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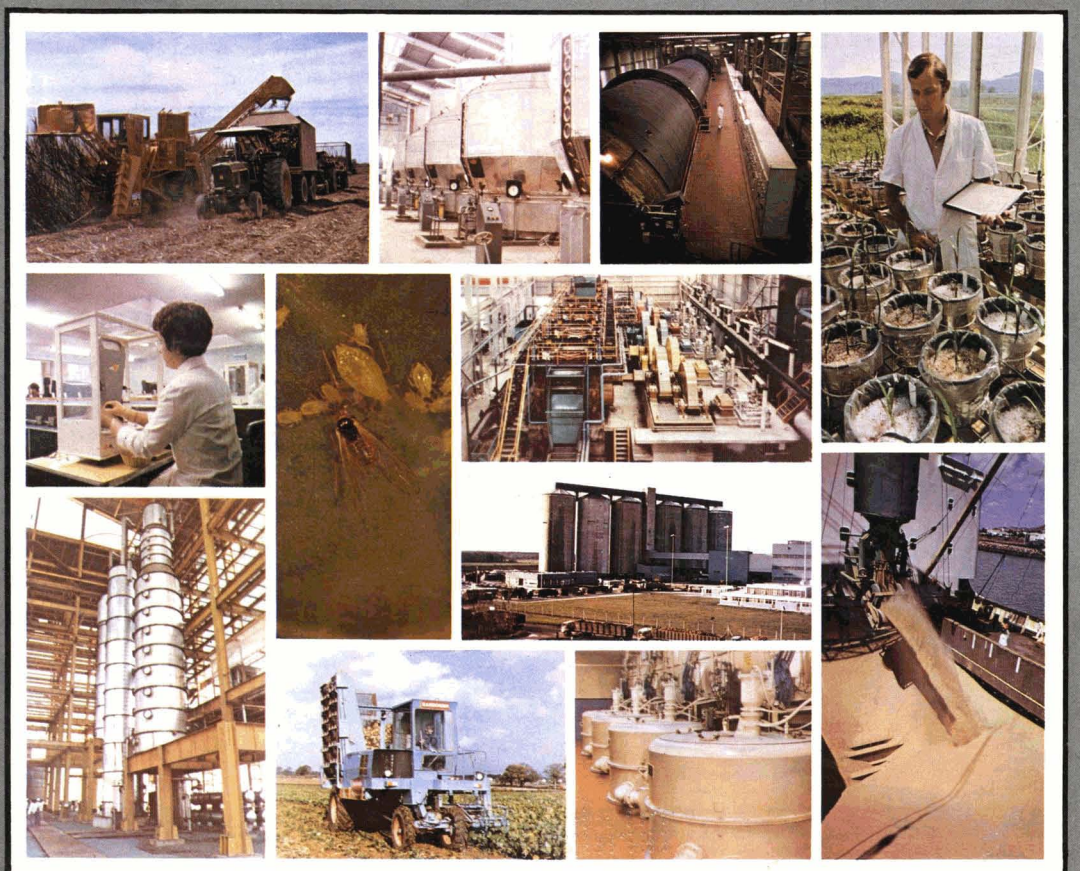

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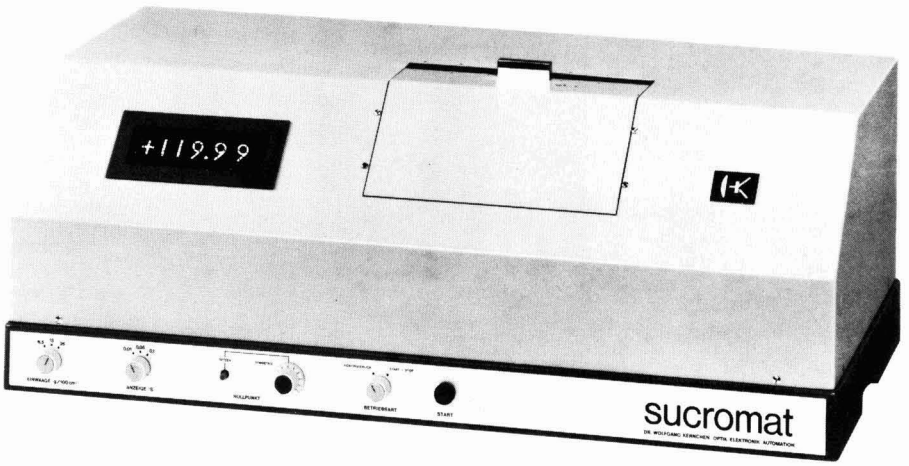

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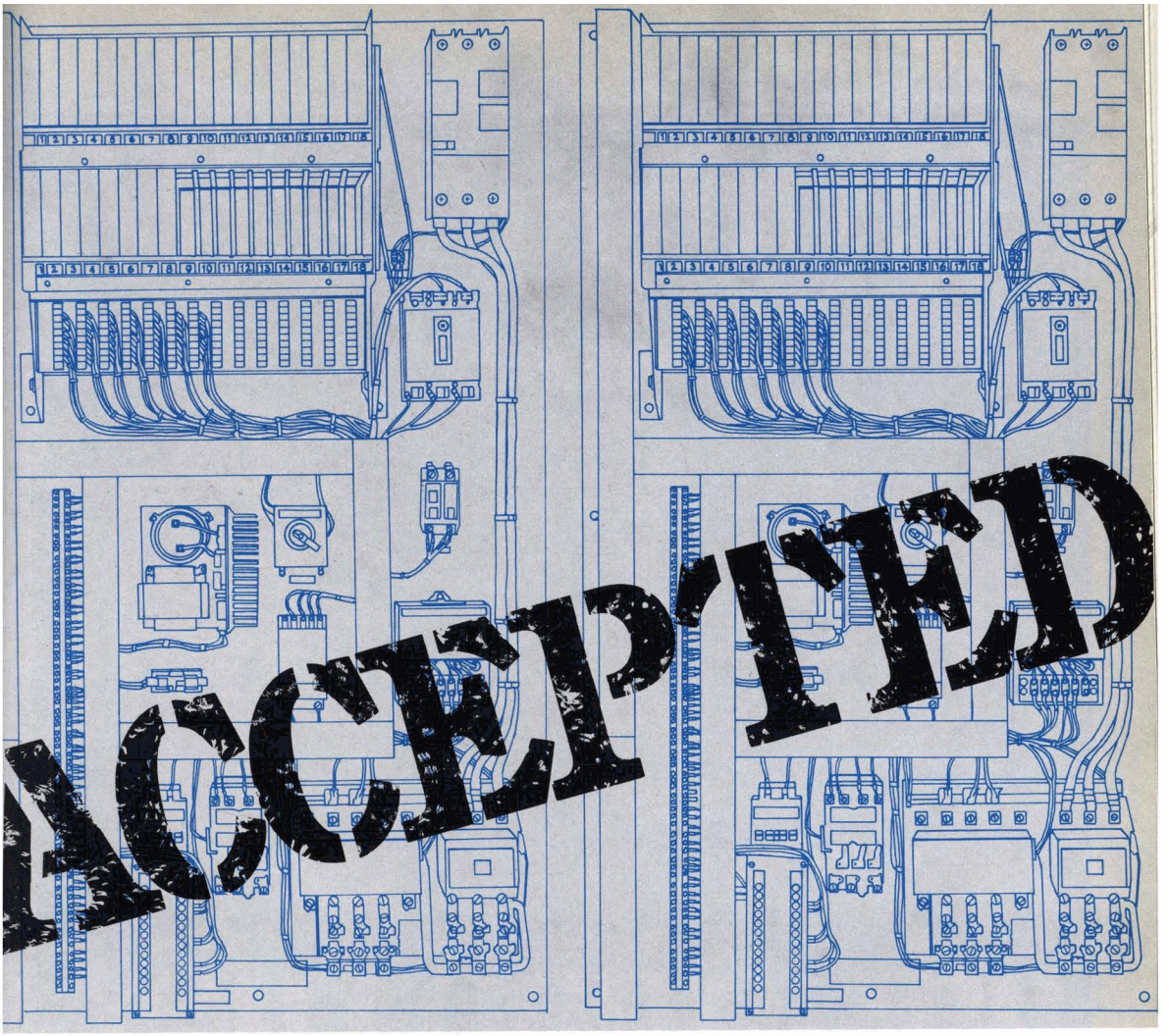

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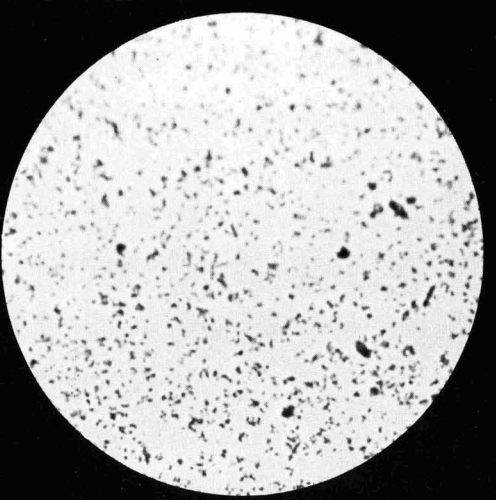

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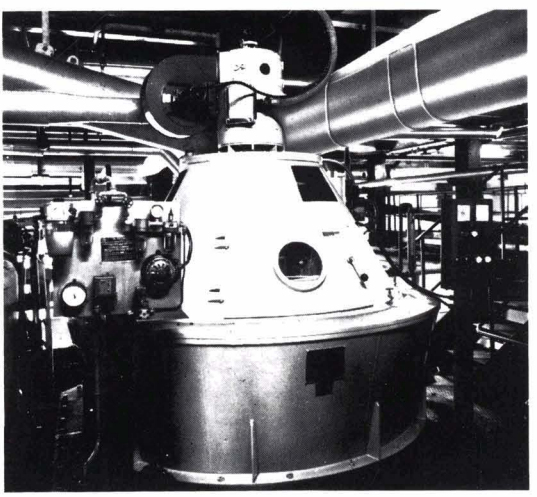

