000	1,082,000
UK	1,090,000	1,032,000
	13,728,000	*13,911,000*
Non-I.A.S.S. members		
Greece	353,000	294,000
Ireland	207,000	182,000
Italy	1,630,000	1,355,000
Yugoslavia	763,000	766,000
	2,953,000	*2,597,000*
Total West Europe	*16,681,000*	*16,508,000*
Albania	20,000	15,000
Bulgaria	250,000	210,000
Czechoslovakia	850,000	939,000
Germany, East	730,000	780,000
Hungary	553,000	486,000
Poland	1,800,000	1,850,000
Rumania	700,000	775,000
USSR	9,100,000	8,825,000
Total East Europe	*14,003,000*	*13,880,000*
Total Europe	30,684,000	30,388,000

The estimate for Western Europe is very similar to Licht's first estimate of December 1978 at 16·7 million tonnes, but this conceals a reduced forecast for Turkey and lost production in the UK resulting from the lorry drivers' strike which cut beet supplies to the factories. Several other countries' estimates are raised, however, and compensate. Compared with 1977/78, the outturns for Belgium, Holland, Italy and the UK are higher because of greater beet areas but those for Denmark, France and West Germany are lower since the higher sugar content of the beet did not fully make up for reduced beet areas.

Output in East Europe is set 123,000 tonnes or nearly 1% higher than in 1977/78, the 275,000 tonnes increase expected for the USSR, 40,000 tonnes for Bulgaria and the 67,000 tonnes more for Hungary being partly offset by decreases in the Czechoslovakian sugar crop as well as those of East Germany, Poland and Rumania. For Europe as a whole, the increase is some 300,000 tonnes or nearly 1% but since the market was aware of the likely production figures, particularly in Western Europe, the I.A.S.S. report did not produce any marked changes in prices.

World sugar prices

The import fee in the US for the second quarter will be fixed in relation to the average world price for the 20 trading days from 20th February and efforts to establish a relatively high average have led to some aggressive bids, although there has been little business during February. Policital developments in the Middle and Far East were responsible to some extent for the rises in sugar prices which occurred during the month but these were also encouraged by optimism in the markets about prospects for US ratification of the ISA. From a level of £96 at the beginning of the month, the LDP moved upwards to reach £109 by February 26, although it had fallen back to £104 by the end of the month.

The white sugar market has remained under the pressure of selling by the EEC but confirmed sales of nearly 300,000 tonnes to the USSR produced a sharp up-turn and the LDP(W) which had started the month at £98 (a premium over raws of only £2) reached £107 by February 9 (a premium of £7) and continued to reach £110 by February 22 but declined to £106 by March 1, when the premium was again only £1.

US sugar production, 1978[2]

The Annual Summary of the Crop Reporting Board of the US Department of Agriculture has been published and includes the following estimates: total 1978 production of sugar from cane and beets is up 2% from the 5·79 million short tons (5·25 million tonnes), raw value, of 1977 at 5·89 million short tons (5·35 million tonnes), raw value. This includes 3·26 million short tons (2·96 million tonnes), raw value, from beet, 5% above 1977 production, 1,600,000 short tons (1·45 million tonnes), raw value, from the mainland cane areas, down 3% from 1977, and 1·04 million short tons (941,000 tonnes), raw value, in Hawaii, up fractionally from the 1977 crop.

The cane crop in 1978 was expected to total 25·9 million short tons (23·5 million tonnes), 1% above that of a year earlier, and was harvested from 709,000 acres (287,000 ha), compared with 719,000 acres (291,000 ha) in 1977. The Florida cane area was up by 4% and that of Louisiana down by 9%. Production of sugar beet, at 25·9 million short tons (23·5 million tonnes) was up 3% from 1977 production, as a consequence of a 5% increase in the crop area but a yield of 20·3 short tons per acre, as against 20·6 tons per acre in 1977.

[1] *International Sugar Rpt.*, 1979, **111**, 71–73.
[2] *Lamborn*, 1979, **57**, 16.

Influence of manganese on the accumulation of free amino-acids in cane leaves

By G. S. C. RAO* and A. P. GUPTA
(National Sugar Institute, Kanpur, India)

Introduction

THERE has been considerable interest during the past ten years in the effects of nutrients on the accumulation of free amino-acids in plants. There have been indications that specific amino-acids accumulate in plants under certain conditions of micro- or macro-nutrient deficiencies and toxicities. Manganese nutritional disorders have been reported[1] to produce marked changes in the free amino-acid contents of many plants. Labanauskas *et al*[2]. observed an 85% increase in the free amino-acids content of Mn-deficient Macadamia leaves, while Steward & Durzan[3] elucidated changes in amino-acid concentration as being governed by season, age and plant species. In oats, according to Scheffler *et al.*[4], manganese deficiency Increased the methionine and glycine contents. Minenberg[5] reported increases in lysine, alanine, cystine and threonine in the case of grapes.

Although there have been a number of reports[6,7,15] regarding qualitative and quantitative assessment of free amino-acids in cane juices and molasses, very little attention has been paid to determining the amino-acid composition of sugar cane tissues. The physiological and biochemical importance of arginine has, however, been recognized by Hawaiian workers[8,9]. Kortschak[10] has reported diurnal fluctuations of glutamic acid and other free amino-acids in sugar cane. He also noted[11] changes in the amino-acid composition of sugar cane during its growth and development.

The present work describes experiments to determine variations occurring in the free amino-acids contents of sugar cane tissues grown under conditions of different manganese concentration.

Experimental

Sugar cane plants, of Co 1148 variety, were grown by pot culture in pure sand containing 0, 0·15, 0·25, 1·00, 2·00 and 100 ppm of manganese, using a technique previously developed[12]. Leaves were sampled at 3, 5 and 7 months of age, kept in 80% ethanol and stored in the cold until analysed. Extraction of alcohol-soluble free amino-acids was in accordance with methods reported elsewhere[5,12,14]. From each sample a 5-kg subsample was weighed and the amino-acids extracted by grinding in a mortar with simultaneous addition of 80% ethanol. Extraction was carried out three times and the composite extract filtered and the filtrate concentrated to 10 cm^3 under reduced pressure at 40–50°C. After removal of chlorophylls by extraction of the concentrate with chloroform, the amino-acids were adsorbed on a 1 cm diameter × 50 cm high volume of cation exchange resin ("Amberlite IR 120"). They were then eluted with 2N NH_4OH and concentrated to dryness under vacuum. The residue was dissolved in 10% *iso*-propanol, transferred to sample vials and preserved under toluene until used for chromatography.

The non-protein amino-acids were separated by two-dimensional paper chromatography using the methods described by Block *et al.*[13] and Thompson *et al.*[16] The general procedure was as follows: 0·1 cm^3 of the isolated sample was spotted on Whatman No. 1 paper chromatography sheets; these were developed in 4:1:5 *n*-butanol: acetic acid:water in the first direction and then with 4:1 phenol:water in the second direction. The amino-acids were developed by spraying with 0·5% w/v ninhydrin in acetone. The different spots on the chromatograms were identified with the help of a standard amino-acid map prepared earlier. Quantitative estimations were carried out according to the procedure suggested by Howell & Crusberg[14], *viz.* the blue and purple spots were cut out and eluted at laboratory temperature with 5 cm^3 of 75% ethanol containing 0·0005% $CuSO_4$ during one hour. After centrifuging at 2500 rpm, the optical density of aliquots was measured spectrophotometrically at 540 nm. The contents of individual amino-acids were then determined by reference to a standard curve for glutamic acid. Asparagine had its own standard curve owing to its brown colour.

Tryptophane could not be separated by two-dimensional chromatography; it was separated by a one-dimensional technique using 4:1:5 *n*-butanol:acetic acid:water as solvent and identified with the help of an authentic spot. Quantitative estimation was carried out as for the other amino-acids.

Results

The levels of individual free amino-acids are recorded in Tables I, II and III for the cane leaves which were 3, 5 and 7 months old. It should be mentioned at the outset that these levels are within the limitations of the method employed, i.e. they are comparative and not the absolute contents. They are expressed as a percentage of the dry weight of total amino-acids.

The individual amino-acids responded differently to the variation in the Mn concentration in the external solutions supplied to the cane plant. Changes also occurred in any given treatment as the growth of the cane progressed. For example, with cane at three months of age, cystine, the basic amino-acid, was present in Treatments (1), (4) and (6) but was totally absent at five months but reappeared in Treatments (1)

*Present address: Central Control Laboratories, c/o Cawnpore Sugar Works Ltd., P.O. Marhowrah, Dist. Saran, Bihar, India.

[1] Hewitt: *Ann. Rev. Plant Physiol.*, 1951, **2**, 25–53.
[2] *J. Amer. Hort. Soc.*, 1970, **95**, (2), 218–223.
[3] "Plant Physiology Treatise", Vol. IV, (Academic Press, New York), 1965, pp. 379–604.
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and (6) at seven months. Likewise, irregular changes occurred with regard to histidine, valine, leucine, threonine, etc. Qualitative changes occurred with asparagine but glutamine did not show any irregularities.

Table I. Effect of variation in manganese on free amino-acids in cane leaves at three months of age*

Treatment	(1)	(2)	(3)	(4)	(5)	(6)
Concentration of Mn in nutrient solution, ppm	0	0·15	0·25	1·00	2·00	100
Cystine	3·36	—	—	—	5·62	1·92
Lysine	4·46	3·17	0·98	3·65	2·72	2·72
Arginine	0·64	—	—	—	—	0·96
Histidine	1·66	1·14	0·73	0·51	1·77	1·80
Asparagine ...	0·49	1·26	3·41	2·56	3·13	7·26
Glutamine	Trace	2·80	5·40	6·84	2·84	5·55
Aspartic acid	4·91	6·26	4·74	3·79	3·49	3·75
Glutamic acid	6·22	10·63	5·09	6·74	4·75	5·66
Serine	10·23	6·22	7·91	8·77	9·75	7·28
Glycine	4·22	5·09	3·84	4·28	2·72	6·38
Threonine ...	2·48	2·80	2·80	2·90	1·42	1·99
Alanine	22·94	19·74	16·74	24·04	18·79	15·98
Tyrosine	10·81	12·37	7·59	6·39	12·47	9·88
Methionine ...	13·15	8·88	6·81	8·97	9·78	8·16
Valine	5·15	3·93	4·51	—	4·35	3·69
Phenylalanine	2·97	3·68	0·56	4·77	3·60	—
Iso-leucine ...	2·97	3·65	3·80	4·20	5·35	—
Leucine	2·10	3·02	2·41	2·60	1·80	—
Tryptophane ...	2·13	3·21	6·33	3·56	3·29	4·64
γ-Amino-butyric acid	—	—	1·33	0·98	0·91	0·55
Unknown I" ...	—	2·21	5·03	4·36	1·38	4·71

* Each figure represents a mean of three replicates.
– indicates that the amino-acid was not detected.
"Trace" indicates that the amino-acid was detected but in an amount too small to measure.

Table II. Effect of variation in manganese on free amino-acids in cane leaves at five months of age*

Treatment	(1)	(2)	(3)	(4)	(5)	(6)
Concentration of Mn in nutrient solution, ppm	0	0·15	0·25	1·00	2·00	100
Lysine	3·15	0·55	1·99	4·81	4·43	2·33
Arginine	1·40	—	—	—	—	1·84
Histidine	—	—	1·75	1·86	0·97	3·44
Asparagine ...	3·46	1·19	1·05	1·38	3·63	2·66
Glutamine ...	—	1·88	2·31	4·37	1·90	0·24
Aspartic acid	2·95	4·15	2·55	3·57	1·87	2·80
Glutamic acid	9·04	7·82	10·05	11·52	5·76	7·06
Serine	5·51	6·91	7·19	7·80	6·56	6·68
Glycine	7·00	6·18	6·70	5·98	5·06	7·34
Threonine ...	7·11	3·42	1·78	3·88	4·33	3·11
Alanine	15·92	22·62	7·96	10·15	19·42	19·80
Tyrosine	13·93	15·84	9·04	14·27	12·71	11·55
Methionine ...	5·89	8·24	7·47	8·61	8·32	—
Valine	8·24	3·77	7·26	1·58	4·69	10·09
Phenylalanine	4·86	5·83	5·13	5·50	4·93	8·04
Iso-leucine ...	4·91	5·30	3·88	2·75	6·92	5·29
Leucine	2·73	3·77	1·92	2·75	4·79	Trace
Tryptophane ...	3·58	3·07	4·40	5·74	3·79	4·61
γ-Amino-butyric acid	—	—	17·66	3·56	Trace	—
Unknown I	—	—	—	—	—	1·25
Unknown II ...	—	—	—	—	—	1·96
Unknown III ...	0·91	—	—	—	—	—

* Each figure represents a mean of three replicates.
– indicates that the amino-acid was not detected.
"Trace" indicates that the amino-acid was detected but in an amount too small to measure.

When no manganese was supplied, γ-amino-butyric acid was found to be absent at all stages of growth, while arginine could only be detected at zero and 100 ppm Mn. Three spots could not be identified; these are referred to as Unknowns I, II and III, of which Unknown I was absent in Treatment (1) throughout growth. Unknown II was present only in Treatment (1) at 7 months, and Unknown III was detected in 5- and 7-months old cane leaves.

Table III. Effect of variation in manganese on free amino-acids in cane leaves at seven months of age*

Treatment	(1)	(2)	(3)	(4)	(5)	(6)
Concentration of Mn in nutrient solution, ppm	0	0·15	0·25	1·00	2·00	100
Cystine	2·56	—	—	—	—	4·75
Lysine	4·36	0·75	1·22	1·29	4·28	0·40
Arginine	Trace	—	—	—	—	Trace
Histidine	3·60	6·54	3·66	5·13	2·64	4·01
Asparagine ...	—	—	—	2·82	3·84	5·03
Glutamine ...	4·10	3·18	2·49	—	7·35	—
Aspartic acid...	2·68	5·65	6·24	3·42	1·70	0·94
Glutamic acid	5·86	5·28	11·95	3·54	7·28	9·38
Serine	6·95	10·85	4·98	11·92	8·29	5·60
Glycine	4·32	3·18	—	7·81	6·28	5·30
Threonine ...	6·80	4·25	—	6·08	3·74	7·30
Alanine	10·47	21·14	22·24	3·02	16·10	12·85
Tyrosine	4·94	6·02	7·90	1·28	4·74	13·63
Methionine ...	5·35	7·05	6·34	2·74	5·48	6·34
Phenylalanine	3·95	6·07	7·71	4·67	4·84	6·34
Iso-leucine.....	3·58	3·69	4·54	5·15	3·91	1·71
Leucine	2·64	3·74	3·46	5·80	2·31	7·23
Tryptophane ...	2·13	5·70	4·10	2·39	2·87	3·34
γ-Amino-butyric acid	—	—	6·15	3·18	5·58	4·41
Unknown I ...	—	Trace	2·4	4·51	3·27	—
Unknown II ...	7·17	—	—	—	—	—
Unknown III ...	13·57	—	—	—	—	—

* Each figure represents a mean of three replicates.
– indicates that the amino-acid was not detected.
"Trace" indicates that the amino-acid was detected but in an amount too small to measure.

Examination of the analytical data reveals that plants grown in Mn-deficient (Treatment I) and Mn-toxic (Treatment 6) conditions accumulated alanine, threonine, lysine, tyrosine and phenyl alanine in their leaves. These observations confirm the studies of Samuels & Alexander[17] and Maretzki *et al.*[8] regarding the influence of Mn on the accumulation of free amino-acids. In immature plants, lysine, alanine, tyrosine, methionine and phenyl alanine exhibited greater fluctuations due to Mn variability than other acids; they were higher in Treatment (1) and Treatment (6) plants. The percentages of leucine and tryptophane were lower in Mn-deficient leaves while the percentages of threonine, glycine and valine did not show much variation. There was an accumulation of 66% and 47% more alanine in Treatments (1) and (6), respectively, than with treatment (3); this suggests that the concentration of alanine is very much dependent on the Mn nutritional status in sugar cane. From the results of the 5-months old samples (Table II) it appears that lysine, threonine and alanine were higher in all the treatments and showed maximum fluctuations according to the Mn supply. Alanine was seven times higher in the Mn-deficient leaves as compared with Treatment (3).

The percentages of methionine and tryptophane were lower in the Mn-deficient plants, while no regular trends were observed between Mn treatments and the concentrations of glutamic and aspartic acids. γ-Amino-butyric acid concentration was highest (17-18% on dry matter) in Treatment (3), while in all other treatments alanine and tyrosine were predominant. In seven months-old cane leaves (Table III) Mn deficiency and toxicity resulted in accumulation of free amino-acids,

[17] *Proc. 13th Congr. I.S.S.C.T.*, 1968, 544–555.
[18] Steinberg: "Inorganic nitrogen metabolism". (Johns-Hopkins Univ. Press, Baltimore), 1956, pp. 153–158.

continuing the trends from earlier stages of growth. There were broadly three types of change:

(a) where the amino-acids were present in higher concentrations in Treatments (1) and (6)—these included lysine, serine, glycine and threonine.

(*b*) where the amino-acids were present in lower concentrations in Treatments (1) and (6)—these included aspartic acid, glutamic acid, alanine, tyrosine and tryptophane.

(c) where the acids were either less affected or did not exhibit any definite relationship with the Mn supply —these included histidine, methioinine, etc.

At all three growth stages the total free amino-acid content of the leaves was twice as high in Treatments (1) and (6) as in Treatments (2)-(5). In the latter treatments, the total amino-acid levels decreased with increase in age, whereas in Treatments (1) and (6) there was a decrease between the 3rd and 5th month after which the total amino-acids increased again.

In immature leaves asparagine and glutamine concentrations were low in Treatment (1) but their concentration increased with increasing supply of Mn. Manganese therefore exhibited a synergistic relationship with these amides and the influence of the Mn was different from that of the total amino-acids at this age.

Discussion

From the analytical data recorded, it is evident that the influence of manganese was more pronounced in immature plants than in the five and seven months-old plants. For example, alanine was high in the three months-old cane but decreased progressively with age —such was also the case with other amino-acids. Steward & Durzan[3] strongly emphasized changes in amino-acid contents with age in different plant species. Kortschak[11] also observed the same in the case of sugar cane. Our studies therefore confirm the above observations and indicate that, in nutritional experiments to ascertain the effect of a particular element, the age of the plant should be taken into consideration. Observations on protein and nucleic acids[12] further confirm this necessity.

Owing to the multiple and complex associations of amino-acids in various biochemical pathways it would be difficult to assess the reasons for the changes which occurred in all the amino-acids. Some acids, the levels of which showed significant changes, deserve some discussion, however.

The alanine content was greatly affected by variation in Mn level. Several workers have established[18] that Mn is closely associated with enzymes of the T.C.A. (three carbon atom) cycle. Steward & Durzan[3] elucidated the "partial degradation of carbohydrates" in plants suffering from malnutrition of Mn. During the present study there was an accumulation of sugars on the one hand[19] and accumulation of alanine on the other. In these plants, owing to the lack of Mn in the tissues, or because of an excess, the T.C.A. cycle might have been disturbed. Subsequently carbohydrates would be metabolized as far as pyruvic acid only and thereafter, owing to blockage of the T.C.A. cycle, the accumulated pyruvic acid might be diverted to other metabolic systems such as free amino pools. In such circumstances there would be every possibility for the conversion of pyruvic acid to alanine through a transamination reaction with glutamic acid. The ketoglutaric acid formed by the above reaction could serve as an alternative source for the operation of the T.C.A. cycle.

Next to alanine, methionine and serine showed major fluctuations in their contents as a result of Mn variation. The synthesis of methionine requires additional C-1 units for the conversion of homocystine to methionine through methylation. The additional C-1 units are supplied from serine which in turn is converted to glycine. Thus, if the serine concentration in the tissue were high, the supply of C-1 units for methionine would be greater, leading to accelerated synthesis of methionine; glycine concentrations in Treatments (1) and (6) support this notion. As serine biosynthesis is achieved directly through pyruvic acid, the concentration of the former was high in Mn-deficient or -toxic plants.

High accumulations of threonine and cystine and low concentrations of asparagine and glutamine also corroborate the active involvement of pyruvic acid in the biosynthesis of different amino-acids and justify the explanations offered for alanine, serine and methionine.

It has been suggested that arginine-rich proteins might exist in sugar cane and, because of its rapid incorporation into polypeptide chains, little or no arginine should be available in the free state[8,9]. The presence of arginine in Mn-deficient and Mn-toxic plants observed during the present study must therefore be a consequence of impaired protein synthesis. In other words, the presence of arginine indicates that manganese is involved in protein biosynthesis and degradation, so that in conditions of Mn deficiency or toxicity the incorporation of arginine into protein was prevented. Total protein content analyses and growth observations confirm this view[12].

With the data in hand one can conceive the relationship between free amino-acid contents and visual symptoms of Mn nutritional disorders. Steinberg[18] suggested that several visual symptoms of mineral nutrient disorders reflected the accumulation of toxic concentrations of certain amino compounds. These amino-acids may therefore be employed as criteria in characterizing the nutritional disorders for particular elements. In the present case, a high accumulation of alanine, absence of γ-amino-butyric acid and the presence of arginine are found to be typical of Mn deficiency in sugar cane.

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Summary

The qualitative and quantitative effects of variation in Mn nutrition on non-protein free amino-acids were studied in sugar cane raised in pure sand pot culture. Free amino-acids were extracted from the leaves at 3, 5 and 7 months of age and separated by two-dimensional paper chromatography. At all three stages of growth manganese-deficient (0 ppm Mn) and -toxic (100 ppm Mn) conditions resulted in accumulation of more free amino-acids, the effects being more pronounced at early stages of growth. Lysine, alanine, tyrosine and methionine exhibited the greatest fluctuations with variation in Mn and their levels were higher in the plants grown under Mn-deficient and -toxic conditions. The

[19] Rao: Ph.D. Thesis, 1977.

presence of arginine and absence of γ-amino-butyric acid appears to be typical of Mn-nutritional disorders in sugar cane. The amides asparagine and glutamine responded independently to different Mn levels. Total amino-acid content was higher in leaves grown in conditions of Mn deficiency and toxicity. The age of the plant was found to be a significant factor in determining the above changes.