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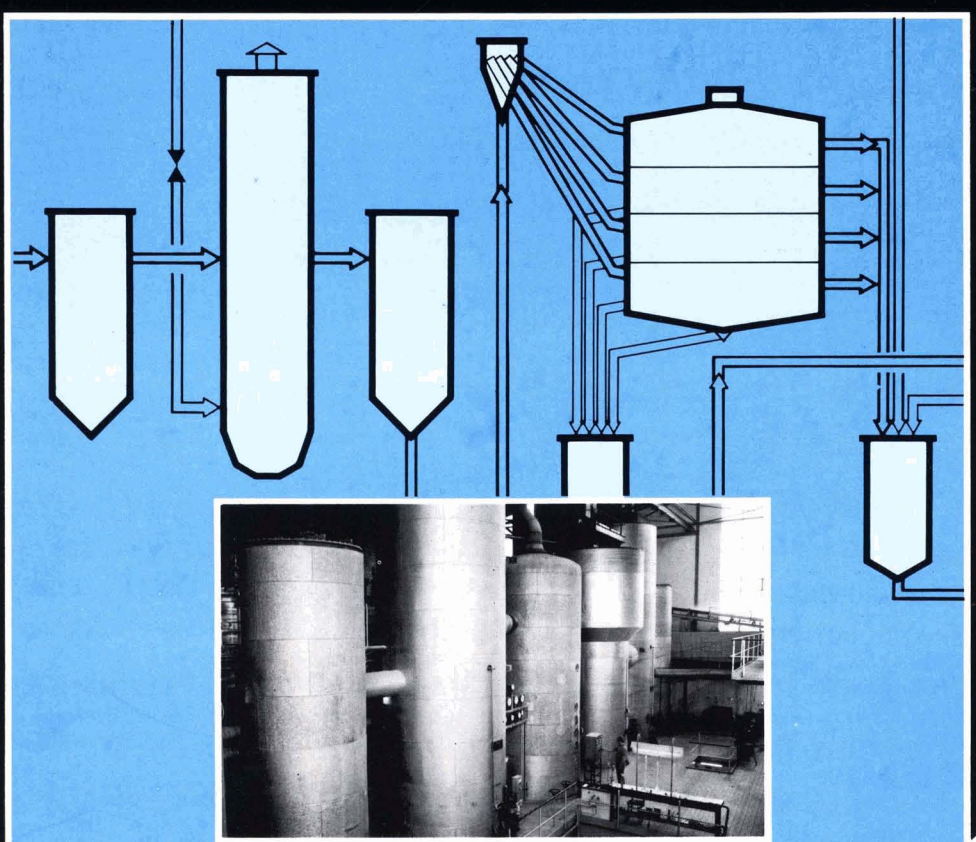

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NOTES AND COMMENTS

World sugar prices

The decline in the London Daily Price of raw sugar continued and, from £323 per tonne on July 1, had fallen to £235 by July 11. There was a recovery to £262 the next day, however, and prices gradually recovered thereafter, to finish the month at £288 per tonne. The decline is attributed to a shake-out of speculative interest which had taken the LDP higher than was justified in view of the ready availability of actual sugar; such speculation was fuelled by the indications of possible longer-term shortages. The gradual strengthening in the second half of the month was influenced by a number of items: reports of problems in regard to the Polish beet crop, confirmed reports of purchases by Cuba of 70,000 tonnes for sale to East European customers, as well as interest by importing countries.

White sugar prices moved in a similar pattern during the month but with much smaller swings; the LDP(W) started the month at £344 and sank to £285 by July 11, then recovering to finish the month at £321. Demand has been steady and there has been little competition for EEC supplies to the market except some white sugar of US origin.

Cuban sugar purchases

A surprising occurrence in July was the purchase by Cuba of sugar from the Dominican Republic. The 70,000 tonnes was expected to be re-exported to East Germany and Poland to take the place of contractual shipments Cuba is unable to make because of current production problems[1]. It has been reported also that deliveries from Cuba to fellow-members of COMECON are to be reduced by up to 30% and some confirmation of this is indicated by reports of purchases of Philippines sugar by the USSR for 1981 shipment and of EEC sugar by other countries of East Europe.

It has been stated by Prime Minister Castro that Cuba's 1980/81 crop would be badly affected by the rust disease affecting the B 4362 cane grown on the island; although half the affected area is to be replanted for the next crop, a yield reduction of between 57 and 71% is expected on the remainder[2]. Thus there is likely to be a reduction in outturn from the island's sugar industry but, in addition, it seems likely that the Cubans wish to protect their ISA quota by ensuring that their deliveries to the world market are maintained at the expense of their COMECON exports. Indeed, it has even been suggested that the reduction in Eastern Bloc sales could be intended to permit a building-up of stocks for future export so as to claim a rise in Cuba's Basic Export Tonnage under the Agreement.

World sugar production

The latest estimates produced by F. O. Licht GmbH[3], which cover crops starting in the period May – April for each country except those which crush cane all year round when calendar year figures are taken, show a revised total for 1979/80 of 84,623,000 tonnes, raw value, remarkably similar to those of C. Czarnikow Ltd. and *World Sugar Journal* quoted in our July issue[4].

With passage of time, official figures of crops in individual countries become available and so it is not surprising that estimates will converge, although there will be cases where differences arise in estimates for countries where crops are still in progress or official figures are not published.

Licht also provides a tentative survey of prospects for 1980/81 as at the moment and emphasizes that they are very much subject to weather conditions; he suggests that world sugar production could be between 88 and 89 million tonnes in that year, of which cane sugar production is tentatively estimated at 55.4 million tonnes. The total would represent 3.4 – 4.4 million tonnes more than in 1979/80, i.e. some 2 million tonnes below 1979/80 consumption and thus probably well under 1980/81 consumption. Such a forecast, even though tentative, reinforces expectations of a further fall in world stocks and probably higher price levels.

EEC proposal for ISA membership

The EEC Commission is reported to be proposing to member governments that the community negotiate membership of the International Sugar Agreement[5]. Earlier talks on Community membership have failed over the issue of an export quota; in the original negotiations the Community did not wish to be restricted by any quota limit, and a 1976 offer of 300,000 tonnes plus 1.6 million tonnes of re-exports fell considerably short of the EEC's exportable surplus; this now stands at over 3.5 million tonnes.

C. Czarnikow Ltd. note[6] that "There are obviously many hurdles still to be overcome and it seems likely that some member governments will have considerable reservations about joining the ISA. The Agreement does leave open the possibility of membership in special cases under which exporters may not have shipments limited by export quotas; so the possibility of EEC membership without the vexed question of a basic export tonnage could be considered. Nevertheless, with the Agreement having less than two and a half years still to run and with the Community still not having its own arrangements for the new five-year regime agreed, it seems more likely that negotiations will be limited to ways in which the Community might adhere to any new Agreement to come into force from the beginning of 1983".

Brazilian alcohol program[7]

Brazil needs to invest a further $4000 million in its national alcohol program by 1985 to achieve its target of producing 10,700 million litres by that date, according to the President of the Sugar and Alcohol Institute. This requires the building of 316 new distilleries each producing 150,000 litres daily and an increase of 1,400,000 hectares in the amount of land turned over to cane cultivation.

Official estimates show Brazil will consume 21,000 million litres of petrol in 1985 and, given an alcohol output of 10,700 million litres, Brazil will be able to keep its petrol consumption at 1973 levels, saving about $1800 million at current prices.

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1 *Public Ledger*, July 19, 1980.
2 *ibid.*, August 2, 1980.
3 *International Sugar Rpt.*, 1980, **112**, 375-379.
4 *I.S.J.*, 1980, **82**, 198.
5 *The Times*, July 25, 1980.
6 *Sugar Review*, 1980, (1502), 147-148.
7 *Reuter Sugar Newsletter*, May 5, 1980; May 29, 1980.

Notes and comments

Up to April 14, 1980, the government had already approved 266 distilleries capable of producing 6100 million litres of alcohol (57% of the 1985 target) and in the 1979/80 crop year Brazil produced 3500 million litres, which compares with 660 million litres produced in the 1976/77 crop year. Alcohol output in 1980/81 is likely to reach about 4200 million litres.

World sugar balance 1979/80

F. O. Licht GmbH recently published their third estimate of world sugar supply and distribution for the period September 1979/August 1980[1] and these figures, with comparative figures for the previous two years are set out below.

	1979/80	1978/79	1977/78
	tonnes, raw value		
Initial stocks	30,568,000	29,860,000	24,611,000
Production	85,314,000	91,346,000	91,110,000
Imports	28,991,000	26,962,000	27,957,000
	144,873,000	148,168,000	143,678,000
Exports	28,768,000	27,448,000	28,256,000
Consumption	91,050,000	90,152,000	85,562,000
Final stocks	25,055,000	30,568,000	29,860,000
Final stocks % consumption	27.52	33.91	34.90

World Sugar Journal[2] have also published their latest corresponding estimates of sugar supply and distribution, but these are not strictly comparable, relating to crop years, rather than indicating stocks at a particular date (August 31 above).

	1979/80	1978/79	1977/78
	tonnes, raw value		
Initial stocks	22,521,000	21,367,000	17,585,000
Production	84,894,000	90,963,000	90,907,000
Imports	26,160,000	25,204,000	24,529,000
	133,575,000	137,534,000	133,021,000
Exports	25,615,000	25,395,000	26,832,000
Consumption	91,391,000	89,618,000	84,822,000
Final stocks	16,569,000	22,521,000	21,367,000
Final stocks % consumption	18.13	25.13	25.19

An article in *World Sugar Journal* comparing crop year stock figures with those established on August 31, when the crop in some countries may be in progress normally, early or late, indicates that this factor permitted a wide variation between the two figures, and that the use of this fixed date gave a stock figure consistently higher than the corresponding crop year stock. The market has considered a level of stocks at August 31 of 25% of annual consumption to be normal; if a crop year basis gained favour the level considered normal would thus be reduced. In any event, the marked drop in production in 1979/80 compared with the earlier two years, and the drastic effect on availabilities, is evident.

Sugar availability in 1980/81[3]

A review of raw sugar availabilities during the 1980/81 crop year leads to an unexpected conclusion that, notwithstanding increases in production in exporting countries, availabilities are going to be considerably lower than in 1979/80. The explanation is that the price increase in 1979/80 prompted producers to sell large quantities from their stocks; raw sugar exports during this crop year therefore included a large percentage of accumulated stocks, along with current crop availabilities.

After this sharp reduction of their stocks, the exporting countries will have to rely only on out-of-production availabilities to supply 1980/81 raw sugar demands. Raw sugar exporters are likely to have 1.5 million tonnes available from extra production, of which at least 400,000 tonnes are needed to match increases in domestic consumptions. To the net figure of 1.1 million tonnes may be added a maximum of 200,000 tonnes from initial stocks. This would give, in million tonnes, raw value:

	1979/80	1980/81
Availabilities from:		
Crop year production	10.7	11.8
Stocks	2.3	0.2
	13.0	12.0

The raw sugar importing countries must consequently face a reduction of one million tonnes in supply potential.

The same reflection is valid for white sugar availabilities where there may be anticipated:

a decrease of 300,000 – 1,300,000 tonnes in availability of export white sugar from the EEC and a decrease of 350,000 tonnes from the other European white sugar exporters, resulting essentially from expected decreases in production;

a stagnation of white sugar availabilities from South America, where exports have been artificially inflated by stock reduction (600,000 tonnes). In 1980/81, the expected increase in production will just compensate for the absence of any possible stock reduction; and

an increase in white sugar exports from Asia, which will be much lower, however, than the production increase, since India has had to reduce its stocks by 1.4 million tonnes this year in order to maintain a (limited) supply for its domestic market. The expected 2.1 million tonnes increase in production for the 1980/81 crop year will thus result in only a 700,000 tonnes rise in export availabilities.