L'influence du manganèse sur l'accumulation d'acides aminés libres dans les feuilles de canne

Les effets qualitatifs et quantitatifs de la variation de la nutrition en Mn sur les acides aminés libres non protéiques ont été étudiés sur de la canne à sucre cultivée en culture en pots dans du sable pur. Les acides aminés ont été extraits des feuilles à l'âge de 3, 5 et 7 mois et séparés par chromatographie sur papier en deux dimensions. Aux trois stades de la croissance les conditions de déficience (0 ppm Mn) et de toxicité en manganèse (100 ppm Mn) se traduisent par l'accumulation d'une plus grande quantité d'acides aminés libres, les effets étant plus prononcés en début de croissance. La lysine, l'alanine, la tyrosine et la méthionine subissent les plus grandes fluctuations en fonction de la variation en Mn et leurs taux étaient supérieurs dans les plantes cultivées dans des conditions de déficience ou de toxicité en manganèse. La présence d'arginine et l'absence d'acide γ-amino-butyrique semble typique pour les désordres de la nutrition en manganèse de la canne à sucre. Les amines, asparagine et glutamine, répondent indépendamment des différents taux en Mn. La teneur totale en acide aminé était supérieure dans les feuilles développées dans des conditions de déficience et de toxicité en Mn. On a constaté que l'âge de la plante était un facteur significatif lors de la détermination des variations ci-dessus.

Einfluss von Mangan auf die Konzentration von freien Aminosäuren in Rohrblättern

Die qualitativen und quantitativen Effekte der Veränderung des Manganstoffwechsels auf die nicht-protein-freien Aminosäuren wurden in Zuckerrohr, angebaut in reinen Sandkästen, untersucht. Die freien Aminosäuren wurden aus Blättern im Alter von 3, 5 und 7 Monaten extrahiert und durch zweidimensionale Papierchromatographie aufgetrennt. In allen drei Wachstumstadien häuften sich unter Manganmangel (0 ppm Mn) und bei Mn-Vergiftung (100 ppm Mn) mehr freie Aminosäuren an, wobei die Effekte im Anfangsstadium des Wachstums ausgeprägter waren. Lysin, Alanin, Tyrosin und Methionin zeigten die grössten Schwankungen bei Variation der Mn-Konzentration, und ihre Werte waren höher bei Mn-Mangel- und Mn-Vergiftungsbedingungen. Die Anwesenheit von Arginin und die Abwesenheit von γ-Amino-Buttersäure scheint typisch für Mn-Stoffwechselstörungen in Zuckerrohr zu sein. Die Amide, Asparagin und Glutamin, reagieren unterschiedlich auf verschiedene Mn-Konzentrationen. Der gesamte Aminosäuregehalt war höher in Blättern, die unter Mn-Mangel und Mn-Vergiftung wuchsen. Festgestellt wurde, dass das Alter ein signifikanter Faktor zur Bestimmung dieser Veränderungen ist.

Influencia de manganeso sobre la acumulación de amino-ácidos libres en hojas de caña

Los efectos cualitativos y cuantitativos de variación en nutrición con Mn sobre amino-ácidos libres y no-proteícos se han estudiado en caña de azúcar cultivado en tiestos de arena pura. Amino-ácidos libres se han extraido de las hojas a 3, 5 y 7 meses y se han separado por cromatografía bi-dimensional sobre papel. En todas etapas de crecimiento, condiciones de deficiencia (0 ppm) y toxicidad (100 ppm) de manganeso han producido acumulación de amino-ácidos libres, siendo los efectos más notable en las etapas tempranas. Lisina, alanina, tirosina y metionina han demostrado las fluctuaciones más grandes con variación en Mn y sus niveles fueron más altos que en plantas cultivado en condiciones de deficiencia y toxicidad de Mn. Presencia de arginina y ausencia de ácido γ-amino-butirico parecen tipico de trastornos nutricional con Mn en caña de azúcar. Asparagina y glutamina han reaccionado independemente a variación del nivel de Mn. Contenido total de amino-ácidos han alcanzado niveles más alto en hojas obtenido en condiciones de deficiencia y toxicidad de Mn. Se ha establecido que la edad de la planta es un factor significante en determinación de los cambios.

Sugar beet—which way forward?

A ONE-DAY conference under this title was organized on February 7 at the National Agricultural Centre, Stoneleigh, Warwickshire, under the auspices of the UK Agricultural Development and Advisory Service, the Royal Agricultural Society of England and the British Sugar Corporation. Mr. J. N. Holmes, Chairman of the Sugar Beet Research and Education Committee, and a member of the Institut International de Recherches Betteravières, was in the Chair.

After four or five years of low production, the good crops of 1977 and 1978 have brought greater attention to sugar beet in the UK, not least in respect of its significance in the forthcoming negotiations for the post-1980 sugar regime of the EEC. This, and a survey of the place of sugar on the European and World market, were the theme of a paper presented by T. P. J. Dyke, Director of Agricultural Services of British Sugar Corporation Ltd.

Problems which have arisen out of the successful development and use of monogerm beet varieties were discussed by Dr. M. H. Arnold, Head of the Sugar Beet Department of the Plant Breeding Institute at Cambridge. While the labour requirement for singling has been eliminated, this has also removed the opportunity of selecting the most vigorous plants and now all plants contribute to the crop. Weed beet has now been recognized as a menace which arises, not from contaminated seed as originally thought, but from seed from multigerm and ground-keeper beets. The difficulties of maintenance of desirable levels of all characteristics while seeking to improve one of them was mentioned and Dr. Arnold considered that major advances will come not from the plant breeder alone but from new combinations of agricultural technology and genetic change.

Dr. R. K. Scott, Director of Brooms Barn Experimental Station, discussed work carried out there which demon-

strated the importance of early sowing in achieving good crops, and stressed the role of solar radiation interception and the factors which affect this, including temperature, water and nutrients, sowing date and seed treatments, and plant population.

Recent progress in sugar beet mechanization was described by C. J. Baskerville, Mechanization Advisor to the ADAS, who described significant progress in drill design in respect of displacement and bad spacing through seed bounce, as well as the soil working components. He also reviewed a prototype drill for strip tillage, reduction of losses in harvesting and a new harvester to cope with high dirt throughput, and a new profile topper which allows 8% more beet to be sent to the factory.

The final paper of the conference was a discussion of the economics of sugar beet farming in the UK, by M. C. Thompson, Estate Manager of Ashton Wold Estate, Oundle. He examined four basic questions concerning the return on extra labour and capital, the risk involved in sugar beet growing, the interactions between beet and other crops, and the effect of beet on the net profit of the farm business, and concluded that sugar beet is a valuable crop to UK farmers except on heavy soils where the value is debatable.

The Quentin process

By J. F. T. OLDFIELD, M. SHORE, D. W. GYTE. C. W. HARVEY and G. C. JONES

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PART I

INTRODUCTION

Historical background

IT was suspected for several decades that the alkali metal ions are highly melassigenic, and during the mid-1950's Quentin[1,2] and Moebes[3,4] independently confirmed this and quantified the melassigenic effect of the alkali and alkaline earth ions. They showed that the melassigenic effect of the ions decreased in the order K> Na> Ca> Mg and that potassium and sodium ions were very much more melassigenic than magnesium ions.

Both workers devised ion exchange processes to substitute magnesium or calcium ions for potassium and sodium ions in factory syrups or juices with the aim of reducing molasses purity. In the Quentin process there was direct ion exchange of potassium and sodium ions in low green syrup for magnesium ions while the initial Moebes process[3,5] involved exchange of the potassium and sodium ions in second carbonatation juice for ammonium ions, with subsequent liming, gassing and filtration to introduce calcium ions and to produce a pH of about 10·5, before conversion to thin juice and evaporation in the usual way. After the initial development work on both processes, the greater simplicity and fewer disadvantages of the Quentin process and the easy availability of a relatively cheap regenerant have caused it to be considerably more favoured.

The Quentin process was successfully tested on a pilot plant in Germany in the 1955/56 campaign[2], and then put into full-scale operation. It was patented in Germany in 1960[6]. Development and refinement have been swift and there are currently over 50 European and American factories using the process.

Sugar recovery by the Quentin process

The process consists essentially of passage of low green syrup through a bed of strongly acidic cation exchange resin in the magnesium form to exchange about 50% of the potassium and sodium ions for magnesium ions, the resin being regenerated with magnesium chloride solution. The process recovers sugar in two ways:—

(*i*) reduction in weight of non-sugars: magnesium ions have an approximate equivalent weight of 12 compared with 39 and 23 for potassium and sodium ions, respectively. The weight of non-sugars is thus decreased by the exchange and hence the weight of molasses produced should be correspondingly reduced. Similar calculations to those in Appendix I show that, if the molasses purity is unchanged by the process, the expected sugar recovery for 50% exchange of potassium and sodium for magnesium ions would be about 0·14% on beet.

(*ii*) reduction in cation melassigenesis: magnesium ions are less melassigenic than potassium and sodium ions, and this is usually assumed to be due to their greater hydration compared with potassium and sodium ions[4,7]. This effectively reduces the amount of water available for solution of sucrose in magnesium molasses and hence favours increased crystallization of sugar. Thus, molasses produced with magnesium exchange would be expected to be more completely exhausted than without exchange, and thus should be of lower purity.

As a further reason for reduced sugar in magnesium molasses it has been suggested[8] that crystallization of sugar occurs more quickly than with normal molasses and hence that a greater proportion of sugar than usual is crystallized in the after-product pans.

The total sugar recovered by these two mechanisms is usually stated to be 0·3 to 0·5% sugar on beet for 40–50% exchange of sodium and potassium for magnesium[7,9,10,11,12,13].

Outline of the economics of the Quentin process

The economic viability of the process depends mainly upon the relative prices of white sugar, molasses and magnesium chloride regenerant, as the operating and capital costs are low compared with those for other methods of sugar recovery, such as the Steffen process.

[1] *Zucker*, 1954, **7**, 407–410.
[2] *ibid.*, 1957, **10**, 408–415.
[3] *Zeitsch. Zuckerind.*, 1957, **82**, 382–386.
[4] *Zucker*, 1957, **10**, 78–85.
[5] Moebes & Wieninger: *ibid.*, 1955, **8**, 129–134.
[6] German Patent 974,408.
[7] "Quentin Process" (Robert Reichling & Co. KG, Krefeld.)
[8] Pieck *et al.*: *Sucr. Belge*, 1968, **87**, 319–326, 371–377.
[9] Neumann: *Zucker*, 1964, **17**, 451–457.
[10] Quentin: *Zeitsch. Zuckerind.*, 1964, **89**, 683–685.
[11] Huberlant: *Sucr. Belge*, 1967, **86**, 505–514.
[12] Schoenrock: *J. Amer. Soc. Sugar Beet Tech.*, 1971, **16**, 299–312.
[13] *Proc. Colloque Applexion*, 1975, 95–115.

As the process, in effect, recovers white sugar at the expense of loss of molasses then, in simple terms, there has to be a sufficiently large differential between white sugar revenue gained and molasses revenue lost to make a profit after paying regenerant costs. Until recently this differential has been too small to make the Quentin process economically worthwhile in the UK, particularly as the sources of magnesium chloride are in central Europe and transport costs are high, in part owing to its supply as a saturated solution. Because of changes in world market conditions, this differential greatly increased in 1974, and in February 1975 it was decided to investigate the possibility of installing an experimental Quentin plant in a British Sugar Corporation factory for operation in the 1975/76 campaign.

Feasibility of decalcification plant conversion

A Quentin plant is broadly similar to a decalcification plant in that both are for batch ion-exchange processes using a single resin, and investigation showed that it would be feasible and relatively inexpensive to adapt one of the latter plants as a Quentin plant.

The resin requirement for a Quentin plant is at least 6 m^3 per 1000 tonnes of beet per day [7,12,14], and only Brigg factory had a suitable, modern decalcification plant of sufficient size. Brigg had a slice of about 3000 tonnes.day^{-1} and a 2×9 m^3 decalcification resin volume, i.e. 6·0 m^3 of resin volume/1000 tonnes daily slice. The Brigg decalcification plant thus had just sufficient resin volume for conversion to a Quentin plant, but any increase in slice, or in sodium and potassium content of the low green syrup would be difficult to accommodate. This lack of flexibility had to be accepted, as only by conversion of this decalcification plant could a Quentin plant be operational by the start of the 1975/76 campaign, there being insufficient time available to design and install a purpose-built plant.

Published data for Quentin plants[7,9,15], and unpublished work from B.S.C. Research Laboratories[14], indicated that a typical Quentin plant should treat about 3·75 resin bed volumes, i.e. about 34 m^3, of 70 RDS (refractometric dry substance) low green syrup each cycle. Thus it was decided that all tanks should be sized on this basis. It was expected that the resulting plant would be able to produce a Quentin molasses of 0·75% w/w magnesium, about 2·2% Mg on molasses non-sugars (see below under *Plant performance—Specification*), and that the consequent recovery of sugar would be 0·3–0·5% on beet.

DECALCIFICATION PLANT CONVERSION

Description of design

The principle aims of the decalcification plant conversion into a Quentin plant were:

to provide a relatively cheap system for testing the Quentin process within the British Sugar Corporation;

to gain sufficient information to design an efficient, purpose-built plant if it was decided to extend the use of the Quentin process to further factories.

The basic system was to be as follows: there would be two columns each containing 9 m^3 of a macroporous strongly acidic cation exchange resin with each column running for about two hours on low green syrup diluted to 70 RDS (refractometric dry substance) at 90°C, then regenerating for about four hours and finally on stand-by for about two hours. The column operating sequences would be staggered by about 4 hours so that the second column would start its run halfway through the regeneration stage of the first column and so on. The flow rates of supply and treated low green syrups would be arranged such that the plant could take a continuous supply of low green syrup and give a continuous feed to process of treated syrup of constant magnesium content. To minimize dilution of treated syrup there would be recycling of both concentrated and dilute sweet waters, with some of the sweet waters used for dilution of supply low green syrup to 70 RDS. Low green syrup cannot be passed through the resin at the solids content at which it is spun from the raw sugar centrifugals, as it is well known[12] that above 70 RDS the resin is damaged by the excessive osmotic expansion and contraction of the resin beads. Partially spent regenerant would be re-used to minimize regenerant use. Each supply tank would always feed its own column and treated syrup tank.

The conversion was designed to take advantage of some of the special features of the British Sugar Corporation decalcification plants, in particular:

(*i*) to use the existing decalcification resin vessels. These are 2·76 m in diameter and are designed to operate with a bed depth of 1·53 m, i.e. with 9 m^3 resin. As mentioned previously, this volume of resin was the minimum quantity needed in each column for Quentin treatment of all the low green syrup at Brigg. Calculations showed (see below) that Brigg should produce about 211 m^3 of 70 RDS low green syrup per day, i.e. a flow rate of about 9 $m^3.hr^{-1}$. Because the columns would only be on stream for about 50% of the time, a flow rate of about 18 $m^3.hr^{-1}$ through the resin was necessary. This is consistent with published Quentin plant data[12,13] which states that optimum flow rates are about 2 resin bed volumes of syrup per hour. Laboratory work with columns scaled from the Brigg dimensions and containing Imacti C16P resin showed that the required flow rate of 70 RDS low green syrup could be achieved at normal pump pressures of 0·3–1·0 bar gauge, i.e. compressed air would not have to be used to force the syrup through the resin. Utilization of the existing vessels would thus avoid using pressure vessels, which are expensive to produce and insure.

(*ii*) to recover and re-use the partially spent regenerant by utilizing the existing regenerant rinse water receiver. This feature of the decalcification plant permits re-use of the water used to displace regenerant from the resin so that in a Quentin plant this should produce a significant reduction in usage of expensive magnesium chloride regenerant; the tanks and pipework could be cheaply modified for re-use of Quentin regenerant.

(*iii*) to use control system triggering methods operating in a similar way to those on the existing decalcification system, i.e. by the level of tank contents. This system was preferred to other methods of control such as conductivity measurement or use of an integrating flow meter because it is simple, robust, relatively inexpensive, and would permit integration of the existing decalcification control into the new Quentin system without extensive modification.

Fig. 1 shows a schematic diagram of the Brigg decalcification plant, and Fig. 2 shows the plant when modified as a Quentin plant. Table I shows the principal differences and similarities between the Quentin plant and the Brigg factory decalcification plant upon which it was based.

[14] Oldfield *et al.*: Unpublished work.
[15] Hoffman & Rother: *Zucker*, 1960, **13**, 380–387.

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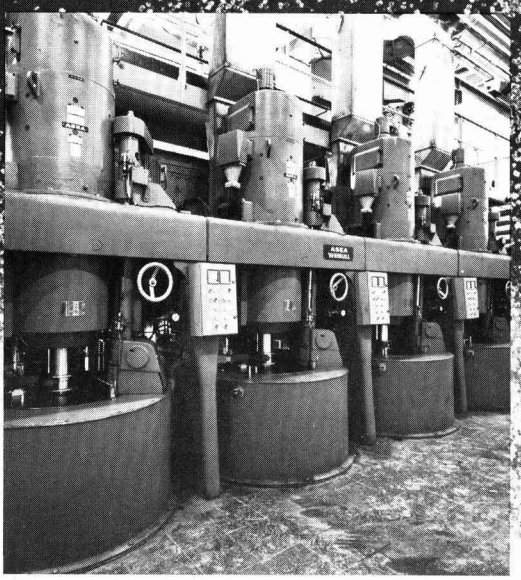

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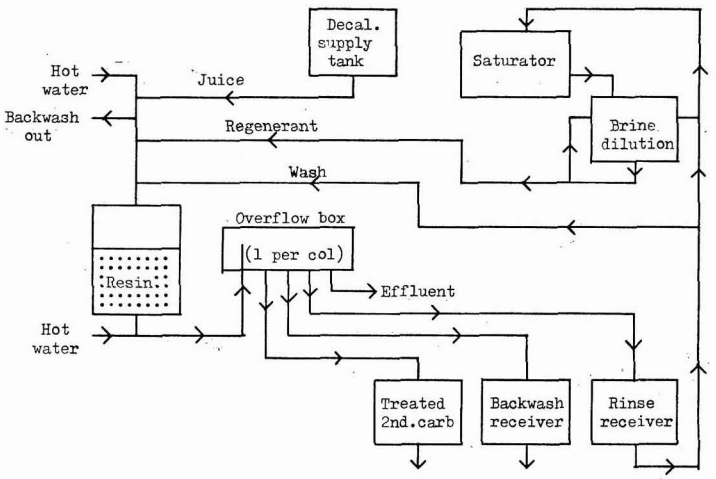

Fig. 1. Schematic diagram of decalcification plant

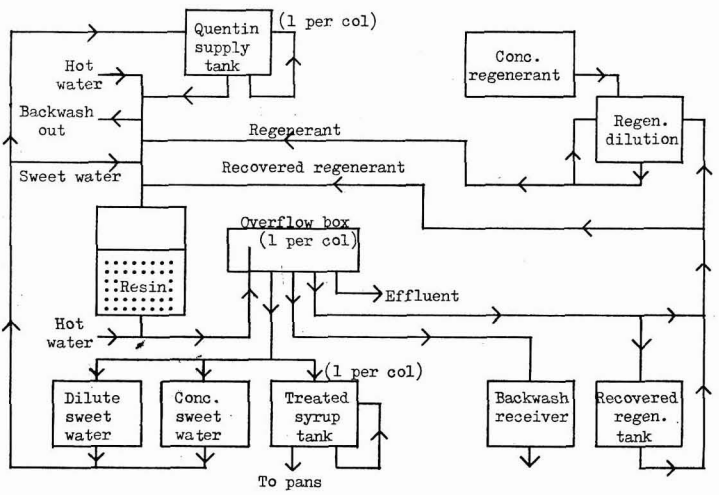

Fig. 2. Schematic diagram of Quentin plant

Table I. Quentin versus decalcification requirements for 3000 tonnes daily slice at Brigg factory

	Quentin	*Decalcification*
Supply syrup tanks	2×36·4 m^3	1×2·5 m^3
Treated syrup tanks	2×38·6 m^3 (Note 1)	1×2·5 m^3
Concentrated regenerant tank	same, 51 m^3	
Dilute regenerant tank	same, 22 m^3	
Backwash receiver	same, 44 m^3	
Recovered regenerant tank ...	1×10·9 m^3	(rinse receiver)
Conc. sweet water tank	1×13·6 m^3	none
Dil. sweet water tank	1×11·3 m^3	none
Resin, 2×9 m^3	macroporous type (Note 2)	gel type (Note 3)
Syrup heating	yes	none
Syrup mixing	yes	none
Number of stages in column sequence	16	11
Spreader in column	high efficiency (Note 4)	rudimentary (Note 5)

Notes:
1. These are part of the existing sugar end, being the low green tanks that feed the AP pans.
2. Surplus Imacti C16P was available in the British Sugar Corporation and was suitable.
3. Zerolit 525 at Brigg.
4. This is to ensure that as little mixing as possible occurs between layers of sweet-water of different Brix in the column, hence effecting a sharp cut-off for sweetening-on and -off. It was decided to achieve this by fixing a large perforated plate immediately under the original rudimentary spreader used in the decalcification plants.
5. This was a very small perforated plate, mounted immediately below the input pipe, which served to break up the input flow to prevent air bubbles being forced into the resin bed, rather than to distribute the liquid across the column.

The modifications were completed and the plant was ready for commissioning by late September 1975.

Commissioning of the plant

The plant was built late in the 1975 off-season and commissioned early in the 1975/76 campaign. The principal modifications found necessary were as follows:

(*i*) Two experimental systems for mixing the supply and treated low green syrups were evaluated. Recirculation through a pipe drawing syrup from the bottom of the tank was successful, but the alternative air mixing proved unsuitable because the contents of the tanks frothed over the top.

(*ii*) A heat exchanger in the recirculation system was found to be preferable to an experimental steam injection system for heating the supply syrup, because the latter method caused charring and excessive dilution.

(*iii*) The low green syrup supply tanks had formerly been carbonatation tanks. They were used because they were readily available, but as each had a working volume of only about 28 m^3 instead of the specified 36 m^3, the quantity of 70 RDS syrup treatable each cycle was reduced from about 34 to about 28 m^3.