On a world basis, white sugar export potential will be at best the same as for 1979/80 and might well be reduced by 1 million tonnes. Combined export sugar availabilities will thus be reduced by a probable 1 – 2 million tonnes for 1980/81 crop year. Such a reduction will force the importing countries to either reduce their consumption – which implies dissuasive high prices – or reduce their stocks, a move they may be reluctant to make in a climate of uncertainty of supply.

Future of the Irish sugar industry[4]

Without major capital investment of about IR £40 million over the next three years, the state-owned Irish Sugar Company will be in serious difficulties, according to the Managing Director and Chief Executive, Mr. M. Sheehy. Since 1970 almost IR £25 million has been spent on factory modernization but much more is needed to modernize factories, replace obsolete machinery and increase production.

With adequate capitalization, daily throughput capacity should reach 17,000 tonnes by 1983, permitting the reduction of the length of the campaign to just one hundred days. Investment since 1970 has raised daily factory throughput by one-fifth – from 11,600 tonnes to 14,500 tonnes. The investment has given the sugar industry the capacity to handle economically a beet acreage which has risen by almost 50% over the past decade.

1 *International Sugar Rpt.*, 1980, **112**, 399-403.
2 1980, **3**, (1), 10.
3 *Sucres et Denrées*, July 8, 1980.
4 F. O. Licht, *International Sugar Rpt.*, 1980, **112**, 410.

The effect of wet lead basicity on the pol value of raw sugar

By J.C. BAIRD and M.R. PLAYER

Introduction

The defecation of raw sugar solutions with basic lead acetate prior to pol determination has been the subject of debate for some time. For almost a century the influence of this reagent on polarization readings has been examined and argued to little avail. Many attempts have been made to quantify the "lead effect" on raw sugars with the view of establishing a standard method that was mutually satisfying to all concerned. A very interesting review of these matters has been given by Watson[1].

The defecation of raw sugar solutions by different methods is known to give different pol results. Gaskin & Hands[2], using a Cuban sugar, found that different volumes of basic lead solutions (0.1 to 2.4 cm^3) at different basicities (33% and 43%) gave differing pol values. Their results indicated that the higher basicity lead solution gave lower pol values and that the difference varied up to 0.14°S for a Cuban sugar having a pol of around 97°S. Their findings showed also that wet lead solutions of different basicities required different critical minimum volumes of lead defecant for adequate filtration rate and filtrate clarity.

Gaskin & Mesley[3] examined the effect of lead on pol values of solutions made from sucrose and levulose. They found that, with increasing volumes of lead reagent, pol decreased at first and then increased steadily. They attributed this to the effect of lead on the specific rotation of sucrose.

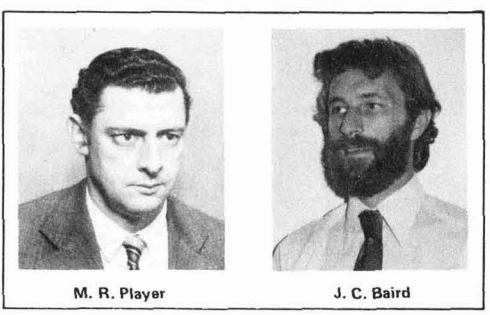
With the advent of "automatic polarimeters", researchers began to compare the pol values of undefecated solutions with wet-leaded solutions. However even these instruments were not satisfactory on very dark solutions. Rutledge[4] reported that the pol values of unclarified solutions differed in an unpredictable way from those of solutions clarified with wet lead. Mesley[5] examined 53 sugars of different qualities from different countries and showed that the lead effect was not in any way constant or related to sugars of varying pol values.

At the 17th Session of the International Commission for Uniform Methods of Sugar Analysis held in Montreal in 1978, recommendations adopted in respect of Subject 11, "Polarization of raw sugars", included:

"Recommendation 2: In the specification of the basic lead acetate solution, the equivalence of the total lead content (expressed as PbO) of 24.7 ± 1.0 g/100 cm^3 for the specific gravity of 1.24 ± 0.01 should be confirmed.

"Recommendation 3: The specification of a single wet lead solution, which would be suitable for all ICUMSA methods calling for this reagent, should be studied.

"Recommendation 8: Since, with some sugars, the use of 1 cm^3 of wet lead may produce solutions which are difficult to read, all aspects of clarification using wet lead should be further studied."



M. R. Player J. C. Baird

Experiments were carried out in CSR Limited's Central Laboratory in Sydney with a view to obtaining data which might help resolve the matters raised in the above recommendations. Specifically, wet lead solutions were prepared by three different methods at similar total lead concentrations but at two different basicities. The analysis of these solutions for total and basic lead was undertaken by the N.B.S. and Rens' methods. The relationship between the specific gravity of the solutions and total lead content was determined. Using these solutions, their equivalence or otherwise in the analysis of raw sugar for polarization was studied.

Preparation of wet lead solutions

Solutions of 1.24 S.G. with 36% and 40% basicity were prepared by three different methods, viz. (i) dissolution of Horne's dry lead of A.C.S. specification with adjustment of basicity using glacial acetic acid according to the official ICUMSA Subject 11 method, (ii) reaction of litharge and glacial acetic acid with adjustment of basicity using glacial acetic acid and (iii) dissolution of neutral lead acetate and litharge with adjustment of basicity with 1.24 S.G. neutral lead acetate solution according to the German Pharmacopoeia method[6]. In addition to the above solutions, two more solutions were prepared at 1.23 and 1.25 S.G. using Horne's dry lead to permit obtaining a relationship between specific gravity and total lead.

All solutions were adjusted to 1.24 S.G. and analysed by the Rens' method[7] for total and basic lead. The results of these analyses were used for the adjustment of basicities. Following adjustment as necessary, the specific gravities were redetermined and all solutions were analysed in duplicate for total lead and basic lead by the Rens' and N.B.S. method. The duplicate analyses are given in Table I.

Statistical examination of the data in Table I and reported in Table II shows that Rens' total lead and basic lead methods of analysis give exceptionally good agreement with N.B.S. methods in both precision and accuracy. The precision of the Rens' total lead analysis and both the Rens' and N.B.S. basic lead analyses was found to be limited by the readability of burettes used for titrations (±0.025 cm^3). The indicators used in these analyses have very sharp transitions and titrations could

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1 *I.S.J.*, 1977, **79**, 243-246, 279-283, 304-307.
2 *Analyst*, 1953, **48**, 334-339.
3 *I.S.J.*, 1958, **60**, 65-71.
4 *Proc. 13th Session ICUMSA*, 1962, 99.
5 *I.S.J.*, 1962, **64**, 75-77, 104-107.
6 Bates *et al.*: *Nat. Bureau Standards Circular*, 1942, (C440),121.
7 *Proc. 17th Session ICUMSA*, 1978, 39.

be repeated to 0.05 cm^3 end-points for a single set of standardized reagents.

Table I. Analyses of wet lead solutions

Solution No.	Specific gravity	Total lead (as PbO g/100cm^3) Rens' method		N.B.S. method		Basic lead as (PbO g/100cm^3) Rens' method		N.B.S. method		Method of preparation
1	1.2331	23.76	23.76	23.73	23.69	10.60	10.60	10.57	10.57	)
2	1.2511	25.59	25.59	25.61	25.51	11.58	11.58	11.58	11.58	)
3	1.2400	24.42	–	–	–	11.13	–	–	–	) Horne's
4	1.2407	24.53	–	–	–	11.07	–	–	–	) dry
5	1.2415	24.41	24.41	24.52	24.52	8.94	8.94	8.90	8.90	) lead
6	1.2404	24.46	24.46	24.40	24.42	9.78	9.78	9.68	9.68	)
7	1.2414	24.41	24.41	24.43	24.46	8.83	8.83	8.79	8.79	)
8	1.2394	24.37	–	–	–	10.03	–	–	–	) Litharge
9	1.2394	24.31	–	–	–	9.98	–	–	–	) + glacial
10	1.2381	24.24	24.24	24.18	24.22	9.16	9.16	9.23	9.23	) acetic
11	1.2389	24.29	24.29	24.27	24.33	9.94	9.94	9.90	9.79	) acid
12	1.2384	24.24	24.24	24.22	24.20	8.74	8.74	8.73	8.73	)
13	1.2436	24.70	–	–	–	10.36	–	–	–	) Litharge
14	1.2439	24.81	–	–	–	10.48	–	–	–	) + neutral
15	1.2423	24.63	24.69	24.74	24.70	9.14	9.14	9.23	9.23	) lead
16	1.2428	24.63	24.63	24.61	24.59	9.72	9.77	9.79	9.79	) acetate
17	1.2421	24.62	24.62	24.60	24.52	9.00	9.00	8.90	9.01	)

The authors believe the Rens' methods are a considerable improvement on the N.B.S. methods. They offer equivalent precision and accuracy for total lead analysis and superior precision for basic lead analysis. Rens' methods are also much less time-consuming.

Table II. Statistical analysis of wet lead preparation data

	Rens' method	*N.B.S. method*
Precision analysis		
Total lead		
Standard deviation σ	0.018	0.029
Repeatability $2\sqrt{2}\sigma$	0.051	0.082
Readability %	0.05	
Basic lead		
Standard deviation σ	0.015	0.044
Repeatability $2\sqrt{2}\sigma$	0.043	0.126
Readability %	0.05	0.11
Accuracy analysis		
Total lead		
Mean difference (Rens' – N.B.S.)	+0.007	
Standard deviation of difference	0.054	
Student's *t*-value	0.448	
Significance of difference	INSIG. at 99% level	
Basic lead		
Mean difference (Rens' – N.B.S.)	+0.015	
Standard deviation of difference	0.061	
Student's *t*-value	0.792	
Significance of difference	INSIG. at 99% level	

Table III. Effect of lead preparation on pol of Lucinda sugar

Basicity of wet lead (%)	Method of wet lead preparation: Horne's dry lead	Litharge + glacial acetic acid	Litharge + neutral lead acetate
36	97.668°S	97.681°S	97.668°S
40	97.625	97.619	97.598
36	98.530	98.532	98.530
40	98.507	98.509	98.512
36	99.520	99.555	99.538
40	99.558	99.550	99.559

Specification of total lead rather than specific gravity

The dissolved substance in a basic lead acetate solution may be generally expressed as $x\,Pb(CH_3COO)_2 . y\,PbO$ where x and y are chosen to give the appropriate basicity. Basicity is simply y/x+y, normally expressed as a percentage rather than a fraction. Generally, the specific gravity of basic lead acetate solutions of different basicities would not be exactly proportional to their total lead contents (expressed as PbO) but over the range of specific gravities and basicities we are interested in here (1.24 ± 0.01 S.G. and 37-45% basicity), any error introduced on this account will be small.

The linear regressions obtained for all the data in Table I but treating analysis by Rens' method separately from the N.B.S. method are as follows:

For Rens' method of lead analysis:

Total lead (as PbO) = $100.077\,S.G.^{20}_4 - 99.699\,g.cm^{-3}$

Correlation coefficient = 0.990

For NBS method of lead analysis:

Total lead (as PbO) = $102.396\,S.G.^{20}_4 - 102.590\,g.cm^{-3}$

Correlation coeffient = 0.993

for both regressions

$1.23 < S.G.^{20}_4 < 1.25$ 35% < Basicity < 46%.

These regressions agree well with the single result published by Rens[8] ($1.234\ \rho^{20}_4,\ 23.70$) and with historical data held in Central Laboratory pertaining to wet lead prepared routinely for sugar analyses conducted there.

Effect of the method of preparation of wet lead on pol value of raw sugar

While one would expect that wet lead solutions of equivalent specific gravity and basicity would behave in similar manner irrespective of the method by which they are prepared, the 17th Session of ICUMSA thought it prudent to have this matter explored in respect of Subject 11, *Polarization of raw sugars*[9]. To this end, the six solutions designated Nos. 6, 7, 11, 12, 16 and 17 were used to analyse raw sugar having pol values in the vicinity of 97.5, 98.5 and 99.5°S. These wet lead solutions were prepared by three different methods at a common specific gravity of 1.24 and with basicities of 36% and 40% in each case.

The raw sugar used for these tests was a single sample of raw sugar taken from Lucinda raw sugar terminal having a pol of around 97.5°S. In order to simulate sugars of 98.5 and 99.5°S pol, standard sucrose was added in such quantity to give these approximate polarizations. The polarization analyses using the various wet lead preparations were carried out according to the official ICUMSA method. The clarified filtrates were read on an Autopol II S automatic saccharimeter fitted with a 589 nm filter of 5 nm bandwidth.

A portion of the clarified filtrate was also used to measure the residual lead (as PbO) by atomic absorption spectroscopy and the optical attenuation (1000 x Absorbancy.cm^{-1}) at wavelengths of 420, 546, 589, 633, 720 and 900 nm.

All the above determinations were carried out in duplicate. The averaged results for pol, residual lead and optical attenuation appear in Tables III, IV and V, respectively.

Statistical analysis of the polarization data to assess any effect of method of lead preparation on polarimetry is given in Table VI. This analysis shows that the method of preparation has no significant effect on the pol values of this sugar at the pol levels studied. However the basicity of the wet lead has a highly significant effect on polarimetry at the 97.5 and 98.5°S level but an insignificant effect at the 99.5°S level.

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[8] *Proc. 16th Session ICUMSA*, 1974, 48.
[9] *Proc. 17th Session ICUMSA*, 1978, 146.

Table IV. Effect of lead preparation on residual lead in clarified sugar solution

Nominal sugar pol °S	Basicity of wet lead %	Method of wet lead preparation: Horne's dry lead	Litharge + glacial acetic acid	Litharge + neutral lead acetate
97.5	36	950 ppm*	960 ppm	970 ppm
97.5	40	840	835	885
98.5	36	1290	1350	1370
98.5	40	1275	1315	1320

* ppm = g/10^6 cm^3

Table V. Effect of lead preparation on optical attenuation of Lucinda sugar

Wave-length, nm	Basicity of wet lead, %	Method of wet lead preparation: Horne's dry lead	Litharge + glacial acetic acid	Litharge + neutral lead acetate
(a) *For nominal 97.5°S sugar*				
420	36	222*	217	203
	40	194	191	188
546	36	23	22	16
	40	16	17	20
589	36	16	15	11
	40	9	11	15
633	36	13	12	8
	40	7	8	13
720	36	7	7	5
	40	3	6	9
900	36	6	5	5
	40	2	6	9
(b) *For nominal 98.5°S sugar*				
420	36	121	123	134
	40	104	102	121
546	36	8	12	13
	40	9	5	13
589	36	5	6	10
	40	6	3	10
633	36	2	6	9
	40	5	2	8
720	36	1	2	6
	40	3	0	4
900	36	1	3	5
	40	3	0	4
(c) *For nominal 99.5°S sugar*				
420	36	223	207	205
	40	210	201	198
546	36	61	54	56
	40	54	51	49
589	36	50	42	42
	40	43	42	38
633	36	41	34	31
	40	35	31	29
720	36	30	25	30
	40	25	23	18
900	36	26	19	15
	40	19	17	11

* Units: 1000 x Absorbancy.cm^{-1}.

Table VI. Statistical analysis of effect of lead preparation on polarimetry

Nominal sugar pol, °S	Effect tested	F value	Degrees of freedom	$F_{0.05}$	Significance
97.5	Effect of preparation	1.676	V1 = 2 V2 = 2	19.00	INSIG
98.5		0.840	V1 = 2 V2 = 2	19.00	INSIG
99.5		0.410	V1 = 2 V2 = 2	19.00	INSIG
97.5	Effect of basicity	53.065	V1 = 1 V2 = 2	18.51	SIG
98.5		163.879	V1 = 1 V2 = 2	18.51	SIG
99.5		2.072	V1 = 1 V2 = 2	18.51	INSIG

Concerning the latter, it was observed during the clarification of these sugars that the precipitate formed by 36% basicity wet lead settled much quicker than that formed by the 40% basicity solution. To quantify this effect, two solutions of the 97.5°S sugar were simultaneously prepared according to the official polarization test method up to the filtration step using 36% and 40% basicity wet lead respectively. These solutions were poured simultaneously into 100 cm^3 measuring cylinders and the position of the interface between clear solution and precipitate was noted for a period of 1 hour. These settling rate data are shown in Figure 1.

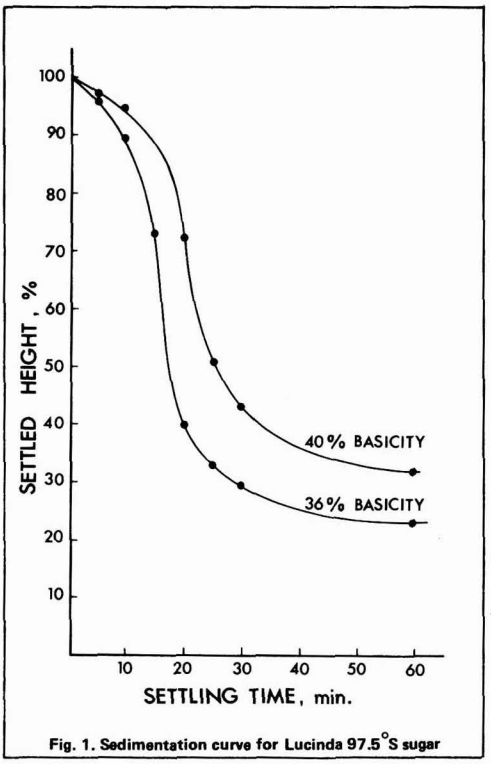

Fig. 1. Sedimentation curve for Lucinda 97.5°S sugar

Effect of basicity and volume of wet lead on the pol values of two Australian sugars

Having established that the method of preparation of wet lead solutions had no significant effect on pol test results but that the basicity had a significant effect when the standard 1.0 cm^3 of this reagent was used, further tests were carried out using different volumes of wet lead on two sugars, one of which was the Lucinda sugar used previously. A raw sugar sample of around 97.5°S pol from the Bundaberg terminal was selected for the second sugar to be tested. As before, samples of 98.5 and 99.5°S approximately were prepared by addition of standard sucrose.

The two wet lead solutions used for this phase of the work were those previously prepared using Horne's dry lead at 36 and 40% basicity (solutions 6 and 7 in Table I).

This part of the program called for polarization, residual lead, optical attenuation analyses similar to that described above but for wet lead additions of 0.5, 0.8, 1.0, 1.2, 1.5 and 2.0 cm^3 for 97.5 and 98.5°S sugars and additions of 0.3, 0.5, 0.8, 1.0, 1.2, 1.5 and 2.0 cm^3 for 99.5°S sugars. These tests were carried out on both the Lucinda and Bundaberg sugars at the two levels of wet lead basicity. The pol values obtained are shown in tabular form and graphically for Lucinda and Bundaberg sugars in Tables VII and VIII and Figures 2 and 3 respectively. It will be noted that there are no data for the 99.5°S Bundaberg sugar because time did not

permit the authors to complete this segment of the program.

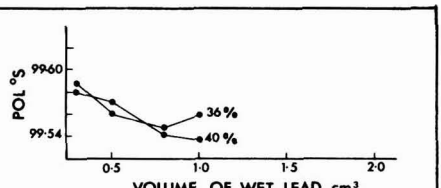

Fig. 2A. Effect of volume of wet lead and basicity on Lucinda sugars

Fig. 2B. Effect of volume of wet lead and basicity on Lucinda sugars

The residual lead and optical attenuation data corresponding to the above polarization data are shown in Tables IX and X and Figures 4 and 5 (residual lead) and Tables XI and XII (optical attenuation) for the Lucinda and Bundaberg sugars respectively.

Comment on effects of basicity and volume of wet lead

It is clear from examination of the foregoing data that the two sugars are affected in different ways by wet lead of different basicity. The extent of these effects depends on the pol of the sugar as well as its origin. One can speculate that

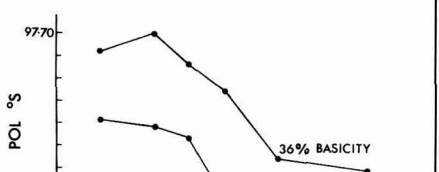

Fig. 2C. Effect of volume of wet lead and basicity on Lucinda sugars

if similar tests were carried out on a wide variety of sugars of different origins and pol levels an even greater variety of wet lead effects might be observed.

At this time the authors do not wish to interpret their data for underlying cause and effect. We think this is fraught with difficulty and would probably involve considerably more tests which time does not at present permit. At any rate, we make the following observations since, based on our data, they appear to be fairly conclusive.

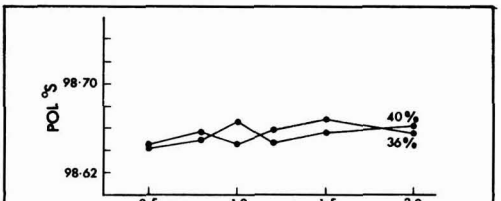

Fig. 3A. Effect of volume of wet lead and basicity on Bundaberg sugars

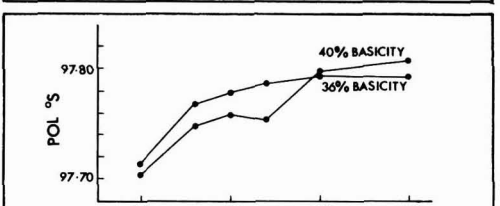

Fig. 3B. Effect of volume of wet lead and basicity on Bundaberg sugars

The effect of different basicities of wet lead is greater in the lower pol sugars than in the higher presumably because the mass of lead-precipitable material is greater

Table VII. Effect of volume of wet lead and basicity on pol of Lucinda sugars

Basicity %	Volume of wet lead used, cm³ 0.3	0.5	0.8	1.0	1.2	1.5	2.0
36		97.702	97.712	97.710	97.658	97.592	97.596
		*	*	97.694	97.652	97.628	97.587
		97.705	97.727	97.676	97.693	97.605	97.605
40		97.658	97.635	97.630	97.585	97.563	97.583
		97.624	97.636	97.622	97.556	97.546	97.570
36		98.603	98.558	98.543	98.514	98.487	98.493
		98.609	98.558	98.526	98.508	98.496	98.500
		98.616	–	–	–	–	–
40		98.550	98.537	98.523	98.511	98.531	98.513
		98.575	98.529	98.502	98.503	98.517	98.522
36	99.580	99.570	99.541	99.536	*	*	*
40	99.588	99.560	99.547	99.588	*	*	*

* gave turbid or cloudy solutions.