(*iv*) The sweetening-on and -off behaviour of the columns was not exactly predictable before commissioning and, in the event, the sweet-water system had to be modified when it was found that the concentration of the recycled sweet-water increased with each cycle. As the concentrated sweet-water tank was 2·5 m^3 smaller than specified, owing to the expediency of having to use an available tank, the sweet-water recycling system could not accommodate all the concentrated sweet-water that was produced during proper sweetening-off. In order to cope with the excess the system had to be modified by using concentrated sweet-water instead of dilute sweet-water for supply syrup dilution. The nett effect of this change, and the changes brought about by the use of oversmall supply tanks, was to reduce the quantity of concentrated low green syrup treated each cycle from about 28 m^3 to only about 20 m^3.

(*v*) Factory hot water of high ammonia content had to be used for the rinse and the high pH of the spent rinse used to dilute the concentrated magnesium chloride regenerant resulted in precipitation of insoluble magnesium salts which blinded the resin and caused channelling. Such precipitation was avoided by an automatic addition of about two gallons of concentrated hydrochloric acid to the diluted regenerant tank each time it was filled. The pH was thereby lowered to about 7, and the precipitation problem ceased.

(*vi*) The resin bed was found to need decompaction after regeneration and washing. Rather than use compressed air, which it was thought at the time might contribute to strainer failure, but was later exonerated, a second backwash was instituted after the final wash stage. About 2·3 m^3 of water proved just sufficient to stir the resin.

(*vii*) A drain stage between the regeneration and wash stages was dispensed with by running the columns at a low liquid level, of about 1 ft above the resins, by shutting the vent during these stages, i.e. the air above the resin bed was not allowed to bleed out normally through the vent, thus saving about 20 minutes in the regeneration sequence.

Most of the modifications would have been very difficult to carry out if the control system had been of conventional hard wiring. A very flexible matrix board system, devised by the Instrument Engineer, proved very useful and its use greatly facilitated any control modifications, thus effectively shortening the commissioning period.

The plant was successfully commissioned in four weeks during the early part of the campaign, but further small modifications were effected during the rest of the 1975/76 campaign. Table II shows the final column operating sequence at the end of the 1975/76 campaign.

The following ancillary operations occur during the sequence shown in Table II:

Before stage 2, the contents of the low green supply tank for the appropriate column are mixed and heated to 90°C by recirculation through a heat exchanger.

After stage 4, the appropriate supply tank can start to fill with low green syrup.

During stages 5 and 6, the treated low green syrup is mixed by recirculation.

During stages 8 and 9, the dilute regenerant is mixed by recirculation.

During stages 8, 9, 10, the contents of the concentrated sweet-water tank are sent to the appropriate supply tank to dilute the supply syrup to 70 RDS.

Table II. Final column operating sequence (January 1976)

Stage (*time in min*)		*To column*	(*volumes in m^3*)	*From column*	(*volumes in m^3*)
1. Standby		—		—	
2. Sweeten-on 1	(15)	dilute low green syrup		spent backwash	(4·5)
3. Sweeten-on 2	(20)	" "	(28·0)	conc. sweet-water	(5·4)
4. Run	(60)	" "		treated syrup	
5. Sweeten-off 1	(25)	conc. sweet-water	(5·4)	"	(26·0)
6. Sweeten-off 2	(40)	dil. sweet-water	(10·0)	"	
7. Sweeten-off 3	(15)	hot water	(8·0)	conc. sweet-water	(8·0)
8. Drain	(16)	—		dil. sweet-water	(7·5)
9. Backwash 1	(20)	hot water	(27·3)	spent backwash	
10. Drain	(16)	—		"	(27·3)
11. Regeneration 1	(16)	recovered regenerant	(7·3)	to sewer	
12. Regeneration 2	(40)	dilute regenerant	(18·2)	"	(25·5)
13. Wash 1	(13)	hot water	(7·3)	recovered regenerant	(7·3)
14. Wash 2	(20)	"	(11·2)	to sewer	(11·2)
15. Wash 3	(29)	"	(16·6)	regenerant dilution	(16·6)
16. Backwash 2	(1)	"	(2·3)	—	
1. Standby		—		to sewer	(2·3)

Total cycle time 346 min.

Note.—The second column cannot sweeten-on until the first column has reached stage 11.

During stages 13 and 14, the concentrated regenerant is transferred from the concentrated regenerant tank to the dilute regenerant tank.

This sequence was used throughout the 1976/77 and 1977/78 campaigns, but the stage times were modified to reduce the cycle time.

Table III gives a summary of some of the operating features of the plant when it was operated according to the sequence in Table II.

Table III. Plant operation (Jan. 1976)

Cycles per day	5–6
Cycle time	5 hr 46 min
Concentrated low green syrup processed	20 m^3 per cycle
Water used	72·7 m^3 ,,
Effluent produced	39 m^3 ,,
Regenerant used	18·2 m^3 ,,
Regenerant concentration	1% w/v as Mg^{++}

PLANT PERFORMANCE

Specification

Published data [7,9,15] indicate that the chosen resin would be expected to treat about 3·5 to 4·0 resin bed volumes of 70 RDS low green syrup per cycle, giving about 34 m^3 of 70 RDS syrup per cycle on a 9 m^3 resin bed.

Prior to design of the plant, details of quantities and composition of Brigg low green syrup were not available, and so the required information was calculated from molasses yields and the analytical data for campaign composite molasses samples for the 5 campaigns before 1975/76.

Assuming that all the molasses non-sugars had originated from low green syrup of 75 apparent purity, it was calculated that about 176 m^3 of 80 RDS low green syrup would be produced per day, i.e. 211 m^3 per day at 70 RDS, requiring 6·2 cycles per day at 34 m^3 per cycle.

On the basis of the molasses analyses, 211 m^3 70 RDS syrup would typically contain 48·8 tonnes non-sugars, including 206·6 keq of sodium plus potassium, giving 33·3 keq Na+K per 7·9 tonnes of input non-sugars per cycle. The proportion of Mg in typical Quentin molasses[9,12,13] is between 2 and 3% on non-sugars, i.e. 2–3% on non-sugars in treated low green syrup. Non-Quentin molasses contains typically less than 0·03% Mg on non-sugars; hence, taking the equivalent weight of magnesium as 12·156 and ignoring the change in weight of non-sugars effected by the ion-exchange, each cycle should exchange $\frac{(2 \text{ to } 3) \times 7{\cdot}9 \times 100 \text{ keq}}{100 \times 12{\cdot}156}$ of magnesium into the treated syrup, i.e. 13·0 to 19·5 keq Mg. Therefore the required resin capacity is 1·44 to 2·17 keq Mg per m^3 per cycle, i.e. within the theoretical capacity of about 2·2 keq.m^{-3} of the available Imacti C16P resin but allowing for use of a lower capacity to facilitate efficient use of regenerant. Such a scheme should give 1·94 to 2·35% Mg on output non-sugars which, for molasses of 85% true dry substance and 60% apparent purity, corresponds to 0·66–0·80% w/w Mg on molasses.

The above calculations confirmed the plant as being just big enough for Quentin operation at the required slice rate.

Parameters for assessment of plant performance

The parameters used in the assessment of the Quentin plant are defined as follows:

(*i*) *Proportion of magnesium in treated syrup expressed as a weight per weight percentage.* The effective capacity of the resin may be obtained by dividing the value for magnesium in syrup treated per cycle by the resin volume of 9 m^3.

(*ii*) *Regenerant utilization*, i.e. the proportion of magnesium in treated syrup expressed as a percentage of the magnesium content of the dilute regenerant but ignoring the contribution of the regenerant recovered and recycled from the rinse.

This parameter combines efficiency of regeneration with efficiency of exchange of magnesium into the low green syrup; thus, diagnostic investigation would require separate analyses of column output samples at selected stages to decide which was the more important in a particular situation.

(*iii*) *Proportion of magnesium in treated syrup and molasses expressed as a percentage of the non-sugars.* The proportion of magnesium on non-sugars in molasses should be the same as for treated low green syrup if all the molasses non-sugars come from the low green syrup, and a difference indicates the extent to which non-sugars are by-passing the Quentin plant, either by direct by-passing of a temporary excess of low green syrup, or by the use of high green syrup as a footing for the final product vacuum pans.

(*iv*) *Proportion of magnesium in molasses expressed as percentage w/w.* This value is dependent upon the concentration of magnesium in the treated syrup and the quantity of non-sugars by-passing the plant.

Values (*i*) and (*ii*) are the principal parameters for assessing the ion exchange performance of the plant as they express the capacity and efficiency of the exchange. Values (*iii*) and (*iv*) are the traditional parameters used for assessing the overall effectiveness of a Quentin system in producing a magnesium molasses.

Other useful parameters, but not of such fundamental importance as those described above, are as follows:

(*v*) *Proportion of equivalents of Mg exchanged expressed as a percentage of the equivalents of magnesium + potassium + sodium.* It is referred to as "% exchange". The Mg content of treated syrup results from exchange with an equivalent amount of (Na+K) in the supply syrup and consequently, under steady state conditions, total equivalents of (Mg+Na+K) in treated syrups or molasses are equal to total equivalents (Na+K) in the undiluted low green supply syrup.

This parameter is a useful guide to plant performance on a day to day basis, but it is dependent on both the resin capacity, i.e. the quantity of magnesium exchanged into the syrup, and upon the ionic loading (see *vi* below) of the plant.

(*vi*) *Ionic loading expressed as meq (K+Na+Mg) per 100 g of TDS (true dry substance) in treated syrup.* This parameter is less by about 2 parts in 100 parts than the true ionic loading, which is meq (K+Na) per 100 g of TDS in undiluted low green supply syrup, because of the change in TDS brought about by the exchange of light magnesium ions for heavy sodium and potassium ions, but it is a more convenient measure in use. High values of (*vi*) would be expected to produce low % exchanges at a given resin capacity.

(*vii*) *Regeneration level, expressed as keq Mg in diluted regenerant per m^3 resin*, is a convenient term for describing the quantity of magnesium applied to the resin during regeneration.

Plant performance 1975–78

The Quentin plant performance has been monitored throughout 2½ campaigns operation and typical results for 4 representative operating periods are given in Table IV.

Table IV. Brigg Quentin plant performance 1975-78

	Date (*note* 1)			
	20th Nov. 1975	*9th Feb.* 977	*26th Nov.* 1977	*17th Jan.* 1978
Mg % w/w in treated syrup (26 m³) .....(*i*)	0·47	0·50	0·50	0·46
Resin capacity keq Mg.m⁻³ from (*i*)	1·50	1·60	1·60	1·47
Regeneration utilization %.....(*ii*)	94·0	87·9	95·0	87·4
Mg % w/w on non-sugars in treated syrup ...(*iii*)	2·84	3·03	2·83	2·79
Mg % w/w on non-sugars in molasses .....(*iii*)	1·03	2·17	2·00	2·76
Mg % w/w in molasses (*iv*)	0·33	0·72	0·64	0·84
% exchange in treated syrup .....(*v*)	48·0	60·4	45·0	43·0
Mg % w/v in dilute regenerant (18·2m³)	0·95	1·08	1·00	1·00
Sugar loss % on beet (note 2)	0·005	0·006	0·006	0·012
Ionic loading .....(*vi*) meq (Mg+K+Na) per 100 g true dry substance in treated syrup	128·5	106·0	147·1	130·4
Regeneration level (*vii*) keq Mg in regenerant per m³ resin	1·58	1·82	1·68	1·68

Notes.—1. A typical cycle is shown for the stated date.
2. Calculated from the pol of all liquids sent to sewer.

(*a*) *1975/76 Campaign.* The typical cycle recorded for 20th November 1975 represents plant operation soon after commissioning. Performance was exemplary and the design specification targets were easily achieved with, at 94%, a very high regenerant utilization.

It had been realized that, dependent upon other operating parameters, a small reduction in slice rate might be insufficient to compensate for the increased demand on the evaporative capacity of the sugar end due to extra water from dilution of treated low green, and that additional evaporative capacity might be needed. During the 1975/76 campaign, thick juice purity was lower than typical: when the data for 20th November 1975 were collected the thick juice non-sugars were some 22% above average, so that the loading on the low purity sections of the sugar end was considerably increased. In consequence, even with a slight reduction in slice rate, the evaporative capacity of the sugar end was insufficient to cope with the specified quantity of diluted low green syrup, and high green syrup was therefore used in the final product vacuum pans to speed up boiling so that about 64% of the molasses non-sugars by-passed the Quentin plant in this way. In addition, the decrease in the size of the supply tanks detailed above, meant that, although the plant was treating all of the production low green syrup, only 75% of the specified quantity was being treated in each cycle. The extra ionic content of the syrup compensated approximately for the decreased quantity of syrup and the ionic load on the plant was, therefore, at about the expected value.

(*b*) *1976/77 campaign.* The cycle recorded for 9th February 1977 is typical of the plant operation towards the end of the campaign. Thick juice purity was higher than in the previous campaign so that the loading of the sugar end was reduced and less high green syrup was being used in the final product vacuum pans. Thus the plant was treating 72% of the total non-sugars. To compensate for the by-passed non-sugars, the concentration of Mg in dilute regenerant was increased from 0·95 to 1·08% resulting in an increase in resin capacity from 1·5 to 1·6 keq Mg per m³. This, and the decrease in by-passing of non-sugars, increased the Mg in molasses from 0·33 to 0·72%. The decrease in ionic loading in juice from 128·5 to 106·0 resulted in an increase in % exchange from 48·0 to 60·4. However, this gain was at the expense of extra regenerant usage and ion exchange efficiency, and the regenerant utilization decreased from 94% to 87·9%.

(*c*) *1977/78 campaign.* The cycle shown for 26th November 1977 is typical of plant operation in the middle of this campaign. A decrease in purity of low green supply syrup gave a 39% increase in ionic loading on the plant from 106 on 9th February 1977 to 147·1, pushing the ion exchange equilibrium during exhaustion towards greater completeness. With a resin capacity again of 1·6 keq Mg per m³, resulting from a dilute regenerant concentration of 1% Mg, the achieved concentration of 0·5% Mg in treated syrup showed a drop in % exchange from 60·4% to 45%, but with a return of the regeneration utilization to the higher value of 95%.

By mid-January an effective flash evaporator system had been installed capable of concentrating the treated syrup to its original Brix before the final product vacuum pans, which were then boiled without any addition of high green syrup as a footing so that there was no longer any requirement for juice to by-pass the Quentin plant. Hence the quantity of 70 RDS low green for treatment increased to about the 211 m³ originally envisaged for the plant. Because the plant could only treat 75% of the design quantity of low green syrup per cycle, the increased quantity of syrup was accommodated by increasing the number of operating cycles to 8–9/day by increasing the flow rates, thereby saving over an hour on each cycle. The operating parameters are reported in Table IV for a typical cycle on 17th January 1978.

The results were similar to those found just after commissioning (20th November 1975), except that the high syrup and regenerant flow rates had reduced the regenerant utilization to 87·4%. The sugar losses increased from 0·005 to 0·012% on beet owing to the necessity for increasing the sweet-water flow rate with less efficient sweetening-off as a result. This loss only amounts to 2·4% on a recovered sugar of 0·5% on beet, however.

The proportion of Mg on non-sugars in treated syrup, at 2·79%, was virtually identical with the proportion of Mg on non-sugars in molasses at 2·76%, showing that only negligible quantities of molasses non-sugars were by-passing the plant.

In general the ion-exchange results indicated that the plant operated to specification and, moreover, corresponded to an increase from the design specification of 1·9–2·35% Mg on molasses non-sugars to 2·7% Mg on molasses non-sugars at a regenerant utilization of about 87%, despite operation of the plant at flow rates which were very much higher than specified.

Assessment of the resins from both columns by methods similar to those used for decalcification resins[16,17] showed them to be in good condition. Owing to strainer failures (below), about 40% of the original resin had been gradually replaced by "Amberlite IR 200C" over the 1975/76 and 1976/77 campaigns, but no losses were experienced during the 1977/78 campaign.

(*To be continued*)

[16] Oldfield, Harvey & Shore: *I.S.J.*, 1973, **75**, 70–74, 103–105.
[17] *Proc. 16th Session ICUMSA*, 1974, 377–379.

SUGAR CANE AGRONOMY

Seepage drainage—finding the water. L. K. Izatt. *Cane Growers' Quarterly Bull.*, 1978, **41**, 69-70.—Advice is given on how to locate water sources when installing underground drains on farms with wet areas.

Role of sugar factories in cane development. D. G. Dakshindas. *Indian Sugar*, 1977, **27**, 443-448.—The part that the sugar factory can play in helping the cane farmer is examined with particular reference to Maharashtra. The problems are classified under four categories of cane development work, *viz.* field production, harvest and transport, cane quality maintenance, and developmental research.

Nitrogen and sugar cane. X. Correlation between leaf nitrogen and tillering. U. S. Singh. *Indian Sugar*, 1977, **27**, 449-450.—A 2-year field experiment was conducted with nitrogen application rates of 0, 112 and 224 kg.ha^{-1} and field planting rates of 20, 600, 37,000 and 53,500 setts per ha. In June, when tillering approached its peak, the number of tillers per plant was recorded and leaves from the mother shoot analysed for N. Results showed that leaf N had a significant positive correlation with tillering, a 1% increase in the N content during June corresponding to an increase of 5·81 tillers per plant.

A review of recent developments concerning the biodeterioration of sugar cane. B. T. Egan, L. K. Kirby and A. G. Noble. *Proc. 16th Congr. ISSCT*, 1977, 321-326.—Recent work has shown that *Leuconostoc* infection causes problems in burnt standing cane as well as after harvesting. Green chopped cane shows basic differences in the deterioration process from burnt chopped cane which loses sugar at twice the rate of green cane and has a higher dextran content. The use of dextranase has been developed further in Queensland for easing of factory processing problems with deteriorated cane; this can be processed in a reasonable manner with the aid of the enzyme but at a considerable cost in money and efficiency.

Soil physical properties and the growth of ratoon cane as influenced by mechanical harvesting. S. J. Yang. *Proc. 16th Congr. ISSCT*, 1977, 835-847.—See *I.S.J.*, 1977, **79**, 169.

Investigations into the vertical and horizontal planting of sugar cane under North Indian conditions. P. P. Singh and K. Kumar. *Proc. 16th Congr. ISSCT*, 1977, 849-854.—Under conditions of late planting it has been found[1] that vertical planting of setts gives better results than horizontal placement. This has been confirmed by experiments in two seasons—1974/75 and 1975/76—at the Crop Research Centre, Pantnagar, and it has also been shown that yields comparable to those from vertical planting are given by horizontal planting of pre-germinated setts.

Effects of inter-row spacing on yields of sugar cane in Taiwan. K. H. Tang. *Proc. 16th Congr. ISSCT*, 1977, 855-859.—Experiments carried out at two locations with three varieties, to compare yields from the standard row spacing of 1·25 m and planting density of 20,000 setts.ha^{-1} with 1·35 and 1·45 m spacing and with smaller (18,000) and greater (30,000) planting density, over a plant cane crop and three ratoons, showed that there was no significant reduction in crop yields when the row spacing was widened to 1·35 m, which is more suitable for mechanical cultivation.

Effect of excess sodium on sugar cane yield. S. Valdivia V. *Proc. 16th Congr. ISSCT*, 1977, 861-866. Trials under field conditions with H 32-8560 cane on 20 plots in the Zaña Valley—an area with a slightly saline soil, predominantly sodic—having exchangeable Na between 2 and 44%, enabled 15% to be established as the critical level beyond which yield of sugar or cane fell by 15%. With 10% exchangeable Na there was hardly any reduction in yield, while 25-26% caused a halving of yield.

Effect of nitrogen and moisture on sugar cane flowering. A. I. Allam, A. H. Nour and T. A. Fayed. *Proc. 16th Congr. ISSCT*, 1977, 875-882.—Some 176 varieties and genetic cane stocks were subjected, over three consecutive years, to treatments with three nitrogen levels and two irrigation intervals (3 days and 10 days), in order to induce flowering under natural conditions. A total of 110 clones flowered readily, while 17 failed to flower at all. Use of 20 kg N per feddan (1·037 acre) and a 3-day irrigation interval gave the maximum floral initiation and full emergence. The 20 kg N level with both irrigation intervals was significantly better than the 40 kg N level as regards full emergence, and both were superior to the 80 kg N level for both floral initiation and full emergence. The importance of low soil N level is emphasized for both stages in flowering, and the lack of stimulating effect of frequent irrigations on floral emergence is noted.

Effect of bagasse furnace ash on the growth of plant cane. Y. C. Pan, K. L. Eow and S. H. Ling. *Proc. 16th Congr. ISSCT*, 1977, 883-889.—A strongly acidic clay soil was treated with 12, 24, 36 and 48 tonnes.ha^{-1} of furnace ash and with 2·5 tonnes.ha^{-1} of silicate slag, and a cane variety GPB 5 grown on the plots, with an untreated plot as control. Both cane yield and sugar content were increased by the treatments (except for the sugar content at the highest ash level), but the cane and sugar yields per ha were not significantly different at the 24, 36 and 48 tonnes.ha^{-1} ash levels.

Minimum tillage: a practical alternative to ploughing in the South African sugar industry. W. Hadlow and E. W. Millard. *Proc. 16th Congr. ISSCT*, 1977, 891-897.—Minimum tillage techniques are described for cane land where either natural vegetation on virgin land or tillers growing from the stools of an old cane crop are sprayed with "Glyphosate" to effect a complete kill and a new crop planted in the inter-row 1-7 days after

[1] Panje: *Ann. Progress Rpt. Indian Inst. Sugarcane Research*, 1967

spraying. The chemical can be applied by hand sprayer or by tractor-mounted boom sprayer where appropriate. The technique has the advantages of soil conservation, improved weed control and earlier crop re-establishment.

An equation for the estimation of agro-industrial sugar cane yield in the Piracicaba region (Brazil). J. C. Ometto. *Proc. 16th Congr. ISSCT,* 1977, 899-905. By application of multiple regression analysis to data collected over the period 1943-1970, the influences of real:potential evapotranspiration ratio, mean:optimum temperature ratio, relative humidity ratio, insolation ratio, available:optimum nitrogen ratio, available:optimum phosphorus ratio and available:optimum potassium ratio have been studied. Of the ratios studied, the evapotranspiration ratio and humidity ratio alone were sufficient to give an accurate estimation of both agricultural yield (tonnes.ha^{-1} of cane) and industrial yield (sucrose % cane). Equations are derived for these in respect of Piracicaba conditions.