Table VIII. Effect of volume of wet lead and basicity on pol of Bundaberg sugars

Basicity %	Volume of wet lead used, cm³ 0.5	0.8	1.0	1.2	1.5	2.0
36	97.717	97.738	97.777	97.761	97.777	97.793
	*	97.776	97.782	97.820	97.814	97.802
	97.711	97.789	97.775	97.781	97.792	97.781
40	*	97.736	97.763	97.743	97.785	97.795
	97.702	97.750	–	97.771	97.815	97.829
	97.712	97.749	–	97.748	97.791	97.793
	97.697	97.756	97.755	–	–	–
36	98.632	98.654	98.644	98.669	98.665	98.659
	98.657	98.660	98.648	98.649	98.672	98.652
40	98.646	98.652	98.689	98.637	98.653	98.657
	98.639	98.648	98.638	98.656	98.660	98.666

* gave turbid or cloudy solutions.

in the former case. In the 97.5°S sugars, the 36% basicity wet lead solution gave higher pol values when the volume of wet lead used was in the 0.5 to 1.2 cm^3 range. From examination of Figures 2 and 3 the effect of basicity on pol at the 98.5 and 99.5°S levels appears quite confused, despite the initial finding of there being a highly significant statistical relationship between basicity and pol when the Lucinda sugar was analysed using only 1.0 cm^3 of wet lead (Table VI above).

The curves showing residual lead in solutions suggest that beyond the amount of lead needed to effect clarifi-

Table IX. Effect of volume of wet lead and basicity on residual lead of clarified Lucinda sugar solutions

Basicity %	Volume of wet lead used, cm^3 0.5	0.8	1.0	1.2	1.5	2.0
(a) *For nominal 97.5°S sugar*						
36	260	630	970	1300	1860	2830
40	287	570	903	1213	1793	2695
(b) *For nominal 98.5°S sugar*						
36	460	920	1280	2140	2840	4200
40	320	760	1260	2000	2660	4040

Note: Units of residual lead are ppm. or $g/10^6$ cm^3.

Table X. Effect of volume of wet lead and basicity on residual lead of clarified Bundaberg sugar solutions

Basicity %	Volume of wet lead used, cm^3 0.5	0.8	1.0	1.2	1.5	2.0
(a) *For nominal 97.5°S sugar*						
36	460	815	1185	1550	2200	3120
40	440	735	1080	1410	2040	2910
(b) *For nominal 98.5°S sugar*						
36	470	1050	1380	1780	2370	3310
40	440	960	1480	1670	2250	3250

Note: Units of residual lead are ppm or $g/10^6$ cm^3.

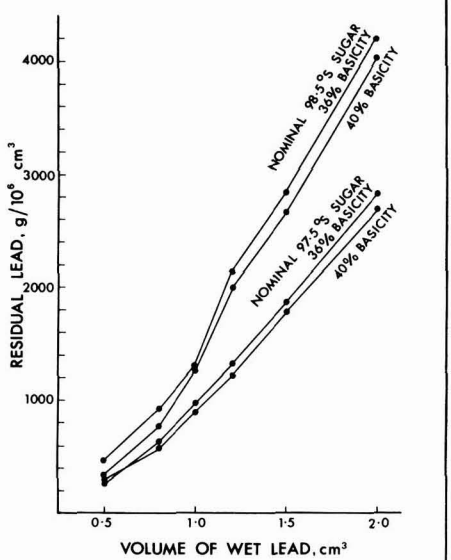

Fig. 4. Effect of volume of wet lead and basicity on residual lead of clarified Lucinda sugar solutions

cation, nearly all the additional lead goes into solution. It is interesting that there is more residual lead when 36% basicity wet lead is used rather than 40%, irrespective of the pol or origin of the sugar.

It was clear that beyond a certain volume of wet lead the solution clarity did not improve further, nor was colour further reduced. In the case of the 99.5°S Lucinda sugar, 1.0 cm^3 of wet lead was too much for good clarification. The best volume from the point of view of solution clarity and colour would be 0.5 cm^3.

The authors feel that in the light of pol differences of up to 0.06°S found for the Lucinda 97.5°S sugar when using 1 cm^3 of 36 and 40% basicity wet lead, there may be a case for tightening the specification of the preparation of wet lead solutions for the official polarization test method. The present specification of 1.24 ± 0.01 S.G. and a basic lead content of between 9.5 and 10.5 g per 100 cm^3 gives a possible range of basicities of 37 to 45%. The use of wet lead at the extremities of this range could give rise to significant differences in analysis of lower pol raw sugars.

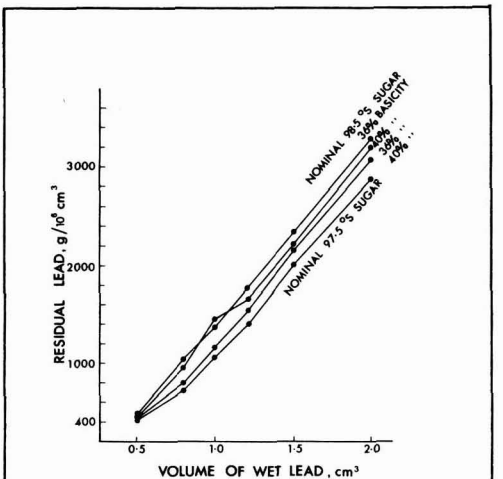

Fig. 5. Effect of volume of wet lead and basicity on residual lead of clarified Bundaberg sugar solutions

Conclusions

The authors feel that the present work demonstrates fairly conclusively the equivalence of wet lead solutions prepared by three different methods for the purpose of raw sugar pol determination.

The relationship between S.G. and total lead content is closely enough established that the present specific gravity specification of 1.24 ± 0.01 could be replaced by a total lead specification of 24.4 ± 1.0 g per 100 cm^3.

Since there are observable differences in the results obtained using 36 and 40% basicity wet lead, more work seems called for to establish the most appropriate basicity to be used for polarization measurement. Since it has been found for other ICUMSA methods that the higher basicity (40%) is too high, every effort should be directed towards seeking a satisfactory result with lower basicity solutions (36%).

Acknowledgement

The authors wish to express their thanks to CSR Limited for the opportunity to publish this work.

Summary

Wet lead solutions for clarification of raw sugar before pol determination were made up by three methods to similar total lead contents but different basicities (36% and 40%). Analysis by the method of Rens proved superior to the N.B.S. method, being quicker while of equivalent or better precision and accuracy. Total lead could be specified by concentration rather than specific gravity. The solutions prepared by the three methods were equivalent but the basicity influenced the results obtained, and work is required on the use of the lower basicity.

Table XI. Effect of volume of wet lead and basicity on optical attenuation of Lucinda sugars (average values)

Wave-length, nm	Basicity of wet lead %	Volume of wet lead used, cm^3 0.3	0.5	0.8	1.0	1.2	1.5	2.0
(a) *For nominal 97.5° sugar*								
420	36		314*	200	193	193	151	143
	40		402	195	179	152	134	130
546	36		27	12	14	16	12	11
	40		69	13	10	10	7	6
589	36		18	6	9	10	8	9
	40		51	8	5	6	3	4
633	36		11	3	6	6	6	5
	40		39	5	3	4	2	2
720	36		4	0	3	3	4	3
	40		26	2	0	2	0	1
900	36		3	0	3	2	4	2
	40		22	3	0	2	1	1
(b) *For nominal 98.5°S sugar*								
420	36		145	133	125	117	127	129
	40		157	123	117	103	106	121
546	36		9	8	7	7	11	10
	40		31	6	6	5	7	16
589	36		5	6	4	4	7	5
	40		20	5	4	3	4	7
633	36		3	3	2	3	6	4
	40		17	2	2	2	2	5
720	36		0	2	2	1	4	2
	40		15	1	3	1	0	4
900	36		1	2	2	0	3	1
	40		12	0	2	0	1	3
(c) *For nominal 99.5°S sugar*								
420	36	81	72	98	213			
	40	78	71	92	201			
546	36	6	4	15	59			
	40	5	3	10	49			
589	36	5	3	10	48			
	40	5	3	7	42			
633	36	4	3	8	38			
	40	3	3	8	32			
720	36	2	1	8	23			
	40	2	0	5	21			
900	36	1	0	7	21			
	40	2	0	3	18			

* Units: 1000 x Absorbancy.cm^{-1}.

Table XII. Effect of volume of wet lead and basicity on optical attenuation of Bundaberg sugars (average values)

Wave-length, nm	Basicity of wet lead %	Volume of wet lead used, cm^3 0.5	0.8	1.0	1.2	1.5	2.0
(a) *For nominal 97.5° sugar*							
420	36	287*	200	160	142	134	125
	40	305	181	146	130	125	111
546	36	20	24	11	8	15	15
	40	28	15	10	8	10	10
589	36	9	16	6	4	10	11
	40	15	9	6	4	7	7
633	36	4	13	4	1	8	7
	40	10	7	4	2	5	4
720	36	2	6	2	0	5	4
	40	4	4	2	0	2	2
900	36	1	6	0	0	4	4
	40	4	3	2	1	2	1
(b) *For nominal 98.5° sugar*							
420	36	136	103	87	96	95	95
	40	126	98	92	90	90	91
546	36	10	6	5	8	5	8
	40	8	6	5	6	5	6
589	36	5	3	3	6	2	6
	40	3	4	3	3	4	3
633	36	2	0	0	5	0	4
	40	0	2	0	2	3	0
720	36	0	0	0	3	0	3
	40	0	0	0	1	2	1
900	36	1	0	0	2	0	2
	40	0	1	0	0	1	0

* Units: 1000 x Absorbancy.cm^{-1}.

L'effet de la basicité de la solution de sous-acétate de plomb sur la polarimétrie du sucre brut

Des solutions de sous-acétate de plomb utilisées pour la défécation avant détermination de la polarisation ont été préparées par trois méthodes de façon à obtenir une même teneur totale en plomb mais des basicités différentes (36% et 40%). L'analyse par la méthode de Rens se révèle supérieure à la méthode N.B.S., vu qu'elle est plus rapide tout en étant d'une précision et d'une exactitude équivalentes ou meilleures. Le plomb total a pu être spécifié par la concentration plutôt que par le poids spécifique. Les solutions préparées par les trois méthodes étaient équivalentes, mais la basicité influença les résultats obtenus et il y a lieu de poursuivre les travaux sur l'emploi de la basicité la plus faible.