The effect of zinc application on yield and nutrient uptake of sugar cane. T. C. Juang, M. M. Kao and C. H. Chang. *Proc. 16th Congr. ISSCT,* 1977, 907-917. Trials were made with application of 25 and 50 kg Zn per ha as $ZnSO_4$ to four cane soils for autumn-planted cane and to two of the soils for a ratoon crop. Two of the soils showed a significant response in the plant crop for both cane and sugar yields, while application to the other two soils increased ratoon cane and sugar yields. A significant response occurred when there was a ratio of Fe:Mn in the +1 leaf of the young cane above 1; below 1 there was no response and it is suggested that the Fe-Mn-Zn balance in the leaf may be very important to cane growth. A significant relationship was found between cane or sugar yield and soil Zn content after harvest, with maximum yields at 12 and 18 ppm, respectively, for plant cane and ratoon.

Reclamation of saline sugar cane plantations by a sub-surface drainage system. S. J. Yang and P. L. Wang. *Proc. 16th Congr. ISSCT,* 1977, 919-930.—Field experiments were conducted in three different soils to evaluate the effectiveness of sub-surface drainage in reclamation of saline cane plantations. Drain characteristics and leaching of salts were studied separately. The outflow rate from each drain was very high, the peak discharge varying with hydraulic conductivity of the soil but all values being greater than 17 mm.day^{-1}. The water tables midway between tile lines were lowered 1·5 m from the surface after 7 days' drainage. A linear relationship was found between the discharge and the height of the water table at the mid-point between drains, the slope of the line increasing with increase in soil permeability. Five commonly used equations were compared for assessing the performance of a given scheme, and the predicted spacing from the Glover-Dumm equation[1] found to be closest to field data and so best for use in design of a drainage system. Desalinization is rapid using a sub-surface drainage system, the electrical conductivity of the saturation extract falling from 17 to below 2 mmho.cm^{-1} over 16 months.

General relationships between sugar cane yield and soil P, K, Ca and Mg as observed using the DRIS approach. E. R. Beaufils and M. E. Sumner. *Proc. 16th Congr. ISSCT,* 1977, 931-943.—The DRIS (Diagnosis and Recommendation Integrated System) of Beaufils[2], is used to relate cane yield to soil P, K, C and Mg, irrespective of site conditions, by means of a general formula. The DRIS calibration formula provides indices as comparable functions of yield for diagnosing both soil and plant requirements for any crop at any stage of its development. It enables classification of plant and/or soil factors in their order of limiting importance in crop yield, thus directly showing the nature of the requirements for the particular site. Graphs relating crop yield to soil characters, calculated in terms of DRIS indices, are presented and analysed. These indicate that, the further an index lies from zero, either negative or positive, the less the chance of a high yield. A low yield may be obtained where an index is near zero because another factor is limiting, however. The standard deviation for the indices gradually increases as the yield improves, showing that, the higher the yield, the smaller the deviation acceptable in the plant and/or soil.

Planting depth and seed material for establishment of sugar cane. J. E. Lonsdale. *Proc. 16th Congr. ISSCT,* 1977, 945-961.—Trials were carried out on the germination of setts of different sizes planted at different depths (2, 8 and 14 cm). Although more stalks were produced with 2 cm planting, yields were consistently higher at 8 cm, while 14 cm planting generally led to lower sucrose content and yield. Dipping of setts in "Aretan" and "Dieldrin" produced better tillering, especially with planting at 2 cm and in June. The 3-bud dipped setts were generally superior to 1, 5 and 7-bud setts. Although shoots from whole sticks generally emerged more slowly and more erratically, particularly if the sticks were not trashed and topped, they produced similar yields. Differences in planting depths and seed material requirements did not cause yields to differ between varieties or seasons.

Deterioration in chopped and whole-stalk sugar cane. J. E. Irvine and B. L. Legendre. *Proc. 16th Congr. ISSCT,* 1977, 963-970.—Chopped green cane samples kept at 10·0°, 18·3° and 26·6°C showed increases in gums and dextran at 1 day and a decrease in purity 2 days after harvest. After six days there was also a significant increase in titratable acidity and decreases in pH, juice sucrose content and sugar per ton. By contrast, whole-stalk samples showed little deterioration, apart from a significant increase in gums, six days after harvest. Chopped samples from frozen cane deteriorated much faster than unfrozen cane. Low post-harvest temperatures slowed deterioration in all samples.

Manganese availability in sugar cane soils of Hawaii and Florida. G. J. Gascho, M. Isobe and H. H. Hagihara. *Proc. 16th Congr. ISSCT,* 1977, 971-985.—Trials and soil analyses have shown that, apart from an area near Pahala, Hawaiian soils should not require Mn fertilization for many years. Mn levels in Florida organic soils are lower and Mn fertilizer and banded sulphur are needed in areas of high soil pH. In one area, however, with high soil and tissue Mn, the Fe:Mn ratio is low and chlorosis through Fe deficiency has been

[1] Dumm: *Agric. Engineering,* 1954, **35,** 726–730.
[2] *Soil Sci. Bull.* (Univ. Natal), 1973, (1); *Proc. 50th Congr. S. African Sugar Tech. Assoc.,* 1976, 118–124.

observed. Difficulty in finding a single extractant for analysis of Mn in all soils in Hawaii is attributed to the wide diversity of the mineralogical make-up and to excessively high Mn in some soils. Work is reported on extractants for soil testing.

Some aspects of the yield and quality of sugar cane. D. MacColl. *Proc. 16th Congr. ISSCT,* 1977, 985-994. The yield and quality of sugar cane is discussed with reference to leaf weight, assimilation rate and distribution of dry matter. In early growth there seems to be competition for dry matter between leaves, tillers and expanding joints, and the outcome differs with variety. During elongation, varieties differ as to leaf:cane weight ratio and, while high values are associated with high quality, they are also associated with low assimilation rates per unit leaf weight. Generally, assimilation rates do not seem to reach their potential during elongation and may be dependent on the ability of the cane to store sugar. Daily dry matter production per cane may remain constant for fairly long periods but tends to decline during ripening; increased sugar content corresponds to reduced production of storage tissue. The finding that small cells with thick walls are more efficient in storing sugar *in vitro* suggests that high sugar % fresh weight may of necessity be associated with reasonably high fibre % fresh weight. How the observations affect the work of the breeder is discussed.

Water management for sugar cane production on the Florida Everglades. S. F. Shih, D. L. Myhre, J. W. Mishoe and G. Kidder. *Proc. 16th Congr. ISSCT,* 1977, 995-1009.—The cane lands in the Lake Okeechobee region of south Florida are subject to a rainy season from May to October, when about 75% of the total rainfall (88-215 cm per year) falls, and a dry winter season; effective water management is thus a necessity. Comparison of methods for estimating evapotranspiration were compared with pan evaporation, and a modified Blaney-Criddle method developed which relates evapotranspiration to temperature and solar radiation and gives results similar to the pan method. The difficulty of water management, owing to the effects of subsidence, is also discussed.

Study by means of labelling techniques on the K-liming relation in soils cultivated with sugar cane. D. A. Cordeiro, L. F. Batista, M. N. Gurgel and V. C. Bittencourt. *Proc. 16th Congr. ISSCT,* 1977, 1011-1025.—K-Ca interaction in cane soils of two types was studied using radio-active materials for the soil analyses, *viz.* ^{45}Ca for calcium and radio-Rb for K by the "reverse-tagging" technique of Hafez & Stout[1]. It was shown that use of liming leads to a decrease in the availability of soil K to cane, a decrease that is directly dependent on the level of liming and a function of the soil type. The availability of Ca to cane is increased as a function of increasing levels of K fertilization.

Seasonal germination pattern of *Rottboellia exaltata* and its control with "Trifluralin" and "Terbacil". R. W. Millhollon. *Proc. 16th Congr. ISSCT,* 1977, 1027-1037.—*R. exaltata* (itchgrass) germinated at seven separate periods from April 13 to July 13 in a fallow cane field tilled 17·5 cm deep, most seeds germinating from near the soil surface — 65% from 0-5 cm, 33% from 5-10 cm and 2% from 10-15 cm. "Terbacil" at 3·6 kg.ha^{-1} and "Trifluralin" at 2·2 kg.ha^{-1} were tested for itchgrass control; while "Terbacil" applied to the surface was not effective (8% average seasonal control), it controlled the weed for 60 days (80% average seasonal control) when incorporated in the top 5 cm of soil, as did "Trifluralin" (89% control). "Terbacil" was most phytotoxic when mixed 5 cm deep with seeds germinating within, rather than below, the treated layer. "Trifluralin", on the other hand, was most phytotoxic when mixed in the top 2·5 cm with seeds germinating below.

Effect of subsoiling on soil compaction and yield of sugar cane. R. Ricaud. *Proc. 16th Congr. ISSCT,* 1977, 1039-1048.—Subsoiling under each row to a depth of 61 cm before autumn planting, using a normal subsoiler, increased cane yield by 11·2 tonnes.ha^{-1} or 19·3%; subsoiling with a vertical mulcher subsoiler increased cane yield by 21·7 tonnes.ha^{-1} or 39·9% on average. This was due to 19·8% more stalks and 23·2% higher individual stalk weight. The increases were larger in plant cane than ratoons. Incorporation of bagasse in the subsoil with the vertical mulcher did not increase cane yield. Although large increases in yield were obtained in a second cycle of cane after subsoiling it was beneficial to subsoil prior to planting each cane crop.

Soil residues of "Tebuthiuron" following single and repeat applications in sugar cane. B. J. Eaton, R. Frank, D. P. Rainey and C. Van der Schans. *Proc. 16th Congr. ISSCT,* 1977, 1049-1058.—Soil measurements using a ^{14}C-labelled material in the US and a wettable powder formulation in Brazil showed that "Tebuthiuron" ("Perflan") herbicide degraded in the soil with a half-life of 12 months.

Investigation into the effectiveness of maturity testing for non-irrigated sugar cane fields. R. G. Hoekstra. *Proc. 16th Congr. ISSCT,* 1977, 1059-1077. Over two seasons a series of cane samples was taken at intervals of two weeks from each of the fields of a non-irrigated estate in South Africa and analysed for sucrose % cane and purity difference between bottom and top of stalk. The sucrose contents of the samples were assumed to represent the sucrose content of the field as a whole at that time. At the end of each season these results were used in simulating the effects of alternative harvest sequences of the fields on total sucrose tonnage obtained from the estate. The alternative sequence criteria used were: actual harvest sequence, age sequence (oldest crop first), sucrose % cane of sample (highest first), stalk purity difference (lowest first), and slope of sucrose % cane curve (lowest first). Little or no gain in total sucrose tonnages was obtained for sequence criteria based on maturity test results and, in view of the cost of sampling and analysing, maturity testing was not considered a worthwhile proposition.

Tolerance to "Dalapon" (sodium 2,2-dichloropropionate) of different sugar cane varieties cultivated in Argentina. R. P. Cossio, N. V. de Ramallo and C. A. Gargiulo. *Proc. 16th Congr. ISSCT,* 1977, 1079-1089. Trials were made in which setts were sprayed with

[1] *Proc. Soil Sci. Soc. Amer.*, 1973, **37**, 572-579.

"Dalapon" solution and planted in the greenhouse, and others in which plant and ratoon cane was sprayed in the field, untreated setts and cane being used as control. Sprouting of buds was reduced as was tiller growth while stalk weights of plant and ratoon cane were reduced in all cases. There was a differential reaction for the five varieties studied.

Furrow irrigation of sugar cane in Araras, São Paulo. J. A. G. C. Sousa and R. Scardua. *Proc. 16th Congr. ISSCT,* 1978, 1091-1111.—Randomized block plots of CB 41-76 cane were grown as plant and first ratoon crops, with five replications, and irrigated by furrow under several levels of soil water tension (Treatments 1, 2 and 3 with 0·33, 0·60 and 1·20 atm for plant cane and 0·35, 0·6 and 1·3 atm for ratoon cane). A control experiment received no irrigation. Treatment No. 3 proved the most favourable for the soil and climatic conditions of the experimental area, with a mean daily consumption of 3·13 mm for plant cane and 3·16 mm for ratoon. The cultural mean coefficient K_C for the Class A pan a ground level was 0·74 and 0·68, respectively, while the mean value of K_C for the elevated Class A pan was 0·78 and 0·67 for plant and ratoon cane. The mean K_C obtained using Penman's formula was 1·00 and 0·98, respectively. The maximum mean weekly growths were 9·7 cm for plant cane and 9·9 cm for ratoon cane in the most active growth period. Increases in yield obtained in the irrigated treatments show that the soil water potential should be kept up to a minimum of 1·2 atm.

Soil preparation for sugar cane. J. Fernandes, D. Camposilvan, V. L. F. Neto and K. Reichardat. *Proc. 16th Congr. ISSCT,* 1977, 1113-1121.—Three experiments in 1973 and 1975 compared the effects on cane yield and soil chemical and physical properties of a number of cultivation methods including ploughing to two depths, subsoiling and heavy harrowings, as well as combinations of these. Ploughing to 45 cm avoided the ill-effects of rainfall deficits, which reduced the yield of crops in soil ploughed to a shallowed depth, owing to the greater water retention resulting. Heavy harrowing was the next most effective treatment while subsoiling was least effective. There was little difference in the physical composition of the soils as a result of the treatments.

Effects of "Tebuthiuron", applied at full and half rates and re-applied at various rates, for weed control in sugar cane (*Saccharum officinarum* **L.).** A. Alves, A. Buss, T. Honda, R. M. Pompeu, S. A. Silva and C. Van der Schans. *Proc. 16th Congr. ISSCT,* 1977, 1123-1140.—Twelve trials, with plant and ratoon cane, were conducted in 1973/76 in clay and sandy soils to test the efficacy and safety of "Tebuthiuron" for control of weeds in cane. It was applied before emergence, at rates from 0·8 to 1·6 kg.ha^{-1}, followed by 0·6 kg.ha^{-1} in the following season. In other trials 0·8 and 1·2 kg.ha^{-1} was applied initially with 10-100% re-applications in the following year. The 0·6 kg.ha^{-1} re-application provided more than 85% control of the weeds evaluated (*Brachiaria plantaginea, Cenchrus echinatus, Digitaria sanguinalis, Eleusine indica, Panicum maximum, Rhynchelitrum roseum, Acanthospermum hispidum, Ageratum conyzoides, Amaranthus* spp., *Bidens pilosa, Emilia sonchifolia, Euphorbia prunifolia, Ipomoea purpurea, Portulaca oleracea, Richardia brasiliensis* and *Sida* spp.) while the full rate re-application gave more than 90% control. Treatments with 0·8 kg.ha^{-1} for sandy soil and 1·2 kg.ha^{-1} for clay gave excellent control (98%) of grass and broad-leaf weeds at re-applications of 40-60% of the initial rates except for *P. oleracea* which required 100% re-application for 90% control. No phytotoxicity to cane was observed and yields were higher in the treated plots than the untreated controls.

Advances in sugar cane fertilization in Mexico. M. Torres B. *Proc. 16th Congr. ISSCT,* 1977, 1141-1153. Results of 40 trials in various parts of Mexico showed that the response to N-P-K fertilization differed with soil characteristics. For the greatest profit the N application rates should be 120-240 kg.ha^{-1} for vertisols, 120-220 kg.ha^{-1} for luvisols and 160-180 kg.ha^{-1} for fluvisols, while only with luvisols should P_2O_5 be applied (at 60-120 kg.ha^{-1}). Sucrose is affected negatively by N in vertisols and fluvisols but positively in luvisols. Phosphate promotes cane maturity but K did not increase the sucrose content in either of the three soil types.

Laboratory analysis of $CaCl_2$-treated sodic saline soils. J. A. C. Gonçalves and A. G. Santos. *Proc. 16th Congr. ISSCT,* 1977, 1155-1164.—In experiments to determine the effectiveness of $CaCl_2$ treatment in reclamation of two sodic saline soils, samples of horizons of two soil profiles were (*a*) leached with an initial $CaCl_2$ solution for 24 hr, followed by washing with tap water, and (*b*) leached with the initial $CaCl_2$ solution for 48 hr, washed with a more dilute solution for 24 hr, and then washed with water. The initial $CaCl_2$ solution was at the lowest concentration which would permit a final conductivity value sufficient to allow the treatment to succeed; a 1 mmho.cm^{-1} solution with treatment (*a*) was sufficient to guarantee reclamation of the soil as indicated by permeability to tap water, and confirmed by stabilization of conductivity and a drastic reduction in % exchangeable Na.

Influence of varieties and soil types on nutritiona status of leaves of sugar cane ratoons. J. Orlando E. Zambello and H. P. Haag. *Proc. 16th Congr. ISSCT,* 1977, 1165-1174.—Randomized block experiments with four replications were made with 16 varieties on four soil types, using similar N-P-K fertilization levels, to determine effects on the leaf macronutrient composition. Both variety and soil type influenced the composition, so that critical levels for one variety and soil type may differ for other varieties or soils.

Determination of available P for sugar cane in tropical soils by extraction with 0·5N sulphuric acid. V. C. de Bittencourt, J. Orlando and E. Zambello. *Proc. 16th Congr. ISSCT,* 1977, 1175-1186.—Tests were made using six extractants on soils treated with N, K and varied levels of P, and the results compared with field and pot trials of cane grown in the soils. It was found that 0·5N sulphuric acid, at a soil:solution ratio of 1:10, with 15 minutes' agitation gave the best results, the critical level of 30 ppm of P for a relative cane production of 90% being established.

Ripening in sugar cane with "Polaris", "Cetrimide" and "Hyamine 1622". A. Kumar and R. Narasimhan. *Indian Sugar,* 1977, **27,** 437-441.—See *I.S.J.,* 1978, **80,** 176.

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SUGAR CANE MECHANIZATION

Tyres and tracks in sugar cane. W. W. Brixius. *Proc. 16th Congr. ISSCT,* 1977, 1949-1961.—A series of field tests conducted in São Paulo in 1976 compared the performance of tyred and tracked tractors, with a study of soil compaction characteristics, and an overall cost/benefit analysis was made which supported the trend to use of four-wheel drive tractors for cane tillage as against crawler machines.

Sugar cane trash measurements in Brazil. A. C. Fernandes, E. R. Oliveira and L. de Queiroz. *Proc. 16th Congr. ISSCT,* 1977, 1963-1973.—Since trash influences cane quality, and cane payment in Brazil is based only on weight, a study was carried out to determine the trash content of 512 loads, hand-cut but mechanically loaded, delivered to three sugar factories in São Paulo and one in Paraná during the 1976 season. Of the total weight of 4755·037 tonnes, the trash content was 310·930 tonnes or 6·5%. At the same time 85 samples (about 2 tonnes each) of cane delivered by four types of chopper harvesters were collected and the trash measured after manual cleaning; the trash content averaged 16·7%.

Trash in mechanical and manual harvesting of sugar cane. N. Tambosco, J. P. B. Teixeira, L. Geraldi, E. J. Ustulin, J. L. de P. Henrique, O. Alonso, W. J. Correa, L. R. Franceschi, R. N. Geraldi, J. C. Salata and G. E. Serra. *Proc. 16th Congr. ISSCT,* 1977, 1975-1979. Four different models of combine cane harvester were found to deliver 8·40-12·74% and 9·42-14·05% of total trash in clay and sandy soils, respectively, when operating in normal field conditions throughout the harvesting season. Immature tops, leaves and soil for both soil types ranged from 6·35 to 10·86%, 1·56 to 4·05% and 0·14 to 0·26%, respectively. The total trash in manually cut and mechanically loaded cane depended greatly on whether the cane from five rows were windrowed before loading or loaded from individual rows, *viz.* 2·69% and 5·88%, respectively, for burnt cane, and 1·54% and 4·79%, respectively, for unburnt cane.

Improving employee attitudes and skills for profit in a cane sugar operation. W. W. Paty. *Proc. 16th Congr. ISSCT,* 1977, 1981-1984.—In 1975 equipment repair and maintenance costs at Waialua Sugar Co. increased by 67% and, if allowed to continue, would more than offset the gains in yields through technical advances such as use of gibberellin and cane ripeners. A programme was instituted for 1976 which included basic training for all supervisors, operator training, repair and maintenance organization, involvement of all personnel concerned and follow-up of servicing operations, whereby the cost of repair and maintenance was reduced to virtually the same level as in 1974.

A system for whole stick cane harvesting. J. C. Hudson. *Proc. 16th Congr. ISSCT,* 1977, 1985-2000. Progress in the development of the method of harvesting developed jointly by the Barbados Sugar Producers Association and F. W. McConnel Ltd. is described. The Stage I machine, described earlier, "cuts" the cane by pushing it over and produces a swathe of cane which is taken up by the Stage II machine. This takes up the cane with tops entering the feed first and separates the stalks which are retained in a bin which is dumped periodically. Extraneous matter is reduced to an acceptable extent, and the system may be applied to burnt cane as well as to green cane. In Barbados the machine has permitted reversion to green cane instead of burning. The bundles of cane dropped from the Stage II machine may be put into trailers by a Louisiana-type push-piler-loader or using another machine developed by the B.S.P.A. and McConnel in the form of a tractor-mounted slew loader.

Efficiency of sugar cane harvesters in the French West Indies. J. Dutartre. *Proc. 16th Congr. ISSCT,* 1977, 2001-2010.—There are 25 chopper-harvesters of eight different types in the French West Indies and a study was made to compare their performance. This depended on the nature of the plot of cane and on whether the cane was burnt or green, but on average the actual working time was only 44·5% of the total, with travel time 21·3%, waiting time 11·1%, routine maintenance 12·5% and emergency repairs 10·6%. It is considered that these figures show the scope for increasing efficiency and reliability.