Der Einfluß der Alkalität von basischer Bleiacetatlösung auf die Polarimetrie von Rohzucker

Basische Bleiacetatlösungen für die Klärung von Rohzucker vor der polarimetrischen Bestimmungen wurden nach drei Methoden mit gleichem Gesamtbleigehalt aber unterschiedlicher Alkalität (36% und 40%) hergestellt. Die Analyse nach der Methode von Rens war der nach der N.B.S.-Methode überlegen, da sie schneller und dabei von gleicher oder besserer Präzision und Genauigkeit ist. Das Gesamt-Blei konnte eher durch Messung der Konzentration als der Dichte ermittelt werden. Die nach den drei Methoden hergestellten Lösungen waren äquivalent, aber die Alkalität beeinflußte die erhaltenen Resultate, und Untersuchungen über die Anwendung der niedrigen Alkalität sind notwendig.

El efecto de basicidad de sub-acetato de plomo en solución sobre la polarimetría de azúcar crudo

Soluciones de sub-acetato de plomo para clarificación de azúcar crudo antes de la determinación de pol se han preparado por tres métodos, con contenidos parecidos de plomo total pero diferentes basicidades (36% y 40%). Análisis por el método de Rens ha resultado superior al método del N.B.S., siendo más rápido mientras de precisión y correctitud equivalente o mejor. Plomo total puede especificarse en términos de concentración en lugar de densidad relativa. Las soluciones preparado por los tres métodos fueron equivalente pero la basicidad tuvo influencia sobre las resultas obtenido y trabajo se requiere sobre el uso de la basicidad menor.

Benin sugar project[1]. — Financing arrangements have been completed and a contract made whereby ABR Engineering is to carry out agricultural and industrial works for Société Sucrière de Save in Benin. The agricultural part consists of developing an infrastructure and irrigation for cane cultivation on an area of 5600 ha. It includes the construction of a dam, roads and rail track, sidings, land clearing and preparation, a drainage system, construction of administration buildings, warehouses and garages, houses, water supply and rolling stock. The industrial part consists of delivering a sugar factory and refinery on a turn-key basis capable of crushing 3750 t.c.d. with an annual production capacity of 40,000 tonnes of white sugar.

[1] *World Sugar J.*, 1980, **3**, (1), 29.

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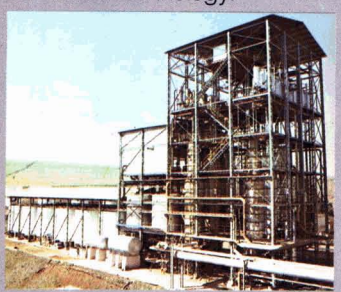

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Spray nozzle and pond performance

Mathematical measures of spray nozzle and pond performance including the effects of subsequent system elements

By L.A. BALZER, B.E., B.Sc. (NSW), Ph.D.(Cantab), AFAIM*
and
M.J. WILSON, B.E. (NSW)†

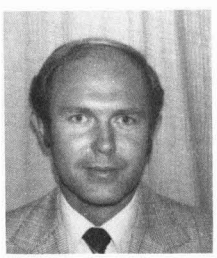
Introduction

Environmental and other considerations usually dictate that modern sugar mills use closed-cycle cooling systems. The two heat-dissipating subsystems most commonly encountered in Australia and certain other countries are spray ponds and cooling towers. The choice between these two is usually not straightfoward and involves local topography, site layout, prevailing winds, land availability, relative construction and operating costs, existing equipment, etc. Each decision involves individual consideration rather than adherence to predetermined policy. This paper is not concerned with the relative merits of cooling ponds and towers.

Our concern is with measuring the performance of spray pond cooling systems and their nozzles. Furthermore explicit consideration of the effects of the significant subsequent elements in the cooling system, namely the steam condensers, are included in the mathematical measures of performance. A performance measure, no matter how technically satisfying, is not really useful for managerial decision making without some account being taken of the associated costs. An attempt to include such considerations and to take account of the different value of money spent on capital costs and on operating costs is made.

In essence, a spray pond usually consists of a rectangular or other suitably shaped area surrounded by fairly low earth embankments which retain the cooling water reservoir. Hot water is pumped to the pond, in many cases over several hundred metres from the mill buildings, with consequent non-trivial head losses and power consumption. The hot water is distributed to rows of risers or standpipes, on which individual spray nozzles are mounted. The droplets of water spray up and out and then fall to the pond surface having undergone evaporative cooling during their flight. Water is drawn from the bottom of the pond and pumped to the mill for use as a coolant.

Most of the cooling water supplied to the mill is used to condense steam from the evaporators and vacuum pans. This dominant use is central to the more advanced measures of performance developed later.



L. A. Balzer

M. J. Wilson

Nomenclature

A	Pond area
C	Cooling capacity, i.e. heat removal per unit time
c	Specific heat of water
d	Diameter of spray pattern at pond surface
E	Efficiency ratio, defined in equation (3)
f	Injection water factor, refer equation (9)
H	Hugot's ratio (mass flow rate per unit area)
m	Mass flow rate
n	Number of nozzles
r	Radius of spray droplet
S	Equivalent steam condensing capacity per unit time
SVR	Surface area to volume ratio for droplets
T_h	Temperature of hot water to nozzle
T_i	Temperature of injection water to condensers
T_p	Temperature at pond outlet
T_s	Temperature of spray droplets at pond surface
T_w	Atmospheric wet bulb temperature
W	Mass of injection water per unit mass of steam condensed
W_o	Value of W under typical operating conditions
Δ	Change in variable following it
η	Cooling efficiency, refer equation (2)
η_{ref}	Cooling efficiency for reference nozzle
∂	Partial derivative
$\propto$	Is proportional to
$\hat{}$	Predicted value of variable concerned

SIMPLE MEASURES OF PERFORMANCE

The cooling mechanism in operation in a spray system is evaporation. Evaporation occurs when water molecules of higher than average kinetic energy escape the water/air interface. The mean molecular kinetic energy of the liquid is reduced which manifests itself as a reduction in the bulk temperature of the liquid. Significant evaporative cooling occurs only while each droplet is in free flight from nozzle to pond surface.

During the period of free flight there are a number of factors which restrict the amount of cooling obtained. One of the major factors is the total area of water/air interface available for phase transfer by evaporation. As the stream of water leaves the nozzle it breaks into a sequence of discrete droplets. To a first order of approximation, the droplets are spherical and hence their surface area to volume ratio (SVR) is

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$$SVR = \frac{\text{Surface area of droplet}}{\text{Volume of droplet}} = \frac{4\pi r^2}{4\pi r^3/3} = \frac{3}{r}$$

$$\propto \frac{1}{r} \qquad (1)$$

To maximize cooling, the *SVR* should be maximized which corresponds to minimizing the radius (r) of the droplet. Hence smaller droplets provide better cooling than larger ones. They are also the ones which are carried further by wind forces, possibly a significant point if the prevailing wind direction combines unfavourably with the location of nearby roads or housing. Experimental results are discussed in the next section.

Another significant factor is the total flight time for each droplet. Clearly this is affected in a non-linear manner by the elevation of the nozzle above the pond surface. Flight time will also vary with nozzle exit velocity which can be controlled by varying the supply pressure.

Irrespective of the preceding factors, there is a theoretical limit to the amount of cooling which can be obtained using an evaporative process. The lowest temperature which can be obtained in the droplet is the wet bulb temperature (T_W) of the surrounding air. Hence a cooling efficiency (η) can be defined as the actual temperature reduction divided by the theoretical limit:

$$\eta = \frac{T_h - T_s}{T_h - T_W} \qquad (2)$$

Whilst the cooling efficiency is a theoretically sound measure of performance it is affected by many factors. Although it might be theoretically possible to isolate and even measure all of the factors affecting η, it may not be simple to correct for them from one experimental trial to the next (sometimes a year apart). An experimentally convenient method is to compare the performance of the test nozzle with that of a standard reference nozzle exposed to the same general conditions. An efficiency ratio (E), defined as

$$E = \frac{\eta}{\eta_{\text{ref}}} \qquad (3)$$

can then be used to remove the effects of unquantified variables. Experimentally, this measure proved satisfactory.

EXPERIMENTAL RESULTS – I

There are many factors and parameters which the investigator with no budgetary and temporal constraints would wish to investigate. However the practicalities of commercial and seasonal operations are ever-present and limited these nozzle and pond trials. Logistic problems caused the complete set of trials to be spread over several years, while structural reorganization necessitated changes in personnel. The results from the early trials are severely restricted and analysed only by the preceding simple measures. They do however reveal interesting information.

The aim of the trials was to see if the cooling performance of the standard nozzles in use at the time could be improved by changing the nozzle elevation or supply pressure or by simple machining operations on the body and/or the agitator of the nozzle.

Nozzle elevation

Figure 1 shows the effect of nozzle elevation on efficiency ratio under two supply pressure conditions, namely restricted to 8.5 psi at the nozzle and unrestricted (average 17 psi). The standard reference nozzle was kept at 6.5 ft elevation and supplied at 8.5 psi. Perhaps surprisingly, increasing nozzle elevation to 9 ft produced no measurable gain in the case of 8.5 psi supply and a drop in performance for the unrestricted case. The additional elevation increased the total free flight distance for an average droplet by an estimated 20%. Apparently most of the mass transfer by evaporation occurs earlier in the flight than this and increasing its "tail" gains little. In the case of unrestricted flow, the increased static and dynamic head losses decreased supply pressure at the nozzle and hence the exit velocity. The peak of the parabolic droplet trajectory appeared lower, thus detracting from the flight time. Droplet size was apparently larger with a reduced *SVR*. The overall effect was a reduction in performance.

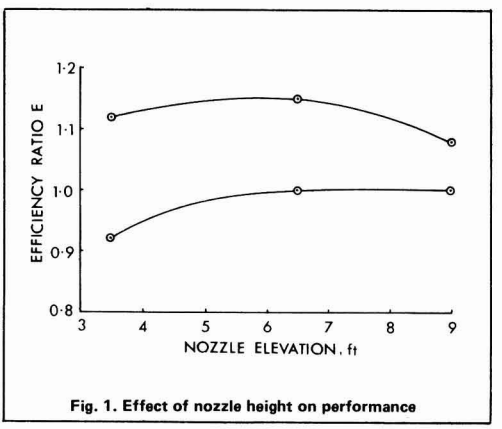

Fig. 1. Effect of nozzle height on performance

Decreasing nozzle elevation lowered performance. In the unrestricted case, the decrease was partially compensated by the consequent increase in pressure at the nozzle. This led to a higher exit velocity (higher parabolic peak relative to nozzle head) and finer droplets (higher *SVR*).

For the most realistic case (i.e. unrestricted nozzle pressure), a definite optimal nozzle elevation existed.

Nozzle pressure

Experimental difficulties were encountered and the only data in which any confidence is held are shown in Figure 2. The nozzle used was standard except for a skimmed agitator (see later). Performance increased with nozzle pressure but the gain beyond 15-20 psi hardly appears worthwhile when the increased head losses and higher pumping costs are considered.

Nozzle modifications

Further brief trials were carried out to determine whether simple machining operations on the nozzles could improve their performance. The cast nozzle bodies were firstly smoothed internally by boring and secondly by conically machining the tapered section. Three simple agitator modifications were also tried. The results, measured subjectively by estimated *SVR* of the droplets, are shown in Table I.

Table I — Effect of simple nozzle modifications

Estimated Droplet *SVR*		Bodies Standard	"Bored"	"Conical"
Agitators	Standard	L-M*	M	H
	"Straight"	L-M	M	M
	"Skimmed"	M	H	H
	"Chamfered"	—	M-H	L

*L — Low M — Medium H — High

The results clearly showed that significant improvements could be achieved by simple modifications to the nozzle itself. This information was used to design special nozzles for later trials.

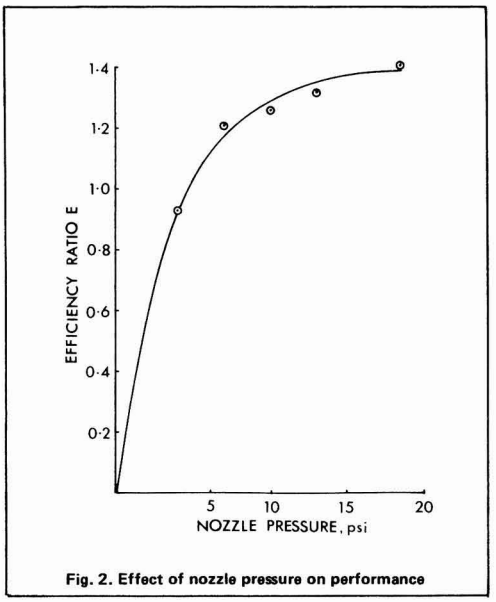

Fig. 2. Effect of nozzle pressure on performance

IMPROVED MEASURES OF PERFORMANCE

Pond area and nozzle flow rate considerations

The simple measures of performance used thus far have given no indication of the area of pond required for any particular nozzle choice nor how this is traded-off against cooling efficiency. Pond area influences many aspects, each of which has a cost associated with it; for example land acquisition or availability, earthworks, piping runs, concrete plinths, maintenance activities, etc. Furthermore no account has been taken of the flow rate possible with each nozzle and hence the number of nozzles required.

Consider a total mass flow rate (m) of hot water to a cooling pond fitted with n nozzles. If the nozzles are arranged in rows so that the edges of adjacent spray patterns just meet, then the effective pond area required for each nozzle is d^2, where d is the diameter of the spray pattern at water level. The mass flow rate per unit pond area for each nozzle is thus given by H (Hugot's ratio):

$$H = \frac{m/n}{d^2} \tag{4}$$

Experimental results can then be analysed by plotting H against efficiency ratio E. Gains in one measure won at the expense of losses in the other are apparent. Whilst H indicates the flow rate per unit area, it is not an entirely satisfactory method of taking area requirements into account.

The purpose of a spray pond system is cooling, but increased cooling capacity at the expense of increased pond area can be costly. Similarly, increased cooling at the expense of increased flow rate is also expensive in terms of both capital and running costs for larger pumps, turbine drives, larger diameter piping, etc. Two measures of cooling performance are clearly relevant; first, the cooling capacity per unit pond area (C/A) and, second, the cooling capacity per unit mass flow rate (C/m). Such measures are now derived.

The total cooling capacity (i.e. heat removal per unit time) C is given by:

$$\begin{aligned} C &= m\,c\,(T_h - T_s) \\ &= m\,c\,\eta\,(T_h - T_w) \\ &= m\,c\,E\,\eta_{ref}\,(T_h - T_w) \end{aligned} \tag{5}$$

Under conditions of constant hot water and atmospheric wet bulb temperatures, the quantities c, η_{ref}, T_h and T_w are constant. Hence, under these conditions

$$\frac{C}{m} \propto E \tag{6}$$

The cooling capacity per unit flow rate is simply proportional to the efficiency ratio.

The total area (A) of the pond is nd^2, hence from equation (4)

$$m = HA$$

Substituting this into equation (6) gives

$$\frac{C}{A} \propto HE \tag{7}$$

The cooling capacity per unit area of pond is proportional to the product of Hugot's ratio and the efficiency factor.

By plotting the experimental results for individual nozzles on a graph of C/A versus C/m, the trade-offs between pond area and mass flow rate are readily apparent. The relative importance of each measure will clearly vary from case to case.

Equivalent steam condensing capacity

In a typical cane sugar mill, most of the cooled water from the spray pond is used to condense steam from the evaporators and from the vacuum pans. The amount of this injection water required to condense one mass unit of steam depends on both the vacuum in the condenser and on the temperature of the injection water. No account of this latter point has been taken so far. In fact, the previous analysis has implicitly assumed that a 20° reduction in water temperature from 50° to 30°C was as valuable as one from 45° to 25°C. For a cane sugar mill this is not true and a more advanced measure of performance should take this into account. The equivalent steam condensing capacity of the spray system per unit of pond area (S/A) and per unit of mass flow rate (S/m) are now developed.

For a constant vacuum in the condensers, the steam condensing capacity (S) is

$$S \propto fC \tag{8}$$

where f is a factor which takes account of the injection water requirements as they vary with the temperature of that water. If W_O is the amount of injection water required per unit mass of steam under average operating conditions and ΔW is the change for a different condition, then

$$f = \frac{W_O}{W} = \frac{1}{1 + (\Delta W/W_O)} \tag{9}$$

Substituting equations (7) and (9) into (8), the steam condensing capacity per unit area of pond is

$$\frac{S}{A} \propto HEf \tag{10}$$

It would be convenient if f could be expressed in terms of η or E. The development of such an expression follows.

Typical conditions in the condensers might require

$W_O = 57$ units of injection water/unit mass steam

Also for a range approximately $\pm 3°C$ about the average injection water temperature (T_i), the amount of injection water (W) required per unit mass of steam can be approximated by a linear expression such as

$$W = 2.60\, T_i - 162$$

Hence for constant vacuum

$$\Delta W = 2.60\, \Delta T_i$$

and equation (9) becomes

$$f = \frac{1}{1 + \dfrac{2.60\, \Delta T_i}{57}} = \frac{1}{1 + 0.0456\, \Delta T_i} \tag{11}$$

It would seem reasonable to assume that any small changes (ΔT_P) in pond outlet temperature would result in an equal change in injection water temperature. That is

$$\Delta T_P = \Delta T_i$$

and hence equation (11) becomes

$$f = \frac{1}{1 + 0.0456\, \Delta T_P} \tag{12}$$

At this stage it is necessary to introduce some results from the next set of experimental trials. A strong correlation between pond outlet temperature and spray temperature was found and linear regression produced the following relationship

$$T_P = 0.456\, T_S + 84.2$$

The mean error was 1% with a standard deviation of 0.6%. Hence

$$f \approx \frac{1}{1 + 0.0208\, \Delta T_S} \tag{13}$$

The remaining step is to relate ΔT_S to a change in cooling efficiency. From equation (2)

$$T_S = (1-\eta)\, T_h + \eta T_w$$

$$\frac{\partial T_S}{\partial \eta} = T_w - T_h$$

During the trials the average value of $T_w - T_h$ was $-42.7°C$ with a standard deviation of $1.4°C$. For present purposes

$$\frac{\partial T_S}{\partial \eta} = -42.7$$

and under constant hot water and atmospheric wet bulb conditions

$$\Delta T_S \approx \frac{\partial T_S}{\partial \eta}\, \Delta \eta = -42.7\, \Delta \eta$$

Substituting this in equation (13) leads to

$$f \approx \frac{1}{1 + 0.0208\, (-42.7\, \Delta \eta)} = \frac{1}{1 - 0.93\, \Delta \eta}$$

Alternatively, in terms of the efficiency factor E, we can proceed as follows

$$\eta = E\eta_{\text{ref}}$$

During the experimental trials the average value of η_{ref} was 0.732, hence

$$\Delta \eta \approx 0.732\, \Delta E$$

and

$$f \approx \frac{1}{1 - 0.932 \times 0.732\, \Delta E} = \frac{1}{1 - 0.68\, \Delta E} \tag{14}$$

Combining equations (10) and (14) gives the following approximate relationship

$$\frac{S}{A} \propto \frac{HE}{1 - 0.68\, \Delta E} \tag{15}$$

Equation (15) (or its counterpart derived for different conditions) is very useful since it allows us to determine the equivalent steam condensing capacity per unit pond area of the nozzle(s) under test.

The equivalent steam condensing capacity per unit mass flow rate is given by

$$\frac{S}{m} \propto \frac{E}{1 - 0.68\, \Delta E} \tag{16}$$

It should be noted that the equivalent steam condensing capacity measures appearing in equations (15) and (16) are much more sensitive to changes in efficiency ratio E than the simpler cooling capacity measures in equations (6) and (7). The denominator factor $1 - 0.68\, \Delta E$ causes amplification of any change. For example, a 10% increase in E (or η) leads to an 18% increase in S/A and S/m, while a 20% increase in E is amplified to a 39% change. The importance of taking subsequent cooling system components into account when measuring the performance of spray nozzles is clearly evident. Apparently minor gains or losses in cooling capacity at the spray pond are magnified at the condensers.

Cost considerations

Consider the construction and operation of a new spray pond. Many of the variable costs can be related approximately but adequately to pond area or to mass flow rate. The mixture of capital and recurrent costs can be handled by either capitalizing the recurrent costs at some appropriate rate or by replacing the capital costs with their recurrent opportunity cost (i.e. the profit lost by not having the capital working elsewhere in the organization). In either case, once the appropriate costs

have been divided between area and flow rate, it is a simple matter to draw curves of constant cost on a graph of S/A versus S/m. The minimum cost solution is readily discernible. The results can be most interesting and can lead to improved decision making by including technical and economic criteria on one simple graph.

EXPERIMENTAL RESULTS – II

Nozzle tests

A number of commercially available nozzles, with and without modifications, and a number of special nozzles were tested. The results, analysed in terms of their equivalent steam condensing capacity, are shown in Figure 3.

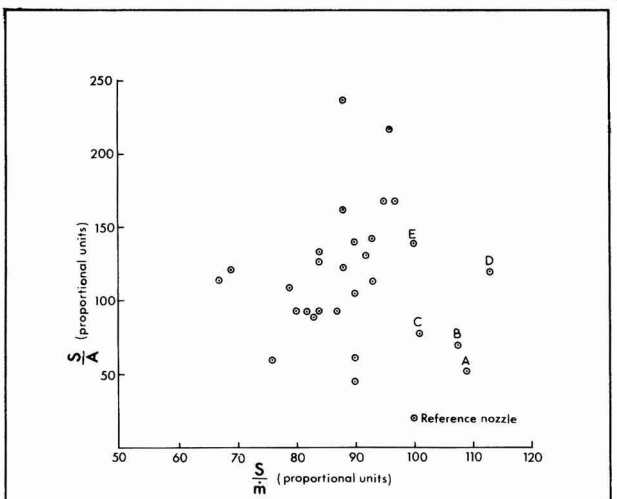

Fig. 3. Equivalent steam condenser capacity of nozzles tested

All of the nozzles tested performed better than the reference nozzle in terms of equivalent steam condensing capacity per unit pond area, none by less than 100% and one by almost 1200%. On the other hand, a much smaller number achieved improved performance in terms of steam condensing capacity per unit mass flow rate the maximum improvement being 13%. The results for the five nozzles which did so are shown in Table II.