Establishing optimum standards for the lower cutting device of the sugar cane harvester. G. Rivas N. *Proc. 16th Congr. ISSCT,* 1977, 2011-2022. There is a wide variety of types of base cutter among the cane harvesters on the market and a study was made to identify the best type for Cuban conditions. The study involved analysis of the problem and identification of parameters to be optimized, experiments with different numbers, speeds and types of cutting elements, etc., as well as the use of a stationary rig for testing, followed by field trials using a KTP harvester. Results of the study are discussed, the most significant being that best results were obtained with "slipless cutting", *i.e.* that where the cutting element trajectory follows a direction normal to the contact point.

Investigation of a pneumatic separation system for sugar cane harvesting machines. J. Brito M. and J. Abreu C. *Proc. 16th Congr. ISSCT,* 1977, 2023-2037. Three types of suction scheme, using different kinds of fans, were examined in a study of the pneumatic cleaning of harvested cane. The results were analysed and a suitable variant selected which is able to separate 75-80% of the extraneous matter in cane fed at a rate of 24 kg.sec.$^{-1}$ and having 28% extraneous matter content, the loss of cane being about 1%.

Evaluation of mechanical sugar cane harvesters in Mexico. E. Zamorano C. *Proc. 16th Congr. ISSCT,* 1977, 2039-2045.—A comparison was made in respect of extraneous matter content in harvested cane and cane left in the field by a Claas "Libertadora" harvester, a Massey-Ferguson 201 machine, and by cutting manually followed by loading with a Thomson grab-loader (the

last being the system most commonly used in Mexico). Randomized plots of 3 ha each were harvested, with four replications. The results favour manual cutting with grab-loading over the two harvesters, the MF 201 having a better performance than the Claas machine.

An economical cultivation system for large-scale cane production. S. W. D. Baxter. *Proc. 16th Congr. ISSCT,* 1977, 2047-2057.—It is pointed out that cultivation of the soil, land forming, trash raking, etc., is frequently done using tractors capable of greater work; for instance, an 80-hp tractor used for subsoiling two rows could be used to cultivate and fertilize three rows and rake trash from five rows. Use for fewer rows raises the number of passes and time of operation, resulting in higher costs than necessary. Use of three kinds of multiple implements is described for the reduction of operating costs.

A system for the handling, transloading and transportation of mechanically harvested chopped cane, developed for Trinidad. L. P. Donawa. *Proc. 16th Congr. ISSCT,* 1977, 2059-2067.—Originally, mechanically harvested cane in Trinidad was hauled to the factories in 7-tonne two-axle trailers by four-wheel tractors. This was slow and unsuitable for harvesting under adverse weather or field conditions. In 1969 a system using an elevating cane transloader fed by cane buggies was introduced; the high-flotation buggies were modified wheeled tractors with a 27 m^3 caged body designed for rear discharge. The system gave greater flexibility and had many other advantages, while later improvements included the use of weight-transfer single-axle trailers which gave as good flotation as the buggies and were easier to maintain. Other systems have been studied and their comparative costs calculated, but the transloader system has been found to be the most economical for Trinidad.

A technique for designing transport systems for sugar cane. B. J. Cochran and R. W. Whitney. *Proc. 16th Congr. ISSCT,* 1977, 2069-2079.—A technique for designing a cane transport system is presented. The delivery rate of a transport system is affected by the loading rate, transport unit capacity, round trip time and the number of units. A nomograph relating the system components was developed using results from a GPSS language computer model and mathematical equations based on Queuing Theory. The rate at which cane can be delivered from the field can be predicted from the nomograph or, given values for the components involved in the nomograph, values for any of the other components may be determined. Equations relating the transportation cost in $\$.tonne^{-1}$ are presented for three expense categories, and values for the transport system components obtained from the nomograph are used with the cost equations to determine a predicted transportation cost. By changing the component values the related delivery cost may be determined until an optimum combination of components is found which will yield a minimum delivery cost.

Modelling a sugar cane transportation system for simulation in the Philippines. O. S. Libunao. *Proc. 16th Congr. ISSCT,* 1977, 2081-2092.—Cane transport management requires maximum utilization of equipment and minimization of resources. This complex system is subject to delays caused by stochastic variables like rainfall and equipment breakdown. A computer simulation model was developed capable of testing alternatives, strategies and decisions in cane transport management from harvesting to transloading in the mill. The model considered the weather, travel times, equipment capacity and equipment breakdown. Before any operations, rainfall is generated on a basis of its frequency and the plantations tested to determine whether harvesting operations (which are dependent on previous and current rainfall) will be possible. The model considers only rainfall for the previous 24 hours and keeps account of the number of deliveries made by plantations per week, the number of round trips per day from field to mill, and queuing of trucks in the mill yard, and gives basic information as indicated in the paper.

Analysis and simulation of sugar cane transport, reception and mechanical harvesting systems. L. V. B. Gentil and T. C. Ripoli. *Proc. 16th Congr. ISSCT,* 1977, 2093-2103.—In a study of transport, reception and mechanical harvesting systems for cane, equations are developed and systems defined which permit theorization on the subject and suggestions for the study of particular problems. An example is given for determining the number of trucks, harvesters and infield transporters in a specific case. The changes in numbers required for individual units is calculated for performance variation between 50% below and 50% above that considered as standard; in the specific case above, the number of harvesters needed ranged from 12·5 to 4·2 against 6·3 for standard performance, the number of infield transport units from 22·8 to 7·6 against 11·4, the number of road transport units from 9·7 to 3·0 against 4·6, and the number of reception road transport units from 6·6 to 4·2 against 4·5 units.

Spectrochemical oil analysis for scientific maintenance management of diesel units. E. Clavery and R. L. Kincaid. *Proc. 16th Congr. ISSCT,* 1977, 2105-2114. The use of spectrochemical oil analysis as a routine measure for assessing the mechanical state of its fleet of more than 4000 diesel units by the Sugar Corporation of Puerto Rico is described. Basing maintenance work on the actual condition of the engine rather than in accordance with an arbitrary time schedule is more efficient and also allows prediction of incipient breakdown, extends oil and filter life, etc.

Losses incurred when chopper-harvesting sugar cane. A. G. De Beer and T. C. Boevey. *Proc. 16th Congr. ISSCT,* 1977, 2115-2126.—Test procedures were developed to determine harvesting losses when using chopper-harvesters, and losses then measured in four separate tests on fields which were very well prepared for mechanical harvesting and in which cane conditions were good. It was found that net millable cane delivered to the mill can be reduced by 4–10% by chopper-harvesters although, in the case of a very brittle, upright cane, this trend might be reversed when handling and transport losses are included. Gleaning of the chopper-harvested fields was not practicable while there was a possible reduction of 43% of cane left in the field with manual cutting.

CANE PESTS AND DISEASES

Disease control and the extension worker. B. T. Egan. *Proc. 16th Congr. ISSCT*, 1977, 315-319.—Education on disease control measures needs to commence with other scientific and extension staff before the farmer and field worker. Motivating such staff can be difficult unless actual yield losses can be demonstrated. Enforcing control measures is easier if some legal or semi-official backing exists and if there is an organization devoted to disease control.

The effect of hot water treatment, ratoon stunting disease and moisture stress on the incidence of smut in sugar cane. R. A. Bailey. *Proc. 16th Congr ISSCT*, 1977, 327-335.—Experimental evidence is presented to show that the incidence of smut in sugar cane may be increased by measures intended to control ratoon stunting disease (RSD). The data indicate that there are at least two mechanisms by which hot water treatment (HWT) can increase smut incidence. A direct effect of HWT on the buds of seed cane setts, producing physical damage, is demonstrated and there is support for the suggestion that smut may be suppressed by an interaction between the RSD bacterium and *Ustilago scitaminea* Sydow (the fungus responsible for smut) which interaction is removed by HWT to eliminate the RSD bacterium, indirectly promoting smut incidence. Moisture stress is also shown to be effective in increasing smut incidence. Disease control recommendations in irrigated areas of South Africa and Swaziland, where smut is endemic but where RSD has little effect on yield, have recently been amended after recognition of the effects of HWT on smut.

Identification of sugar cane mosaic virus and characterization of strains of the virus from Pakistan, Iran and Cameroun. A. G. Gillaspie, R. G. Mock and F. F. Smith. *Proc. 16th Congr. ISSCT*, 1977, 347-355. The viruses in two samples of diseased sugar cane from Cameroun, seven samples from Iran and ten samples from Pakistan were identified as sugar cane mosaic virus (SCMV) and the strains were partially characterized. All isolates tested produced a light-scattering zone in the same position as that shown by SCMV after density gradient centrifugation; virus morphology was similar to that of SCMV. Differential host symptoms indicated that one sample from Cameroun contained SCMV strain D and the other sample probably an atypical strain D. The samples from Iran contained SCMV-B, six of the samples from Pakistan contained SCMV-F and the remainder from Pakistan probably contained a mixture of SCMV-A and SCMV-F. The virus isolates from Cameroun and Iran reacted strongly with antisera to strains A, B, D, H and I. Nine of the isolates from Pakistan gave weaker reactions with antisera to the known SCMV strains and to the antiserum to the tenth Pakistan isolate, but reacted strongly with an antiserum to one of the nine isolates. The tenth Pakistan isolate reacted most strongly with strain I and J antisera, and produced milder reaction with other SCMV antisera. Preliminary aphid transmission attempts with two of the Pakistan isolates to sorghum and sugar cane yielded negative results.

Methods for artificial inoculation of the causal organism of red stripe in sugar cane. A. Chinea, F. R. Márquez and A. Cañada. *Proc. 16th Congr. ISSCT*, 1977, 337-345.—The pin, hypodermic syringe and pressure-gun methods of inoculating the causal organism of red stripe in sugar cane were studied using as control a hand sprayer, the action of which is similar to that of natural spread by a combination of rain and wind. Statistical analysis of collections of diseased leaves revealed highly significant differences between the three methods studied and the control. Regarding the length of the stripes produced, significant differences were obtained between the pin method and the control, while those for the hypodermic syringe and pressure-gun methods were highly significant. The combined analysis of variance of length of symptom per leaf did not show any significant difference between the methods of inoculation, each of which may be used in appropriate circumstances for determining the pathogenicity of the organism.

Inoculum additives for sugar cane mosaic virus. J. L. Dean. *Proc. 16th Congr. ISSCT*, 1977, 357-364. Media used for extraction and dilution of crude-sap inocula of sugar cane mosaic virus were tested for their ability to increase infectivity. Phosphate buffer, sulphite, phosphate plus sulphite, and phosphate plus any of several sulphhydryl-containing compounds, e.g. glutathione, cysteine and mercaptoethanol, enhanced infectivity when the sorghum cultivar Mn 1056 served as the virus donor. None was effective when the donor was St. Augustine grass or sugar cane. Phosphate plus sulphhydryl-containing compounds inhibited infectivity when St. Augustine grass or sugar cane was the donor. Extracts of healthy leaves of sorghum or sugar cane inhibited infectivity when included in inocula at a dilution of 1:10; the amount of inhibition was different for different sugar cane cultivars. No inhibition was detectable for extracts of cane leaves at a dilution of 1:45 or above.

Study on rind disease of sugar cane in Pernambuco, Brazil. H. P. Liu, S. L. Wang and C. A. Wismer. *Proc. 16th Congr. ISSCT*, 1977, 365-381.—The physiology of *Pleocyta sacchari*, the causal agent of rind disease, was studied. The best medium for mycelial growth was cane juice agar of pH 5-6 at 30°C. Cornmeal and oatmeal agar were the best media for sporulation of the fungus at 20-25°C. Normal mycelial growth was obtained in cane juice agar and in water agar containing 10-15% sucrose. Good germination of spores was obtained in crude cane juice mixed with water but not in distilled water or in sugar solutions of various concentrations. The optimum temperature for spore germination was between 30° and 35°C. The stimulating effect of light on spore germination was significant. Good germination was obtained with spores six months old which had been kept in sealed tubes. Spores kept in a water solution at 4°C for 20 days or in spore masses on sterilized stem

tissue kept at —15°C for 21 days gave good germination, although the rate of germination was lower for the latter treatment. The thermal death point of spores subjected to hot water treatment was 52°C for 50 minutes or 53°C for 30 minutes. Inoculation of sterilized stem tissue with a spore suspension of the fungus was found to be the most convenient and economical method for producing spores of *P. sacchari* for disease resistance tests. 417 local and foreign varieties have been tested in Pernambuco for resistance to rind disease by artificial inoculation.

Inoculation of sugar cane seedlings for selection of resistance to *Ustilago scitaminea*. M. L. R. Duarte and H. Tokeshi. *Proc. 16th Congr. ISSCT*, 1977, 383-393. After inoculation of caryopses by spraying with spores of the fungus causing smut, *U. scitaminea* Sydow, (6×10^6 spores.cm^{-3}) 24 or 48 hours after sowing, it was demonstrated that sampling to verify mycelium in seedling tissues may be started four days after the spores are applied. Tests to determine the influence of the age of the seedlings showed that seedlings of cane variety PR 980 are most susceptible 6 days after sowing (66·25%) while seedlings of CP 5848 are most susceptible after 10 days (72·63%). Plants with mycelium of *U. scitaminea* in the leaflets produced whip-like appendages under greenhouse conditions.

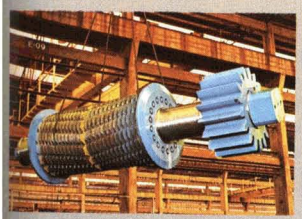
Discriminant function as a reliable guide for assessing varietal reaction to red rot of sugar cane. K. K. Prasadarao, M. N. Sarma, Y. Satyanarayana and M. Atchutaramarao. *Proc. 16th Congr. ISSCT*, 1977, 395-401. Drying of tops, the most outstanding field symptom of red rot disease, is the cumulative effect of lesion width (x_1), the presence of white spots (x_2) and the number of nodes penetrated by the pathogen (x_3). The relative influence of these characters in causing top drying does not appear to have been assessed previously in a precise manner, but an equation $z = 3{\cdot}5x_1 + 36{\cdot}7x_2 + x_3$ is advanced which takes into consideration the relative influence of the three factors and facilitates a reliable assessment of a variety in respect of its reaction to red rot (z).

Eradication of cane diseases. C. G. Hughes. *Proc. 16th Congr. ISSCT*, 1977, 403-406.—The various factors necessary for a successful eradication campaign are discussed; the essentials are a certain level of resistance in popular varieties and the discarding of very susceptible varieties. Given these, other factors which apply include: (1) the methods of transmission must be known and understood, (2) transmission must be relatively inefficient, (3) the disease must have a short incubation period, (4) symptomless carriers must be absent, (5) there must be no reservoir of infection outside the cane crop, and (6) appropriate legislation must be enacted and enforced. There must be no let-up in the campaign when the disease has been reduced to a low incidence; the dangers of reintroduction of a disease after eradication must also be borne in mind.

Preliminary studies on invertases of sugar cane stalks inoculated with *Colletotrichum falcatum* **Went.** G. A. da Silva, M. A. A. da Silva and P. C. T. de Carvalho. *Proc. 16th Congr. ISSCT*, 1977, 407-415.—Varieties CB 47/355, IAC 52/326 and CB 49/260, respectively considered to be resistant (R), moderately susceptible (MS) and susceptible (S) to red rot, were inoculated by introducing a toothpick colonized with *C. falcatum* into the stalk. Invertase activity in the stalks was determined 15 and 38 days after inoculation and was found in all cases to be higher than in corresponding uninoculated stalks, the difference being smallest with R varieties. Invertase activity in inoculated and uninoculated stalks of R varieties was almost the same after 38 days, whereas the differences between inoculated and uninoculated stalks of MS and S varieties increased between 15 and 38 days. It is proposed that the increase in invertase activity in inoculated stalks might be due to an increase in respiration rates or to a metabolic deviation towards the production of defensive phenolic compounds, or even to direct utilization of reducing sugars by *C. falcatum*. In any of the hypotheses presented, the regressive system of invertase would be altered with a consequent activation of acid invertases. Another possibility would be the activation of invertases through the production of auxins by *C. falcatum*.

Sugar cane seed piece germination: field application methods and protective efficacy of thiophanate-methyl. S. M. Yang and H. J. Braud. *Proc. 16th Congr. ISSCT*, 1977, 417-423.—Four methods of applying a systemic fungicide, thiophanate-methyl (TPM), to cane for control of pineapple disease and red rot, were tested. These methods involved (1) spraying onto 3-node setts in the furrow, (2) soaking 3-node setts in a TPM suspension before planting, (3) applying TPM as a dust or suspension to the root zone of plants in the field, and (4) spraying TPM on the leaves of growing plants. Method (1) increased germination, recorded at 7-8 weeks, by 65% compared with the control in 1974 when 11·2 kg.ha^{-1} of TPM was used and by 16 and 11% in 1975 and 1976 when half this amount was applied. With method (2) germination was increased by 11% at 0·04% TPM and 17% at 0·08% TPM but these increases were not significant. 2-6 weeks after TPM application by methods (3) and (4) stalks cut from the treated cane were inoculated with the pathogens and growth found not to be inhibited.

Biological characteristics of two populations of *Lixophaga diatraea* **(Tachinid:Diptera) and their reciprocal crosses at three different temperatures in the laboratory.** E. G. King, J. H. Hatchett and D. F. Martin. *Proc. 16th Congr. ISSCT*, 1977, 509-516.—Populations of *L. diatraea* from Barbados (BA) and Louisiana (LA) were found to intermate freely and the ability of the maggots to seek out host larvae (*Diatraea saccharalis* F.) was similar. The populations and reciprocal crosses were reared in the laboratory at 16, 26 and 32°C; the developmental time of LA pupae was shorter and percentage adult emergence greater and there were indications that these differences were inherited by F_1 progenies of LA females, as was the greater emergence of LA than BA from puparia at 16°C. Female *L. diatraea* flies lived longer than males (mean 36·7 hr *vs.* 27·4 hr) when water was removed 6 days after emergence, but there was no significant difference between the BA and LA populations. Characteristics of the LA population did not change after rearing for five generations and BA/LA differences remained. The LA population may be a source of flies for colonization in areas not inhabited by *L. diatraea*, particularly where tolerance to low temperature is desirable.



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Fator

CANE BREEDING AND VARIETIES

Induction of flowering in sugar cane at Pantnagar (29°N), India. Q. Q. Khan and P. K. Bhatnagar. *Proc. 6th Joint Conv. Indian Sugar Tech. Assocs.*, 1977, Ag.119-Ag. 124.—Ten varieties of cane were subjected to six photoperiods as well as exposed to natural daylight in order to achieve flowering induction in one state of India (Uttar Pradesh) where no systematic cane breeding has been carried out because of the failure of cane to flower under normal conditions. Greatest success was achieved with three varieties, while minor success was achieved with a further three. The percentage of canes in each variety which flowered differed according to the photoperiod length, which was maximum at 12·5 hours. No flowering occurred under natural daylight conditions.

A new approach to cane seed nurseries. M. N. Gokhale. *Proc. 6th Joint Conv. Indian Sugar Tech. Assocs.*, 1977, Ag. 163-Ag. 166.—Since Maharashtra suffers from drought twice in every five years, it is considered important to find a means of propagating cane in a minimum of area using a minimum of water. Trials were therefore carried out in which the cortical portions containing single eye buds but excluding pith were chipped from the cane and planted horizontally. Germination was good, although gaps did occur (these being filled with more eye bud chips). The advantage of the scheme is that the cane plants used as sources for the seed material can be crushed as normal cane, while germination of the eye bud requires a minimum of water.

Mutation breeding and its implications in the sugar industry. H. K. S. Rao, R. S. Sachan and M. Singh. *Proc. 6th Joint Conv. Indian Sugar Tech. Assocs.*, 1977, Ag. 175-Ag. 179.—Budded setts of variety Co 419 were irradiated with gamma rays from a ^{60}Co source at a rate of 6 krad.min^{-1}. Nine months after planting of the material, tillers exhibiting mutation were replanted and their breeding behaviour in the subsequent vegetative generation studied. A large number of first-generation mutants occurred, and details are given of the growth characteristics of three specific types, between which wide differences were found. The characteristics of the parent cane are also given.

Cane breeding and varieties in Mauritius. Anon. *Ann. Rpt. Mauritius Sugar Ind. Research Inst.*, 1976, 22-26.—Crossing and selection work at the MSIRI is reported and results of varietal trials tabulated. The performances of 11 varieties planted in M5 nurseries were considered by the Cane Release Committee and 3 of them recommended for release. They were: (*i*) M 555/60, the progeny of M 241/40 × M 213/40; it is a high-yielding cane which appears to be resistant to cyclonic winds and is well adapted to most regions of Mauritius. Its sucrose content is, however, on the low side but improves in the second half of the crop period. (*ii*) M 574, bred from Co 779 × M 147/44 and adapted to most regions; its yield and sucrose content are slightly above average. (*iii*) "Triton", which has as parents Co 270 × "Eros"; produced by CSR Ltd. and imported from Australia in 1964, it is a rich variety adapted to low altitudes. Recommendations are given on varieties best suited to particular soils and altitudes as well as where cane on a given soil is or is not irrigated. Four trials planted in 1972 to compare varieties currently planted with those of past repute were harvested for the last time as a 3rd ratoon crop. Tabulated results show that, in terms of yield per ha, most of the currently popular varieties performed better than those of former major commercial importance. Twelve varieties were received from Brazil and placed in quarantine, while 48 varieties were exported—10 to Australia, 29 to Benin and 9 to South Africa.

Review of sugar cane varieties and breeding in Brazil. J. Y. J. Miocque and G. R. Machado. *Sugar J.*, 1977, **40,** (7), 9-13.—A brief history is given of cane variety introductions into the different states of Brazil and of cane breeding in Brazil. Brief mention is made of the measures introduced to prevent the spread of smut. Thirty-eight references are given to the literature.

Changing farm practices for different varieties. C. L. Toohey. *Cane Growers' Quarterly Bull.*, 1978, **41,** 62-64.—It is stressed that an agronomic programme that works well for one cane variety may fail to produce satisfactory results with another. Seven factors, each of which directly influences the suitability of a variety and governs its management, are briefly examined, *viz.* germination, tillering, root formation, growth habit, productivity, maturity and ratooning performance.

The role of *Saccharum officinarum* in nobilization. W. M. Symington. *Proc. 16th Congr. ISSCT*, 1977, 11-22. Accumulated information from trials involving various levels of *S. spontaneum* nobilization has allowed an assessment of the role of the nobilizing parent. The effects of *S. officinarum* clones were examined up to and including the third nobilization stage. Acceptable fibre levels were reached at the BC_1 stage, but low sucrose was still a problem at the BC_2 stage. There was no advantage in proceeding to the BC_2 stage using *S. officinarum* clones as females except when n + n chromosome transmission occurred at the F_1 stage. However, the use of nobles selected on the basis of progeny performance for sucrose was desirable for first nobilization and appeared to be worth consideration for the BC_1 stage where a third stage of nobilization was anticipated. Outbreeding to a different noble at the BC_1 stage was also worthwhile.

Sugar cane improvement through tissue culture. M. Krishnamurthi. *Proc. 16th Congr. ISSCT*, 1977, 23-28. Sub-clones obtained by culture of callus tissue from 11 donor clones were examined for characteristics including resistance to diseases, sucrose and fibre contents, germination, sex, growth habit, leaf morphology and

flowering. The data obtained were examined statistically and show significant variation in a number of cases from the corresponding data of the donor clones, including sucrose, Fiji disease resistance and speed of germination. It is concluded that the system could be used for improvement of cane varieties and to support conventional breeding systems.

Tissue and cell culture as aids to sugar cane breeding. III. Aneuploid cells and plants induced by treatment of cell suspension cultures with colchicine. M. C. Liu, K. C. Shang, W. H. Chen and S. C. Shih. *Proc. 16th Congr. ISSCT,* 1977, 29-42.—Cell suspension cultures derived from 8 sugar cane (*Saccharum* spp. hybrid) varieties were studied. Chromosome numbers (2n) varied from 92 to 191, with a mean of 111, in cells of a colchicine-free suspension culture of F 164, of which the donor's number was 108. The numbers rose to as many as 309 when the cells were treated with 100 ppm colchicine. Similar results were observed for other varieties. One-tenth of pieces of colchicine-treated calluses could be differentiated into plants. A total of 182 regenerated plants were obtained. Only 10 of them, derived from 61-1248, showed drastic morphological alterations equivalent to a 5·5% mutation rate. All of the variants were stunted in appearance and had stiffer leaves. Their chromosomal constitution was of aneuploid type with metaphase numbers around 2n = 156, which were much higher than their donor's number, 104. In the esterase zymograms they had fewer bands than their donor. This confirms the observation that drastic morphological changes are associated with aberrations in chromosomal constitution and/or isoenzymatic patterns. It is suggested that the aneuploid plants can be utilized as parents in a sexual breeding programme or in making crosses amongst themselves so that hybrid vigour might be created.

Utilization of *Saccharum spontaneum* **in sugar cane breeding.** B. T. Roach. *Proc. 16th Congr. ISSCT,* 1977, 43-58.—It has been found that selection within *S. spontaneum* for sucrose content prior to nobilization would be effective in increasing the sugar content of the subsequent F_1 hybrids. Selection for cane yield would be only moderately effective. It is concluded that use of a select and, if possible, progeny-tested clone of *S. officinarum* is preferable to use of a commercial hybrid as the initial nobilizing parent for crossing to *S. spontaneum*. As the resultant F_1 hybrids will rarely meet commercial requirements, back-crossing to *S. officinarum* or a commercial hybrid is necessary. Use of an elite commercial hybrid as the nobilizing parent to produce the BC_1 generation is shown to be preferable. Possible reasons for the yield superiority of such BC_1 hybrids are discussed. Where clones of *S. officinarum* are used as the nobilizing parents for two generations, inbreeding drastically reduces cane yield. It is considered that this effect may also apply to programmes using commercial hybrids as the nobilizing parents. BC_2 populations produced by use of *S. officinarum* as the maternal nobilizing parent at each generation exhibit reduced cane yield by comparison with F_1, BC_1 or commercial hybrid populations. This is considered to be due to a high chromosome number and the low ratio of *S. spontaneum* to *S. officinarum* chromosomes. This yield reduction may possibly be averted by use of the BC_1 clone as the maternal nobilizing parent to produce the BC_2 generation. Selection of parents for sugar content during nobilization should be effective, with selection for cane yield being less effective.

Collecting *Miscanthus* **germ plasm in Taiwan.** C. C Lo, Y. H. Chia, W. H. Chen, K. C. Shang, I. S. Shen and S. C. Shih. *Proc. 16th Congr. ISSCT,* 1977, 59-69.—*Miscanthus* spp. have been found widespread on the island of Taiwan. A total of 181 clones were collected during 14 months in 1976/77, and 135 clones have been maintained at the Taiwan Sugar Research Institute in Tainan. The 98 clones identified have been classified into four species, viz. *M. floridulus* (Labill.) Warb., *M. sinensis* Anderss., *M. flavidus* Honda and M. *transmorrisonensis* Hayata. About three quarters of the germ plasm has been studied in more detail to obtain information on distribution, morphology and pollen fertility. At the same time, the chromosome numbers were determined in 33 clones and found to be almost identical. In addition, resistance to downy mildew and smut diseases of a fraction of the collection was investigated.

The taxonomic status of *Saccharum robustum* **Brandes & Jeswiet** *ex* **Grassl.** J. Daniels, P. Smith, N. H. Paton and B. T. Roach. *Proc. 16th Congr. ISSCT,* 1977, 71-83.—The leaf flavonoid patterns of 48 *S. robustum* clones were examined in a chemotaxonomic survey of this species. The data were used to examine the *S. robustum* types recognised by Price[1] which were based on chromosomal, morphological, ecological and geographical criteria. This study suggests that the term *S. robustum* should be restricted to Price's Port Moresby type. It would appear that *S. sanguineum* (red-fleshed type) and Teboe Salah and Wau-Bulolo types, as revised in the paper, deserve species status. Price's other euploid type, Goroka, could be a geographical isolate of the Port Moresby type or a hybrid between *S. officinarum* and *S. spontaneum*. Hypotheses are advanced for the origin of types.

The mean yield of seedlings as a guide to the selection potential of sugar cane crosses. R. S. Bond. *Proc. 16th Congr. ISSCT,* 1977, 101-110.—The value of different sugar cane crosses in a selection programme, as determined from previous progeny records, compared favourably with the mean yield of sugar obtained from replicated plots of closely spaced sister seedlings. Single stools derived from these crosses were selected according to current criteria and the selection rates achieved showed a positive correlation with this yield ($r = 0{\cdot}69$). The use of this type of cross evaluation in a selection programme is discussed in general terms.

[1] *U.S.D.A. Tech. Bull.,* 1965, 1337.

CANE SUGAR MANUFACTURE

Basic considerations for fuel and steam economy measures in sugar factories. S. K. Ghosh. *Indian Sugar,* 1977, **27,** 315-323.—Sources of heat loss in a sugar factory are discussed and means of reducing such loss examined. While modern sugar factories have ample scope for steam economy measures, old factories pose a problem, particularly when expansion is considered. Measures to improve the process steam economy are listed, and a table given which shows the typical steam consumption at each process station and the maximum economy that is attainable by remedial measures. A list is given of simple corrective measures applicable in old factories.

The auto cane system at Gangavati Sugars. N. Chandappa, G. Balachandran and K. Damodaran. *Indian Sugar,* 1977, **27,** 379-380.—To maintain a uniform rate of bagasse feed from the primary mill to the "Saturne" diffuser at the factory, the level of prepared cane in the Donnelly chute feeding the primary mill is sensed by eight probes located at different levels in the chute. The signal from the sensors is used to regulate the speed of the carrier preceding the chute as well as the level of cane on it. A time-delay circuit overcomes the problem of stray pieces of bagasse sticking momentarily to the probes.

Mill sanitation a necessity for reduction of the losses in sugar mills. R. P. Mittal. *Indian Sugar,* 1977, **27,** 433-435.—Forms of juice contamination occurring in cane mills are listed, the types of micro-organisms found are classified, the results of their activity listed and remedial measures indicated.

Cost of producing sugar cane and processing raw sugar in south Florida. D. L. Brooke. *Sugar y Azúcar,* 1977, **72,** (12), 33-37.—The economics of cane production by 19 growers and of cane processing by 7 factories in south Florida in 1975/76 are discussed.

Utilization of waste heat in a sugar factory. P. P. Chaturvedi. *Maharashtra Sugar,* 1978, **3,** (3), 9-24.—The loss of heat in the form of boiler flue gases is discussed and means of reducing the losses (and the stack gas temperature so as to reduce the amount of bagasse consumed) are examined. The flue gas heat can be utilized in a superheater, followed by an economizer and then an air pre-heater, the hot air from which can be used to dry bagasse; hot air is preferable to flue gas used directly to dry the bagasse since burning particles in the flue gas may cause a fire. The bagasse moisture content should not be taken below 42% for fear of damage to the furnace as a result of the elevated temperature, which would also lead to increased stack gas losses. The benefits resulting from bagasse drying to 48, 46, 44, 42, 40 and 35% moisture are tabulated—a constant steam requirement of 60% on cane and a 10°F rise in flue gas temperature per 2% absolute reduction in excess air are assumed. A description is given of a bagasse dryer design suitable for the bagasse corresponding to a crushing rate of 100 t.c.h. Use of the hot air from the air heater to dry sugar is also a possibility, as is recovery of the heat from blow-down water. Utilization of the evaporator final effect and pan vapours for raw juice heating and accumulation and utilization of waste hot water are also mentioned. Calculations are made of the parameters involved in the various measures discussed.

Introduction and import substitution of continuous centrifugals in the sugar industry. A. Chatterjee and B. R. Math. *Maharashtra Sugar,* 1978, **3,** (3), 33-35.—The manufacture in India of stainless steel baskets and of nickel screens for use in continuous centrifugals made by Walchandnagar Industries Ltd. under licence from Hein, Lehmann AG is reported. Indigenous manufacture of the components has reduced the import requirements to a negligible proportion, only the bearings now needing to be brought into India.

Minimization of losses in the process of sugar manufacture. N. R. Tagore. *Maharashtra Sugar,* 1978, **3,** (3), 37.—Sources of known and unknown losses are briefly examined and a list given of 19 measures for reduction of unknown losses.

Flangeless top rollers at Tongaat. J. A. P. Jacquelin. *S. African Sugar J.,* 1977, **61,** 592-593.—See *I.S.J.,* 1978, **80,** 209.

An equitable sugar pricing system. W. F. Allison. *Proc. 16th Congr. ISSCT,* 1977, 2167-2172.—The objectives of a cane payment system are set out and proposals made for calculating the value of the recoverable sugar in cane and for sharing this between the grower and miller. The formulae provide an incentive to the grower to deliver above-standard quality cane and penalize the grower delivering sub-standard cane while paying the mill for the extra cost of milling the latter.

Effect of extraneous material and fibre in sugar cane on the sugar extraction and recovery. W. F. Allison. *Proc. 16th Congr. ISSCT,* 1977, 2173-2178.—The various harmful effects of extraneous matter on mill extraction, on sugar recovery from juice, on the processing of refined sugar, on the recovery of raw sugar and on milling costs are surveyed.

Roller bearing mills in the Australian sugar industry. G. D. Jacklin, B. J. Doolan and T. G. Gatley. *Proc. 16th Congr. ISSCT,* 1977, 2179-2186.—The use of roller bearings in the milling tandem at Pleystowe sugar factory has been extended from one mill[1] to the first three mills of the tandem and their pressure feeders, and to the pressure feeder of the fourth mill, while the fourth mill itself and the fifth mill and pressure feeder retain the conventional mill brasses. The No. 1 mill has completed three seasons of over 2·5 million tonnes of cane at rates of 294, 318 and 357 t.c.h. while the remaining units have

[1] *I.S.J.,* 1976, **78,** 54.

completed one season's operation of 900,000 tonnes. There has been a direct saving in lubrication costs of each mill and pressure feeder of $2000 for the season, the bearings are cool, power transmission is smooth and dismantling and reassembly are simple and quick. Brasses replacement is saved during the 20-year bearing life and there is no wear on the shafts or their journals. Hygiene is improved and the need for cooling water removed, while a saving of the order of 25% is made in power requirements.

An investigation of juice flow behaviour in cane and bagasse diffusers. G. A. Matthesius. *Proc. 16th Congr. ISSCT*, 1977, 2187-2197.—To obtain information about retention times of juice, percolation angles and stage design, percolation tests have been carried out in a BMA cane diffuser at Dalton and a BMA bagasse diffuser at Empangeni. The experimental technique, using NaCl as a tracer, is described. Typical percolation characteristics are given for each diffuser. Retention times are obtained from these characteristics and the percolation angles are calculated. The results are illustrated by graphs, showing the conditions of the particular diffuser. The influence of bed compaction on the retention time was also investigated.

The theory, design and operation of multiple barrelled screw presses for bagasse. J. Farmer. *Proc. 16th Congr. ISSCT*, 1977, 2199-2229.—The long fibre in bagasse provides space for free passage of juice and makes it possible to expel most of the juice from bagasse quickly and with relatively low pressure. The barrels and screws of a multiple screw press installation may therefore be short, the barrels of light fabricated construction and the high pressure, required to expel the last of the juice from the fibre, can be confined to the last 10-20 cm of the press discharge area. The use of multiple barrels makes it possible to have high capacity with small diameter screws. Advantages of such construction include outstanding feed and drainage properties without the need for auxiliary force feeding devices, wide feed hoppers for drainage of free juice, thin bagasse mats with a short juice path out of the press, sufficient time under high pressure to yield low-moisture bagasse, low screw shaft torque, low pressure and power requirements, and inexpensive construction. It is stated that a large installation capable of handling 40 tonnes of dry fibre per hour has an installed cost less than 25% of that of a comparable 5-roller mill, and that 50% or less moisture can be achieved with 30 hp per tonne of fibre per hour.

The steam balance of a large sugar factory with abnormal steam and electrical demands. M. K. Hicks. *Proc. 16th Congr. ISSCT*, 1977, 2231-2240.—An efficient thermal or steam balance is essential when designing a new sugar factory or extension and the method of calculating such a steam balance is demonstrated using an extension to an existing factory with abnormal steam and electrical demands as an illustration. Two important aspects affecting steam balance efficiency are described in detail: the evaporator and the boiler feed make-up system. The evaporator illustrated is unusual in that it involves two units, one for each diffuser line, with the first two vessels of each quadruple acting as a pressure evaporator and the 3rd and 4th vessels under vacuum, with an intermediate control valve to maintain the required pressure (42 kPa) in the second vessel. The boiler feed make-up is also unusual in that it employs a feedwater evaporator as used in power stations.

The toothed roller continuous pressure feeder. N. C. Farmer. *Proc. 16th Congr. ISSCT*, 1977, 2241-2249. A new type of continuous pressure feeder superior in performance to the conventional grooved-roller continuous pressure feeder is described. This feeder utilizes toothed rollers and has particular application at high fibre rates and for mills that have less than ideal feeding arrangements. The device has been proven in operation on several full-scale installations. Comparative performance figures are given together with details of construction and maintenance.

Structural design of vacuum pans and evaporators. D. Macey. *Proc. 16th Congr. ISSCT*, 1977, 2251-2261. Strain gauge measurements were made on two vacuum pans and compared with stresses calculated from simple membrane theory. It was found that bottom covers were the only area where stresses above the usual code design stresses existed. Methods are outlined for analysis of radial stiffening ribs and flat plates between ribs. Agreement has not been found between calculated and measured stresses at points of discontinuity.

A review of ash handling systems in Queensland sugar mills. G. M. Sawyer and R. N. Cullen. *Proc. 16th Congr. ISSCT*, 1977, 2263-2275.—The various ash handling plants employed with modern large suspension-fired boilers in Queensland are surveyed and reference made to the investigational work carried out by the Sugar Research Institute in Mackay in the field of ash handling and disposal. The individual nature of each installation is emphasized and the factors affecting the type chosen are listed.

Foamy two-phase flow evaporation applied to sugar cane processing. O. O. Omatete and H. H. Sephton. *Proc. 16th Congr. ISSCT*, 1979, 2277-2288.—Addition of 50-113 ppm of a surfactant, sodium dodecyl sulphate, to cane sugar solutions between 10 and 50°Bx then subjected to evaporation in a downflow vertical tube evaporator increased the overall heat transfer coefficient by about 70% as a consequence not only of the surfactant but also because of the special arrangement of the entrance orifice in order to initiate a continuous two-phase liquid-vapour flow throughout the tubes.

A new design of rectangular resistance heater for reheating low-grade massecuites. N. A. Ramaiah and H. N. Gupta. *Proc. 16th Congr. ISSCT*, 1977, 2375-2388.—A new design of rectangular electrical resistance heater for reheating low-grade massecuites has been developed at the National Sugar Institute and is described and illustrated. In factory tests a rise in temperature from 41° to 51°C required 5·4 kW per tonne of massecuite. Molasses purity was reduced by 1·5 to 2·0 units and recovery increased by 0·06%. The head loss in the rectangular heater was lower than that in earlier designs so that less space is required between the crystallizer and the centrifugals.

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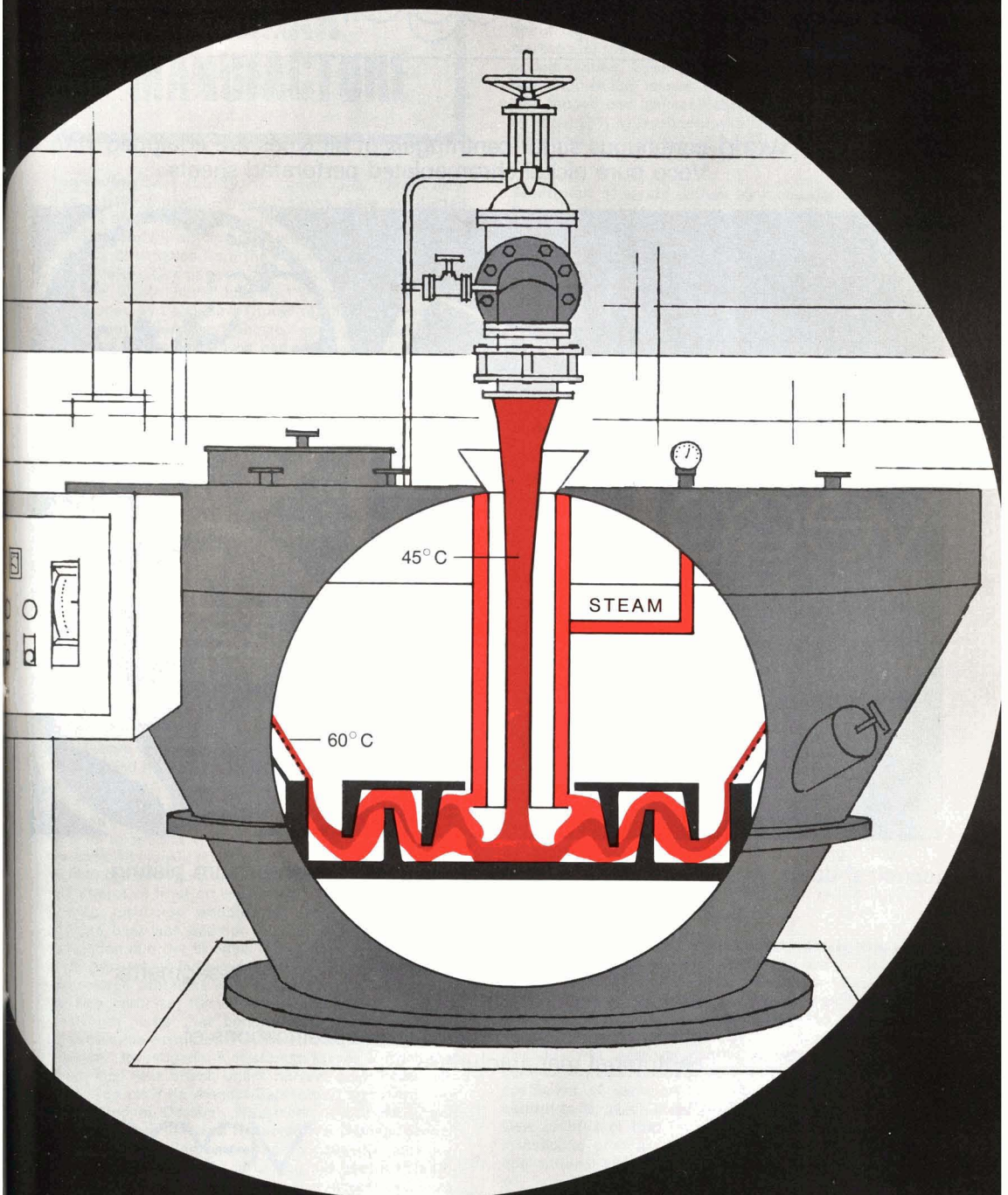

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BEET SUGAR MANUFACTURE

Improving beet quality. M. Loilier. *Sucr. Franc.*, 1978, **119**, 91-106 (*French*).—Investigations were conducted on brei prepared from (i) topped beets, (ii) crowns and petioles, and (iii) whole beets where the samples (representing 22 varieties from the same field) carried about 5% petioles. Comparison between the average analysis for the whole beets and for "reconstituted" beets [calculated by combining (i) and (ii), making allowance for weight differences] showed wide divergency. By contrast, where the leaves had been entirely removed before brei preparation, there was little difference between the analyses of reconstituted and whole beets. Hence, removal of petioles is necessary before analysis. Analysis of topped beets and beet crowns for α-amino-N, ammonium salts, amides and betaine as forms of soluble N showed little correlation between the values for the different components; there was considerable deviation in the ratio of α-amino-N to melassigenic N, although that between volatile N and α-amino-N was less variable; however, determination of α-amino-N is not adequate for prediction of volatile N or melassigenic N. For prediction of melassigenic N, it is necessary to determine total N and volatile N and deduct the latter from the former, or add together values of α-amino-N, volatile N and betaine. Since means of automatic determination of α-amino-N and volatile N are well known, there is need only to establish an automatic method for betaine and total N determination in order to complete the series of analyses for prediction of molasses sugar from beet brei. A graph clearly shows how the net return from extractable sugar (kg per tonne of beet) would have been maximum at a pre-drilling N dosage rate of 36 kg.ha^{-1}, whereas the average amount applied by farmers was 158 kg.ha^{-1}, at which the sugar yield and net return were minimum; the average recommended rate was 81 kg.ha^{-1}. Details are given of the system used by IRIS to predict crop yield before the campaign on the basis of weekly returns from factories for a certain number of fields selected as representative of the region. The effects of frost on beet in 1977/78 are summarized. Among measures adopted at factories processing affected beet was addition of $CaCO_3$ before 2nd carbonatation in order to offset the adverse effect of gums in the juice which inhibited growth of carbonate crystals and caused problems in filtration through blockage by the fine particles; the added carbonate crystals were sufficiently large that continued growth during 2nd carbonatation permitted a final size adequate for normal filtration. Investigations of storage losses showed that variety had little effect, unlike harvest date; beets harvested too early (in August-September) lost more than those lifted in October, November or December and stored at strictly identical temperatures. Damage caused to the beet by falling onto concrete caused a considerable increase in losses. Washing the beet with water recycled from the storage ponds also increased losses, while use of limed or deionized water had little positive effect on storage. The pattern of storage losses has been traced for three varieties for a period extending to more than 140 days, showing that the initial 8-day period of marked respiration is followed by a fall in losses, after which there is a gradual increase to a maximum at about 130 days; at this point, development of yeasts is marked and the beet starts to show considerable signs of degradation. Leaving about 5% of the petioles on the beets increased losses considerably by comparison with topped and leafless beets. Losses were reduced by about 20% by treatment with "Benomyl" or "Epidor" fungicides.

Treatment of waste waters by mesophilic methane fermentation. J. P. Lescure and P. Bourlet. *Sucr. Franç.*, 1978, **119**, 107-114 (*French*).—Tests with a pilot plant at Escaudoeuvres showed that the anaerobic fermentation method of effluent treatment[1] reduced the COD by 87·7% from an initial 2620 mg.litre^{-1} and the BOD_5 by 91·6% from 1363 mg.litre^{-1} after a residence time of at least 18 hours in a tank having an effective volume of 30 m^3. The volume of methane gas produced was not measured. At Vauciennes, an average of about 50% reduction in the parameters was obtained by treating refinery waste water during the post-campaign period at an average feed rate of 25 m^3.hr^{-1} in a small industrial-scale installation of 800 m^3 effective tank capacity, while 70-80% purification efficiency was achieved with 35 m^3.hr^{-1} of sugar factory effluent during the 1977 campaign.

Sealing ponds. J. P. Lescure and P. Bourlet. *Sucr. Franç.*, 1978, **119**, 115-116 (*French*).—Investigations on permeability of effluent ponds showed that it is possible to reduce water loss by filling the pond a number of times with muddy water, while satisfactory results are also obtainable by means of a 25-cm bed of compacted mud introduced before the campaign. Mention is made of other possible methods, some of which, however, require the services of specialists.

Demineralization of sugar factory syrups. J. C. Giorgi and R. Gontier. *Sucr. Franç.*, 1978, **119**, 117-124 (*French*).—Details are given of a patented Japanese system of treating all delimed 2nd carbonatation juice with ion exchange resins in the order: strong cationic—weak anionic—strong anionic—weak cationic, followed by evaporation, decolorization and boiling. Tests conducted by IRIS are described in which the scheme gave *A*- and *B*-sugars of high quality.

Adaptation of the micro-computer control system to 1st massecuite strikes. G. Windal and A. Deleurence. *Sucr. Franç.*, 1978, **119**, 149-152 (*French*).—The system of automatic boiling control used at Toury for *B*- and *C*-massecuite[2] was adapted for use at Guignicourt on *A*-massecuite, the major difference being that viscosity was used as control parameter instead of conductivity as previously. Results showed a fall in the coefficient of variation from 35-40 before automatic control to 30, which is considered highly satisfactory in view of the fact that no water was injected into the massecuite after graining, in contrast to the parallel conventional boiling which achieved the same C.V.

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[1] Devillers *et al.*: *I.S.J.*, 1978, **80**, 53.
[2] Windal: *ibid.*, 1977, **79**, 322; 1978, **80**, 375.

SUGAR REFINING

Modernized dryer in a unit for refined sugar pressing and drying. V. A. Zubatov, A. M. Bekker and Zh. G. Kan. *Sakhar. Prom.*, 1978, (1), 63-65 (*Russian*).—Details are given of modifications to the drying section of a Soviet tabletting machine. The alterations have been made in the interests of operator safety.

On the use of granular carbon in series for the decolorization of sugar liquor. S. Sakamaki and T. Onishi. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1977, **27**, 49-52 (*Japanese*).—At the authors' refinery, carbonatation liquor is treated with active carbon followed by anion exchange resin. Earlier, the carbon system had comprised two pulse-bed columns in parallel, the first holding 57% more carbon than the second and treating 70% of the total liquor. In 1974, a series system was adopted in which 40% of the liquor from the first (larger) column was passed to the second column, while the remainder of the liquor was transferred directly to the treated liquor tank, to which all the liquor from the second column was eventually sent. Advantages of the series system include a higher decolorization efficiency than with the parallel system, resulting in a greater quantity of liquor processed per resin cycle, thus reducing regeneration costs. Apparently, the high molecular weight colouring matter is removed in the first carbon column and the lower molecular weight colorants in the second stage.

Optimization of the heat conditions in a vacuum pan. V. G. Tregub, V. D. Popov and V. A. Miroshnik. *Sakhar. Prom.*, 1978, (2), 49-51 (*Russian*).—Mathematical calculations have been made of the specific heat flow in *A*-, *B*- and refined sugar massecuite boiling as a function of absolute pressure at any given moment in the heating steam temperature range 110-150°C. Graphs are given of the results for each massecuite as a contribution to establishment of optimum conditions whereby the effective temperature difference is reduced and the heat transfer coefficient raised.

Studies on melt carbo-sulphitation and melt carbo-phosphatation processes for production of good quality refined sugar. K. K. Gupta, K. H. Rao, K. P. Sinha and R. K. Dikshit. *Proc. 6th Joint Conv. Indian Sugar Tech. Assocs.*, 1977, M.57-M.68.—Raw sugar melt of 98 purity and 50 or 60°Bx was heated to 70-75°C, limed with 0·6% CaO on weight of melt, subjected to simultaneous liming and gassing to pH 8·2-8·4, heated to 80-85°C and filtered. It was then treated with active carbon and phosphoric acid added to bring the pH to 7·0-7·1, after which the Brix was adjusted to 70-75°. Results showed that the purity rise was about the same as with carbon treatment plus sulphitation, but without the need for sulphur which must be imported into India. The resultant refined sugar was found to be suitable for use in canning and drinks manufacture.

Refining of raw sugar. A. C. Chatterjee and A. R. Bhide. *Proc. 6th Joint Conv. Indian Sugar Tech. Assocs.*, 1977, M.69-M.83.—The Indian standard specifications for raw and refined sugar are given, as well as the international standards recommended by the Codex Alimentarius Commission for refined and plantation white sugar. Typical analyses are given of raw sugar from Australia, India and Japan, and descriptions are given, with diagrams and flow sheets, of refining practices in Australia, Japan and Malaysia.

Development document for effluent limitations guidelines and new source performance standards for the cane sugar refining segment of the sugar processing point source category. R. Dellinger. *Rpt. EPA-440/1-74-002-C, PB* 238 147 (US Dept. of Commerce, National Technical Information Service), 1974, 174 pp; through *S.I.A.*, 1978, **40**, Abs. 78-225.—The findings are presented of an extensive study of the US cane sugar refining industry, for the purpose of recommending effluent limitations guidelines, Federal standards of performance and pretreatment standards for the industry. The industry is divided into two sub-categories: liquid cane sugar refining and crystalline cane sugar refining. Effluent limitations guidelines are set forth for the degree of pollution reduction attainable through the application of the "best practical control technology currently available" and the "best available technology economically achievable", which must be achieved by existing point sources by July 1, 1977 and July 1, 1983, respectively. The "standards of performance for new sources" set forth a degree of pollution reduction which is achievable through the application of the best available demonstrated control technology processes, operating methods or other alternatives.

Application of ion exchange resins to the decolorization of melt from very high pol raw sugars. P. Hoareau, D. James and J. P. Lamusse. *Proc. 16th Congr. ISSCT*, 1977, 2623-2634.—Decolorization of raw sugar melt by means of Rohm & Haas SDC301 ion exchange resins on a pilot-plant scale is described. Two columns in series have been used to lower the colour of melt to below 450 ICUMSA units. Regeneration of the resins is by means of a NaCl solution. Results indicate that a resin life of at least 15,000 bed volumes may be expected and that the process could be applied industrially in the refining of very high pol sugars. Bagacillo, which fouled the resin bed, must be removed by pre-filtration of the melt; this filtration was also necessary to avoid a faint haze in clear liquor after decolorization. The pH of the melt must be adjusted with NaOH from its natural 6·5 to the optimum 8·0, and the Brix employed in the trials was in the range 60-69° with an optimum of 67° to avoid crystallization.

Activated carbon for refining sugar. A. R. Dominguez and A. Y. Hyndshaw. *Proc. 16th Congr. ISSCT*, 1977, 2645-2656.—The nature and use of activated carbon is described and the effect of regeneration, up to nine cycles, on iodine number, molasses decolorization index and pore size illustrated by graphs (the last only for the 1st, 3rd and 5th regenerations).

LABORATORY STUDIES

Improved gas-chromatography method for the quantitation of saccharides in enzyme-converted corn syrups. I. R. West and G. J. Moskowitz. *J. Agric. Food Chem.*, 1977, **25**, (4), 830-832; through *Anal. Abs.*, 1978, **34**, Abs. 3F19.—Glucose, maltose, maltotriose and maltotetraose were separated by gas-liquid chromatography of trimethylsilyl derivatives prepared with *N*-(trimethylsilyl)imidazole. The procedure was rapid, derivatives were prepared under mild conditions without evolution of heat, and the reaction mixture was completely soluble and homogeneous. The derivatives were separated on a stainless steel column (5 ft × 0·125 in) packed with 3% of OV-1 on "Chromosorb W HP" (100-120 mesh) temperature-programmed from 135° to 340°C at 8°.min^{-1}, then held for 10 min at 340°, with He as carrier gas (18 cm^3.min^{-1}) and a flame ionization detector. The α- and β-anomers of glucose were well separated; those of maltose were nearly separated; maltotriose and maltotetroase were well separated. The method was applied to freeze-dried syrups and to syrups containing 80% of solids; recoveries of added glucose, maltose and maltotriose were 99%.

Tests on molasses exhaustion. R. Detavernier and J. Roger. *Sucr. Franç.*, 1978, **119**, 125-127 (*French*).—The Wagnerowski formula for molasses exhaustion has been modified to include viscosity in place of the non-sugars:water ratio. The modification is considered justified in view of the fact that the non-sugars:water ratio is not a true physical parameter and it is viscosity which generally limits the centrifuging of molasses in the Polish test. Comparison was made between four sets of molasses purities as found by the two formulae; in two cases, a difference greater than unity was found between the values, but the authors still prefer the modified formula. (See also Devillers *et al.*: *I.S.J.*, 1979, **81**, 26.)

Methods of analyses. R. Detavernier, M. Groult and J. Roger. *Sucr. Franç.*, 1978, **119**, 135-143 (*French*). Comparison was made between two means of establishing diffusion losses, *viz.* the enzymatic method of determining lactic acid[1] and a much simpler and more rapid method of determining organic acids based on measurement of the yellow colour formed in clarified raw juice by addition of ferric chloride (the results being expressed as lactic acid). Results for juice from various types of diffuser showed considerable variation in the lactic acid content and total acids:lactic acid ratio, indicating differences in the type of infection and more homogeneous fermentation where there was marked infection. It is considered preferable to estimate sugar losses by the ferric chloride method rather than the enzymatic method which tends to underestimate losses occurring as a result of only slight infection; the increase in molasses sugar is more important than the loss of sugar proper, however, since the acids formed by fermentation are in the form of highly melassigenic salts. Results obtained at a factory where determination was made of pH, acidity (as CaO), bacterial counts and degree of infection (as established by the resazurin method), parallel to the enzymatic and ferric chloride methods of lactic acid determination, showed a distinct correlation between all values, demonstrating the effect of processing very poor beets. The sucrose content in diffusion juice as determined by polarization and enzymatically showed an average difference of 0·73% absolute for the 22 factories in question, the pol value always being higher; the difference was found to be a function of time, being 0·4% at the start of the campaign and rising to 1% by mid-December. In the case of molasses, the pol value was lower than the enzymatic value at the start of the campaign but was higher at the end. This apparent rise in purity is not a result of differences in molasses exhaustion but merely indicates that optically active substances such as raffinose intervene more in the measurements. The value of a Perkin Elmer 300 atomic absorption spectrophotometer for monitoring of evaporator scale and corrosion and analysis of limestone is mentioned. The problems of estimating scale formed by lime salts are briefly discussed; marked variation in the lime salts content of pre-evaporation juice necessitates continuous sampling of both thin and thick juice. Maintenance of pH at a suitable level in 1st carbonatation has been found to minimize silica deposition in evaporators. A gas-liquid chromatographic method developed for determination of molasses moisture involves adding, to 4 g of a solution of 50% molasses by weight in propylene glycol, 4 g of methanol and 2 g of ethanol (to act as internal standard), and injecting 2 μlitre of the mixture into a column of "Porapak Q" heated to 130°C. A catharometer heated to 150°C is used as detector and nitrogen as gas carrier. About 15 min is needed for analysis. Comparison of results for 5 molasses samples with values given by the Karl Fischer and oven drying methods showed good correlation between all three sets of values, although the standard deviations for the GLC and Karl Fischer values were three times greater than for the other method. A method has been devised for determination of nitrates in soil samples using an ion-specific electrode (details are not published), while a chloride-specific electrode has been applied to an automatic system for detecting chloride in thin juice which has been delimed by ion exchange, the resin regenerant being the source of contamination. Juice is tapped from the main feed line and led to a constant-level tank, from which a peristaltic pump removes just sufficient for analytical purposes and transfers it to a mixer where a little phosphoric acid is added to reduce the ammonia effect. The value given by the electrode is compared with that of a reference electrode; the signal is read by a pH meter calibrated in 0·001 units which amplifies and continuously records the reading. The system permitted detection of a chloride leak from a faulty valve which could not otherwise have been found without great difficulty.

Studies on the effect of dextran structure on cane sugar crystal elongation and methods of analysis. M. T. Covacevich, G. N. Richards and G. Stokie. *Proc. 16th Congr. ISSCT*, 1977, 2493-2508.—Using a series of dextrans with a wide range of known chemical structures,

[1] Detavernier *et al.*: *I.S.J.*, 1977, **79**, 326.

effects have been studied on analysis of the dextran in sugar by the "haze" method[1] and by enzyme dialysis[2]. The haze method is very sensitive to variations in dextran structure but is influenced by the molecular weight of the dextran and by the presence of starch, including starch degradation products which may not give an iodine blue colour. The enzyme dialysis method is not affected by the molecular weight of the dextran but is less precise and slower in use, and is rather sensitive to chemical structure in the dextran. Elongation of the sugar crystal by dextran is significantly affected by the latter's chemical structure and occurs only when the dextran contains more than 84% of $1 \rightarrow 6$ linkages.

The determination of grain size of Mauritius raw sugars. E. C. Vignes. *Proc. 16th Congr. ISSCT,* 1977, 2563-2568.—The grain size of Mauritius raw sugars has been determined using a modification of the well-known methanol/*iso*-propanol washing procedure. M.A. and C.V. indices found graphically according to the Powers method[3] are compared with those obtained by a purely mathematical assessment of the data using a computer[4]. It is concluded that, in the case of local raws, determination of their grain characteristics does not present any particular difficulty with the newer technique which can be applied satisfactorily to *A*- and *B*-sugars but not to *C*-sugars. Less time is involved in working out M.A. and C.V. with the computer if, as seems likely, the differences between the results of the two methods are negligible.

How crystals grow (and dissolve). A. VanHook. *Proc. 16th Congr. ISSCT,* 1977, 2613-2621.—The development of theoretical views on the growth and dissolution of sugar crystals is summarized with an introduction to the Burton-Cabrera-Frank dislocation theory in which solute molecules after diffusing from the solution to the surface of the crystal then diffuse over the surface until they encounter a dislocation to which they can attach. The relative times and factors affecting these stages result in differing crystallization rates which, especially at very low supersaturation levels, diverge markedly from the linear pattern of a simple first-order reaction. The author suggests areas for study to gain a better knowledge of the mechanisms of the two processes of crystal growth and dissolution.

A method for the separation and identification of phenolic acids in sugar products. N. H. Paton. *Proc. 16th Congr. ISSCT,* 1977, 2635-2643.—A simple method for the separation of phenolic acids in leaves was adapted for use in the analysis of cane sugar. The phenolic acids are extracted from acidified solutions with ether and then identified by two-dimensional thin-layer chromatography on microcrystalline cellulose plates using either 6:7:3: benzene:acetic acid:water and 10:1:200 sodium formate:formic acid:water or 4:2:2:1:2 *iso*-propanol:*n*-butanol:*tert.*-butanol:ammonia:water and 70:29:1 anisole:acetic acid:water as solvent systems. Identification was by comparison with R_f values of authentic acids, locating the phenolics by examination in U.V. light with and without fuming with ammonia, and reactions with diazotized *p*-nitraniline, ferric chloride, flavone and tungstate-trichloracetic acid spray reagents. Thirteen phenolic acids were identified in cane leaves, cane juice, raw sugar and other process streams.

A rapid method for determining titratable acidity of sugar cane. F. A. Martin. *Proc. 16th Congr. ISSCT,* 1977, 2743-2747.—A rapid estimate of titratable acidity of cane juice can be obtained by measurement of pH after addition of 0·1N NaOH in a ratio of 1:5. Using this indicator of deterioration following a severe freeze, consignments may be classified as those which (*i*) can be processed without difficulty (pH $>$ 7·7), (*ii*) can be processed with difficulty (pH 5·25–7·7) or (*iii*) cannot be processed (pH $<$ 5·25). Only those consignments in the first two classes would be accepted for milling and only samples from the second class would need further analysis to determine the expected degree of process difficulty.

Behaviour of D-glucose and D-fructose in the sugar manufacturing process and their enzymatic-photometric determination. W. Mauch and E. Krause. *Proc. 16th Congr. ISSCT,* 1977, 2829-2845.—Enzymatic methods (using hexokinase, dextrose-6-phosphate dehydrogenase and phosphodextrose isomerase) were used to determine the individual contents of dextrose and levulose in samples of raw cane sugar, white sugar and cane molasses. The ratio was almost 1:1 in cane sugar products, with a slight surplus of dextrose in the raw and white sugar. By contrast, in beet sugar products the ratio is more like 1:2, the difference being statistically highly significant. The divergence is explained by the different reaction mechanisms of hexose degradation and colour formation in beet and cane sugar processing.

Polarimetric analysis in the sugar industry: influence of clarifying agents and of polysaccharides on the polarization of cane juices and molasses. B. Guzmán. *Proc. 16th Congr. ISSCT,* 1977, 2897-2908.—A comparison has been made of pol values obtained for juices clarified by different methods and is reported; the methods include the use of dry basic lead acetate in aqueous and alcoholic media and with Herles' reagent in aqueous medium, in all cases with one normal weight of cane juice in a 100 ml flask. Pol values vary linearly with the amount of basic lead acetate employed and similar results were obtained using Horne's method in which 200 ml of juice are treated with the acetate. Pol values determined in alcoholic medium were systematically higher than the corresponding aqueous polarizations for most of the samples studied. Polysaccharides present in juices from deteriorated cane (frozen or stored) have some influence on the polarimetric reading when Horne's method or the normal weight method in aqueous medium are used and in some cases these juices cannot be clarified even if an excess of basic lead acetate is used. Herles' reagent was useful in clarifying juices of different quality, even those from severely deteriorated cane. Polarimeter readings were not significantly different when the amount of Herles' reagent was varied, and polysaccharides seemed to be completely eliminated from influencing the polarization. Pol values for molasses when clarified with basic lead acetate and with Herles' reagent show similar behaviour to that reported for juice.

[1] Keniry *et al.*: *I.S.J.*, 1969, **71**, 230–233.
[2] Richards & Stokie: *ibid.*, 1974, **76**, 103–107.
[3] *ibid.*, 1948, **50**, 149–150.
[4] Butler: *Proc. 16th Session ICUMSA,* 1974, 262.

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BY-PRODUCTS

Activated carbon. I. Preparation from groundnut hull and bagasse. A. M. H. R. Khan, T. A. Bhuiyan and M. Eusuf. *Bangladesh J. Scientific Ind. Research,* 1975, **10,** (1-2), 32-37; through *S.I.A.,* 1978, **40,** Abs. 78-183.—The effects of the temperature and time employed for one-stage carbonization and of the amounts of $ZnCl_2$ and HCl used to pretreat the bagasse were studied. The activity of the carbon obtained was measured by its adsorption of iodine, methylene blue and permanganate. The first two of these values showed maxima at a $ZnCl_2$:bagasse ratio of 1·4:1, but the $KMnO_4$ adsorption increased as this ratio increased up to 3·5:1. All three adsorption values showed maxima at a HCl:bagasse ratio of 2·5:1, the maximum in permanganate adsorption being very pronounced. Maximum adsorptions were obtained after carbonization at 700°C for 30 min.

Production of dextran from sucrose by *Leuconostoc mesenteroides* **L-M 523.** N. M. Sheikh and M. Hossain. *Bangladesh J. Scientific Ind. Research,* 1975, **10,** (1-2), 80-83; through *S.I.A.,* 1978, **40,** Abs. 78-193.—Dextran was produced by culturing the above organism in a solution containing 10% commercial sugar (95·95% sucrose and 2·3% reducing sugars) and 0·5% K_2HPO_4 at pH 5·5-5·8. Fermentation was complete in 24 hours at 30°C in stationary conditions. Dextran was separated by repeated precipitation with ethanol or methanol; the yields of native dextran were 27·0 and 26·5%, respectively, while the yields of clinical-grade dextran obtained after further purification were 8·2 and 7·5%, respectively, and the average molecular weights were 99,000 and 44,800, respectively.

Cane wax from filter mud. Anon. *Indian Chem. J.,* 1975, **10,** (3), 24; through *S.I.A.,* 1978, **40,** Abs. 78-185. Methods used to extract cane wax from clarification mud and to purify it are outlined.

The energy value of unmolassed and molassed dry pulp as fodder. E. Pfeffer. *Zuckerind.,* 1978, **103,** 203-205 (*German*).—Tests to determine the energy value of beet pulp showed that it was as good as barley in terms of daily energy production in fat stock (lambs and bulls) as well as dairy cows, while incorporation of molasses gave only slightly better results than obtained with the pulp alone.

Sucrose-modified melamine-formaldehyde resins. C. H. Lin, C. C. Kuo, W. C. Hsieh and J. P. W. Yang. *Proc. 16th Congr. ISSCT,* 1977, 3113-3128.—Melamine-formaldehyde-sucrose resins were prepared with different constituent ratios and by two different methods in efforts to improve their hardness, resistance to chemicals, etc. and as a less costly alternative to resins containing melamine and formaldehyde alone. Details are given of the resins and their properties. Infra-red spectroscopy confirmed that the sucrose was chemically bound in the polymer before and after curing.

Making bagasse available for pulp, paper, paperboard, fibreboard, particle board and other industrial products at what price—Equivalent fuel values of bagasse and other fibrous raw materials as compared with fossil fuels. J. E. Atchison. *Proc. 16th Congr. ISSCT,* 1977, 3129-3144.—Calculation of the equivalent fuel cost of bagasse is discussed, with an indication of the effect of moisture content on boiler efficiency, and a graphical method is presented for calculating the value of bagasse in terms of the cost of fossil fuels to meet a particular steam raising requirement. Bagasse still appears to be competitive with pulpwood in most cane sugar producing areas in spite of the drastic increases of recent years in the cost of replacement fossil fuels. Furthermore, it has been predicted that the cost of such pulpwood will grow faster than the cost of fossil fuels so that the competitiveness of bagasse should improve.

The by-products industry in South Africa, its achievements and difficulties. R. J. Andrews. *Proc. 16th Congr. ISSCT,* 1977, 3145-3176.—A survey is presented of the literature of by-products utilization, especially as affecting South Africa, together with the factors such as mechanical harvesting, mill technology, geography, environmental considerations, etc. which have a bearing. Bagasse, its properties and its utilization for paper, board, furfural and animal feeds manufacture are discussed; in South Africa such applications account for just under 10% of the total bagasse produced. Aspects of molasses production, composition and utilization are discussed; the last includes use as a fermentation feedstock (largely for alcohol production in various forms), as animal fodder, and for yeast cultivation.

Studies on industrial gum production by fermentation. IV. Production of gum on a pilot plant scale. W. P. Chen, S. L. Cheng and S. L. Sang. *Proc. 16th Congr. ISSCT,* 1977, 3177-3185.—Laboratory and pilot-plant trials have been made on the cultivation of *Xanthomonas manihotis* on a sucrose medium to yield a gum of commercially interesting character. A 4% sucrose solution is seeded with 5% inoculum and cultured aerobically at 28°C for 60 hr (the 14 litres laboratory experiment) or 72 hr (the 50 litres and 400 litres pilot plants). The cultured broth from the largest scale fermentation had a viscosity of about 38,000 cp and contained 2·5% gum, corresponding to a yield of 62% on the initial sucrose.

Production of ribonucleic acid and nicotinamide adenine dinucleotide from molasses yeast. M. C. Hsie. *Proc. 16th Congr. ISSCT,* 1977, 3187-3194.—The possibility of producing the two title compounds (RNA and NAD) from Torula yeast was investigated. It was found that, when the yeast was harvested after nine hours of growth, the total yield of RNA was the highest while, for NAD, the highest yield was obtained after 11 hours of growth. Addition of NAD precursors could raise the concentration of intracellular NAD in yeast. The optimum conditions for extraction of NAD from

yeast are discussed. The most suitable process for extraction of both compounds from yeast was to extract the NAD first and then the RNA from the residues. It was concluded that no unfavourable effects would result when the NAD was extracted first and a higher purity RNA could be obtained.

Utilization of sugar cane bagasse in the dissolving pulp industry. J. J. Hough and J. S. M. Venter. *Proc. 16th Congr. ISSCT,* 1977, 3195-3207.—Results are presented of a preliminary study of the prehydrolysis and pulping of bagasse to prepare a material suitable for further processing into dissolving pulp. Strong relationships were found to exist between the pentosan content of prehydrolysed bagasse and that of bleached and unbleached pulp. These relationships make it possible to determine the prehydrolysis conditions required to produce a bleached pulp with any desired pentosan content. A suitable product can be obtained by prehydrolysis at 180°C without the presence of acid. Furthermore, retention time during prehydrolysis and pulping need not exceed 10 minutes. It was found possible to manufacture a bleached pulp with acceptable hemicellulose and alpha-cellulose content. The final yield of prehydrolysed unbleached pulp based on depithed bagasse amounted to about 33%. As this yield is rather low compared with the unbleached dissolving pulp yield of about 42% from hardwoods, it will probably be necessary to recover by-products such as furfural if the manufacture of dissolving pulp from bagasse is to be economically viable.

Enzymatic saccharification of bagasse pith. L. H. Wang and Y. C. Kuo. *Proc. 16th Congr. ISSCT,* 1977, 3209-3220.—A fungal strain capable of producing high activity of bagasse pith saccharifying enzyme was isolated from Taiwan soil. The enzyme exhibited its maximum action towards bagasse pith at pH 4·8 and 60°C, when the inculation time was 1 hour. The enzyme was very stable within the pH range 4·0–6·5 and up to 50°C and it was not inhibited by the product of bagasse pith hydrolysis by chemical or enzymatic action. Enzymatic saccharification of bagasse pith was carried out with continuous shaking in a 500 cm^3 Hinton flask containing 200 cm^3 of reaction mixture. A 5% concentration of pith was suitable and was used in the experiments. Although the best ratio of bagasse pith per enzyme unit has been calculated to be 12, the degree of pretreatment of the pith affected the saccharification efficiency intensely. An easier and more economical pre-treatment was to hammer-mill the bagasse pith to 60–80 mesh and then treat with 1% NaOH on dry weight of solid pith at a liquor ratio of 1:7 and at 160°C for 1 hour. By this means, saccharification could be increased to 10 times that of untreated material. Moreover, the pH value of the treated pith was 5·0, near the 4·8 optimum, so that it was not necessary to add any chemicals to adjust the pH. Most of the hydrolysis product was dextrose, with smaller amounts of xylose and cellobiose. It is considered that the potential for enzymatic saccharification of bagasse pith might be expected to be high.

An overview of by-products utilization in the cane sugar industry. J. M. Paturau. *Proc. 16th Congr. ISSCT,* 1977, 3221-3234.—The main utilizations of sugar cane by-products are summarily reviewed. The present commercial value of these by-products is indicated as well as the value upgrading that would result from further processing. Attention is drawn to the possibility of bagasse savings in a raw sugar factory through better utilization of exhaust steam. The outlook for molasses utilization in fermentation industries and as animal feed is considered. Economic data on industries based on bagasse and molasses are summarized in graphical form and an example given to show how the thorough utilization of by-products can significantly increase the revenues of a sugar estate.

Alcohol manufacture in a sugar factory. P. M. A. M. Chenu. *Proc. 16th Congr. ISSCT,* 1977, 3241-3251.—Many Brazilian sugar factories have annexed distilleries in which the molasses produced is fermented to produce alcohol. Depending on market conditions it can sometimes be necessary to divert to alcohol manufacture what would otherwise be crystallizable sugar and this can be done by taking from any product stream from mixed juice to sugar. Diversion of mixed juice, last mill juice, clarified juice, filtered juice and sulphitated juice are considered in turn; the choice of a suitable stream depends on a number of factors including, e.g. cane quality, cane fibre content, boiler efficiency, factory heat balance, and other local conditions. It is always possible and advisable to divert mixed juice and, in certain circumstances, last mill juice. As to the avoidance of contamination by rogue yeasts or bacteria, the choice between pasteurization and control by antibiotic materials will depend on the personnel operating the distillery; pasteurization is simple but cannot eliminate all risks of infection, requires more equipment, more steam and cold water for final cooling of the juice, whereas control using pentachlorophenol or penicillin requires good biological control by skilled personnel.

Establishment of mini paper plants based on surplus bagasse by the sugar factories. P. J. M. Rao. *Proc. 16th Congr. ISSCT,* 1977, 3253-3275.—See *I.S.J.,* 1976, **78,** 349.

Chemical quality of sugar cane tops silage made with and without molasses, urea and ammonia. J. Deville and Y. Wong You Cheong. *Proc. 16th Congr. ISSCT,* 1977, 3277-3290.—Experiments in laboratory silos (3 levels of molasses and 3 levels of N as ammonia or urea or half of each) showed that silages of good quality could be made from cane tops alone or with the addition of molasses, urea or ammonia. Tops ensiled alone had a low pH (3·8) and a volatile fatty acid and lactic acid content similar to that reported in silages made from grass, whole crop maize and sunflower. Molasses lowered the pH and increased acetic and lactic acid levels but decreased propionic and butyric acid levels. When no N was added to the molasses, acetic acid production exceeded that of lactic acid but, when ammonia was also added, lactic acid was the main acid formed. In the presence of urea, high levels of molasses were required to increase lactic acid levels. Urea depressed the pH and volatile fatty acid levels and severely depressed lactic acid formation; with ammonia these effects were less severe. The highest levels of ethanol (>2% of dry matter silage) were obtained in the urea treatments, whether with or without molasses, and the lowest levels were obtained in the ammonia treatments. The most suitable combination was molasses either at 5 or 10% on fresh weight of cane tops and ammonia at 0·2% N.

Argentina sugar exports, 1978[1]

	1978	1977	1976
	tonnes, raw value		
Afghanistan	0	10,869	0
Angola	0	14,242	54
Chile	22,035	185,630	39,089
China	0	21,114	0
Colombia	0	17,237	0
Denmark	0	12,600	0
Egypt	43,355	8,804	33,737
Finland	0	11,278	0
France	0	11,500	12,193
Germany, East	0	0	5,900
Ghana	0	6,521	4,308
Haiti	5,419	0	0
Indonesia	12,094	0	0
Iran	28,042	13,695	0
Italy	0	1,087	0
Jamaica	5,435	0	0
Jordan	0	5,435	0
Libya	0	6,195	10,326
Malaysia	0	12,199	0
Mauritania	0	0	6,600
Morocco	0	76,983	0
Pakistan	0	10,869	0
Portugal	19,000	44,644	10,817
Rumania	0	32,206	0
Senegal	6,000	26,600	0
Spain	0	0	3,536
Sri Lanka	0	11,956	0
Sudan	12,287	0	11,129
Syria	0	29,422	0
Tunisia	0	0	38,334
Uruguay	0	4,376	0
USA	186,915	325,212	99,336
Venezuela	25,691	35,132	17,232
Yemen	0	4,565	0
Zaire	542	0	0
	366,815	940,371	292,591

West Germany sugar production, 1978/79[2].—Sugar production in West Germany fell to 2,740,000 tonnes in the 1978/79 campaign from 2,810,000 tonnes in the previous campaign, according to the Verein der deutschen Zuckerindustrie. The total amount of beet processed was 18,840,000 tonnes compared with 20,580,000 tonnes, and the sugar content averaged 16·5% against 15% in 1977/78. Production comprised 2,310,000 tonnes of white sugar, unchanged from the previous campaign, and nearly 430,000 tonnes of raw sugar, against just over 500,000 tonnes.

Kenya sugar developments[3].—The Kenya Sugar Authority is to receive a World Bank loan of 156 million shillings to carry out a rehabilitation programme on the four factories at Ramisi, Miwani, Chemelil and Muhuroni. The Authority will receive a further $6 million from the African Development Bank and additional funds will be provided by the government and the sugar factories concerned for the same purpose. The aim is to make Kenya self-sufficient in sugar by 1980. The factories are to be expanded, cane farms increased, roads improved and better employee houses erected. A new company is also being formed to set up a 200 million shillings factory at Muhuroni to manufacture power alcohol and yeast from cane molasses. The factory will provide a ready outlet for molasses produced by the existing and proposed sugar factories in the Nyanza sugar belt.

Lebanon sugar factory refinery section[4].—A refinery section is to be brought into operation in 1979 at the only beet sugar factory in Lebanon at Bekaa. At first it will process 200 tonnes of raw sugar per day, to be increased later to 350 tonnes. At the end of 1978 there were 15,000 tonnes of raw sugar in storage which was being processed by adding 20 tonnes per day into the *A*-massecuite.

Norway sugar imports, 1978[5]

	1978	1977
	tonnes, white value	
Belgium/Luxembourg	3,944	5,887
Czechoslovakia	3,705	2,844
Denmark	71,839	76,574
Finland	19,038	14,892
Germany, West	20,401	26,507
Poland	4,540	4,821
Sweden	3,172	85
UK	36,585	33,055
Other countries	33	299
	163,257	164,964

Iran bagasse paper plant[6].—Babcock-Krauss-Maffei Industrieanlagen GmbH of Germany, together with a Swiss company, are currently erecting in Misan a paper and cellulose plant which will use reeds and bagasse as alternative raw materials.

Refining in the USSR[7].—The Soviet sugar refining industry comprises 15 refineries and 11 sugar factory refining sections. On January 1, 1978, its total daily output was rated at 9481 tonnes, including 3441 tonnes as tablet sugar. However, while the total production of refined sugar in the first 10 months of 1978 exceeded the planned output, there was a shortfall in the amount of tablet sugar. Among the chief reasons given for this are poor labour organization and inadequate use of tabletting machinery such as the Chambon equipment installed at a number of refineries. Labour productivity is low, one example being 4·25 man-days per tonne of pressed sugar produced. Fuel consumption at some refineries is also extremely high. To meet the increased requirement for refined sugar (of which 2,651,000 tonnes is planned for 1979, including 742,000 tonnes of tablet sugar), under the Five-Year Plan 1981-85 it is planned to build new refineries in the Kirgiz, Alta, Poltava and Krasnodar regions.

Nigeria sugar expansion plans[8].—Against annual consumption of around 250,000 tonnes, or 3·7 kg per caput, the Nigerian Sugar Company at Bacita produces 40,000 tonnes of refined sugar, with most of the remainder imported from the EEC. Nigeria is helping to finance a sugar factory in neighbouring Benin, which would permit imports of an undisclosed quantity, while it is also planned to raise domestic production to 80,000 tonnes by 1980/81 with a number of integrated sugar projects on which over 350 million Naira (about £280 million) is to be spent. These include the Savannah Sugar Co.'s factory which was to start operations in December 1978 and reach a production level of 100,000 tonnes by 1983 and later 300,000 tonnes. The Sunti sugar estate was also due on stream in 1978 and to have a capacity of 60,000 tonnes per year, while annual capacity of the Lafiaji project in Kwara state is expected to be more than 50,000 tonnes.

UK interest in Chinese sugar industry contracts[9]. Reuters have reported that UK sugar companies hope to sell equipment and their experience in growing and refining cane and beet sugar to China as a joint British project, as a result of planned visits there this year. Tate & Lyle Ltd. and Booker McConnell Ltd. have agreed to form a joint company to follow up any opportunity that may arise to present proposals on developing China's sugar industry. A British Sugar Corporation Ltd. spokesman said it had agreed to give its support to any contracts which might eventually be obtained. John Davis, Managing Director of Fletcher and Stewart Ltd., the contracting and technical subsidiary of Booker McConnell, told Reuters that the company has meanwhile received some preliminary inquiries for complete processing plants.

[1] F. O. Licht, *International Sugar Rpt.*, 1979, **111**, S46.
[2] *Public Ledger*, January 27, 1979.
[3] *Standard Chartered Review*, January 1979, 10, 11.
[4] *Zuckerind.*, 1978, **103**, 1076.
[5] C. Czarnikow Ltd., *Sugar Review*, 1979, (1428), 38.
[6] *Zuckerind.*, 1978, **103**, 1076.
[7] *Sakhar. Prom.*, 1979, (1), 2–6.
[8] *World Sugar J.*, 1979, **1**, (7), 16.
[9] F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 81.

Thailand sugar exports, 1978[1]

	1978	1977
	—— *tonnes, tel quel* ——	
China	236,177	674,338
Indonesia	5,250	9,500
Iran	85,800	97,827
Iraq	0	26,400
Japan	393,763	626,108
Korea, North	0	1,995
Korea, South	72,547	8,450
Malaysia	114,971	172,770
Singapore	23,987	699
Sri Lanka	0	19,500
Sweden	12,600	0
USA	64,343	0
	1,009,438	1,637,587

New Indian sugar factory[2].—The U.P. Minister for Cane Development inaugurated a sugar factory at Nand Ganj Shirohi, about 18 km from Ghazipur on November 24 last. The factory has a crushing capacity of 1250 tonnes of cane per day.

Australia, Fiji and New Zealand sugar economies.—The latest in the series of studies on the sugar economies of individual countries prepared by the International Sugar Organization, which updates the two volumes published in 1963, covers Australia, Fiji and New Zealand. It reviews developments in production, consumption and trade of the countries concerned since 1960. It is available in English while translations into French, Russian and Spanish are in preparation. The publication is available from the I.S.O. at 28 Haymarket, London, England SW1Y 4SP.

French bulk sugar terminal[3].—A 50,000-tonne sugar terminal at Dunkirk, which started operations at the end of September 1978, was officially opened by the French Minister of Agriculture in February. The terminal is contributing to smoother storage and loading at France's premier sugar exporting port. The new storage and bagging facility will be open to all sugar producers and dealers. It is intended to reduce port costs and labour difficulties. The investment, financed by the participants and by development grants, is estimated to represent some 30 million francs.

Fiji distillery[4].—The Government has approved a project for the establishment of a distillery by the Fiji Sugar Corporation at Lautoka. It will manufacture rum, gin and vodka and a small quantity of industrial alcohol. The cost of the project is estimated at US $2 million and financing will be covered half by issue of new shares and half by a loan.

Kenya sugar project[5].—A large new sugar project costing about £50 million is being established in Kenya's South Nyanza province near Lake Victoria. Partly Government-owned, it is to be managed by the Mehta Group of Companies which had large sugar interests in Uganda before President Amin's purge of Indian businessmen.

Sugar production in the USSR.—Amongst data given in *Sakharnaya Promyshlennost'*, the Soviet sugar industry publication[6], are figures of sugar production in 1978: 12,200,000 tonnes of white sugar were produced, of which 8,605,000 tonnes were manufactured from beet. The corresponding figures for 1977 were 12,037,000 tonnes and 8,173,000 tonnes. Beet sugar recovery in the second half of 1978 was 11·49% on beet compared with 10·5% in the corresponding period of 1977. Beet sugar target production in 1979 has been set at 9,703,000 tonnes, while refined sugar manufacture is expected to total 2,651,000 tonnes. Total daily beet slicing capacity is to be increased by 14,500 tonnes in 1979; the start-up of a new sugar factory at Zolotukhin in the Kursk region will represent 6000 tonnes of this figure. Syrup will be the end-product at 63 factories.

Brazil sugar exports, 1978

	1978	1977
	tonnes, raw value	
Algeria	14,880	200,742
Canada	5,250	0
Chile	40,219	10,826
China	142,185	163,967
Ecuador	15,157	0
Egypt	146,268	130,793
Finland	27,250	35,742
France	90,574	62,925
Ghana	10,826	21,652
Haiti	0	2,897
Indonesia	88,587	145,311
Iran	170,105	64,307
Iraq	127,092	352,294
Japan	21,400	79,085
Jordan	19,920	10,284
Kenya	0	6,344
Korea, South	15,320	0
Malaysia	11,192	13,407
Morocco	0	22,826
Nigeria	45,240	15,969
Portugal	97,020	120,815
Qatar	0	5,684
Rumania	0	59,160
Senegal	24,375	11,150
Somalia	13,130	11,777
Sri Lanka	10,826	22,711
Sudan	11,345	41,324
Sweden	0	11,000
Syria	9,743	23,276
Tanzania	24,413	0
Tunisia	0	28,886
UK	0	54,259
USA	579,541	679,841
USSR	83,270	24,359
Venezuela	79,463	41,065
Yemen	0	11,909
	1,924,591	2,486,587

PERSONAL NOTES

The death has been reported of **Dr. Stanisław Gawrych.** Born in 1904, he was a student at Poznań University where he gained his Master of Philosophy in chemistry in 1933. He joined the staff of the Faculty of Inorganic Chemistry of the University, where he worked until the outbreak of World War II, receiving his doctorate in chemistry. He worked as chemist at Gniezno sugar factory, becoming assistant director in 1945. From 1949 to 1959 he was chief engineer of Lublin factory, after which he joined the Sugar Industry Institute in Warsaw to be in charge of the work on juice extraction and purification. In 1962 he became head of the Institute of Sugar Technology where he remained until 1974.

Emory E. Coll, involved in research on cane sugar production since 1954, retired in October 1978 from the Southern Regional Research Center of the US Dept. of Agriculture[8]. A chemical engineer, he organized a programme for the Sugarcane Investigations group at the SRRC relating cane varieties to processing problems in the sugar factory. He designed and built some of the first high-voltage electrophoresis equipment in the USA. His processing studies extended into the problem area of filtrability and developed the Millipore filtration test for raw sugars that was included in the US No. 10 Contract quality standard tests. In recent years, working in cooperation with the Cane Refining Research Project, Coll studied dextran production in field and factory in Louisiana, relating dextran formation to cane variety and nature and performance of factory operations.

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[1] C. Czarnikow Ltd., *Sugar Review*, 1979, (1428), 38.
[2] *Maharashtra Sugar*, 1979, **4**, (3), 69.
[3] F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 65.
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[6] 1979, (2), 1–6.
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[8] *Sugar J.*, 1978, **41**, (6), 25.

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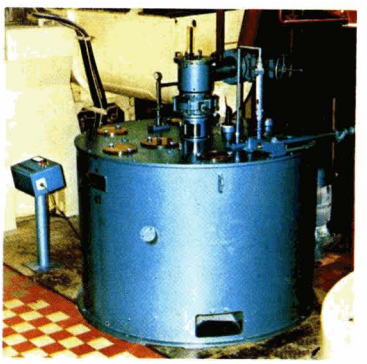

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