Table II. Performance of selected nozzles

Nozzle	Improvement over standard nozzle		Number to replace 10 standard nozzles
	S/A	*S/m*	
A	160%	9%	4.2
B	250	8	2.9
C	285	1	2.6
D	495	13	1.9
E	600	0	1.3

In the case of upgrading an existing system, the cost of replacing the existing injection water pump and its drive (often a steam turbine) is very high. When the pump is already operating at its limit, the S/m measure of performance is of greatest interest. In one such situation nozzle "D" has been used to advantage.

Table III. Features of sections of spray pond

Section	Nozzle type	Nozzle spacing	Row orientation*
Old	Standard	0.28 d	45°
Modified Old	"C"	0.75 d	45°
New	"C"	1.00 d	Aligned

* Relative to prevailing wind direction

Pattern and spacing of nozzles in a pond

Over a period of time, three distinct sections had developed in the spray pond in which these trials were carried out. The differences related to nozzle type, nozzle spacing and orientation of the rows as summarized in Table III. The nozzle spacings for the "Old", "Modified Old" and "New" sections of the pond imply considerable, moderate and no overlap of adjacent spray patterns for the respective sections.

Over a one-week period the spray cooling efficiencies on the windward and leeward sides of each section of the pond were measured a number of times. Their mean values are shown in Table IV. In each case, the transition from "Old" to "Modified Old" to "New" corresponds to an increase in cooling efficiency (η). On the windward side the jump from Old to Modified Old is large, while that from Modified Old to New is small. On the leeward side, both improvements are large. The drop in cooling efficiency across the pond is quite large for the Old section, still fairly large for the Modified Old and relatively small for the New section. Had nozzle D been used in place of C, the results would probably have been even better. The effects of nozzle spacing and alignment of rows with the prevailing wind are obviously important.

Table IV. Spray cooling efficiencies in each section

Side	Old	Modified Old	New
Windward	66.7%	75.0%	76.5%
Leeward	51.3	64.4	72.6

Due account of area, mass flow rate and equivalent steam condensing capacity can be taken by considering S/A and S/m as shown in Figure 4. The equivalent steam condensing capacity per unit flow rate is improved dramatically. On the windward side the increase from Old to New is 27% while that on the leeward side is 75%. The drop in performance across the pond is reduced significantly. However these gains have not been won without a loss in performance per unit pond area. In this particular situation the economic gains from improved S/m performance far outweighed the losses from reduced S/A values. On the basis of Table II, it appears that the use of nozzle D (which was developed later) would push the S/A figures for the new section into the 155-170 range while improving S/m even further. If the original nozzles had been used in the new

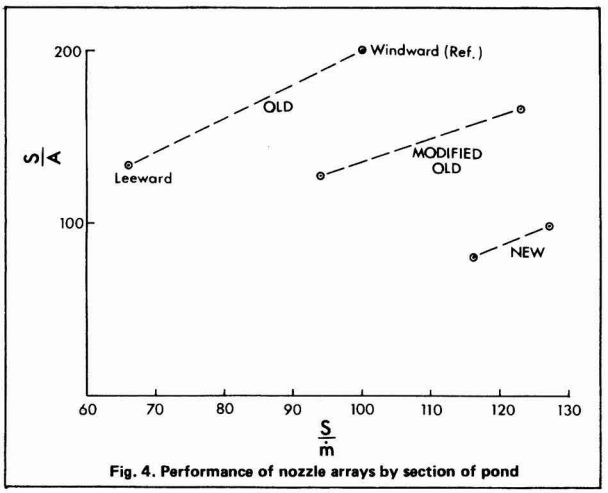

Fig. 4. Performance of nozzle arrays by section of pond

section, the loss in overall *S/A* would have been prohibitively expensive in terms of pond area required.

Pond outlet temperature

There are many variables which influence the pond outlet temperature (T_p). Four readily available variables, viz. temperature of the hot water (T_h), atmospheric wet (T_w) and dry bulb temperatures and time of day were analysed. Only hot water and wet bulb temperatures were found to have any statistically significant effect.

It is obvious that the system is dynamic, since a step change in either T_w or T_h will produce only a slow response in T_p (of approximately second order overdamped nature). There will not be an instantaneous step change in T_p as would be predicted by a static (algebraic) model. To model the dynamic behaviour, either a differential or difference equation is required. A suitable discrete time difference equation model is

$$\begin{aligned}\hat{T}_p(k) = {} & a_1\hat{T}_p(k\text{-}1) + \ldots + a_n\hat{T}_p(k\text{-}n) \\ & + b_0T_w(k) + \ldots + b_mT_w(k\text{-}m) \\ & + c_0T_h(k) + \ldots + c_\ell T_h(k\text{-}\ell) \\ & + \text{constant}, \ell, m < n \end{aligned} \quad (17)$$

where k,k-1, etc. refer to the kth, (k-1) th, etc. equally spaced sampling instants in time and the "hat" symbol denotes the predicted values of T_p. Time did not permit the development of such a dynamical model.

By restricting attention to the case when $a_i = b_i = c_i = 0$ for $i \neq 0$, the following static model was calculated by linear regression:

$$\hat{T}_p = 0.243\,T_w + 0.219\,T_h - 1.48 \quad (18)$$

where the temperatures are measured in degrees Centigrade. Perhaps surprisingly for such a simplistic model, the mean error over one week, excluding a twelve-hour period of intermittent rain, was 0.4°C with a standard deviation of 0.3°C. During this week the wet bulb temperature ranged from 17 to 25°C and the hot water temperature from 43 to 47°C.

Pond stratification

Water temperature in the pond did not appear to change significantly with depth. The variation between the surface and depths as great as eight feet was consistently less than 0.5°C while the mill was operating.

CONCLUSIONS

The performance of both spray nozzles and ponds can be improved significantly with moderate expenditure. Simple measures of performance lead to simple results; however, more advanced measures of performance are just as simple to use. These latter measures which take account of subsequent elements in the overall cooling system are both more sensitive and more satisfactory. The inclusion of economic data in the manner indicated in the paper is relatively simple and should lead to better decisions.

ACKNOWLEDGEMENT

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Summary

Several measures of spray nozzle and pond performance are developed. The more advanced measures take account of the effect of subsequent system elements, namely the steam condensers, on overall performance. Pond area and mass flow rate requirements are included, and a method of including capital and running cost data is discussed. The results of a number of experimental trials indicate that the equivalent steam condensing capacity of isolated nozzles and arrays of nozzles can be improved significantly by relatively simple modifications.

Mesures mathématiques de la performance des pulvérisateurs et du bassin, comprenant les effets des éléments subséquents du système

Plusieurs mesures de la performance des pulvérisateurs et du bassin sont exposées. Les mesures les plus avancées tiennent compte de l'effet des éléments subséquents du système, notamment les condenseurs de vapeur, sur la performance totale. Les besoins en surface de bassin et en débit de masse y sont inclus, tandis qu'une méthode d'introduction des données concernant les coûts de capital et d'exploitation est discutée. Les résultats d'un certain nombre d'essais expérimentaux indiquent que la capacité équivalente de condensation de vapeur de pulvérisateurs isolés et de rampes de pulvérisateurs peut être améliorée de façon significative par des modifications relativement simples.

Mathematische Bestimmung der Spritzdüsen- und Kühlteichleistung einschließlich der Einflüsse der nachfolgenden Systemelemente

Mehrere Meßverfahren für die Spritzdüsen- und Kühlteichleistung wurden entwickelt. Die weiterentwickelten Verfahren berücksichtigen den Einfluß der nachfolgenden Systemelemente, insbesondere der Dampfkondensatoren auf die Gesamtleistung. Die erforderliche Teichfläche und Durchflußmenge sind eingeschlossen und eine Methode, die das Kapital und die laufenden Kosten berücksichtigt, wird diskutiert. Eine Reihe von Versuchen führte zu dem Ergebnis, daß die äquivalente Kapazität der Dampfkondensation von einzelnen Düsen und von Düsenreihen signifikant durch relativ einfache Modifizierungen verbessert werden kann.

Medidas matemáticas de lanzas para aspersión y función del estanque de enfriamiento inclusivo de los elementos subsecuente de la sistema

Varias medidas de la función de lanzas para aspersión y del estanque de enfriamiento se desarrollan. Las medidas más avanzadas toman cuenta del efecto de elementos subsecuente de la sistema, es decir los condensadores de vapor, sobre función global. Requisitos en área del estanque y velocidad de flujo de masa se incluyen y un método para incluir dados de costos de capital y de operación se discute. Las resultas de algunos ensayos experimentales indican que la capacidad equivalente para condensación de vapor de lanzas individuales y juegos de lanzas puede mejorarse significantemente por modificaciones relativemente sencillas.

Genetic variability, heritability and genetic advance in Saccharum officinarum L.

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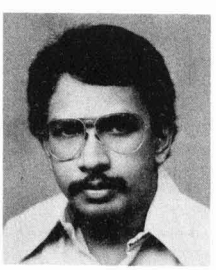
An understanding of the various genetic parameters that govern a population under improvement is essential for proper planning and direction of a plant breeding program. Genetic variability, heritability and genetic advance are useful parameters that can help the breeder during the different stages of a crop improvement program. The success of any such program will depend largely on the extent of genetic variability available in the base population, heritability of the characters under improvement and the extent of genetic advance possible for these characters.

In sugar cane several attempts have been made in the past to study these parameters and to orient the breeding programs according to the information gained therein[1-7] But these studies have been largely confined to the commercial hybrid populations only. At the species level similar studies have been quite few and *Saccharum officinarum* is no exception. Here an attempt has been made to evaluate a representative collection of *Saccharum officinarum* clones for these genetic parameters.

Materials and methods

126 typical clones of *Saccharum officinarum* formed the material for this experiment. The experiment was planted in a randomized block design with three replications. Each clone was planted in a single row 1.5 metres long. Data were collected on ten attributes: (1) number of tillers on 90th day per plot, (2) number of millable stalks/plot (NMS/plot), (3) stalk diameter, (4) number of internodes/stalk, (5) stalk length, (6) single stalk weight, (7) Brix in juice, (8) sucrose % juice, (9) stalk yield/plot, and (10) commercial cane sugar/plot (CCS/plot).



N. V. Nair

The data were analysed for variation according to the method of Panse & Sukhatme[8]. Genotypic coefficient of variation (GCV), heritability in the broad sense and expected genetic advance as a percentage of the mean (GA) were estimated as per Burton[9], Johnson *et al.*[10] and Robinson[11].

Results and discussion

In Table I are presented the estimates of mean, range, PCV, GCV, heritability in the broad sense and expected genetic advance as % mean obtained for the ten characters. The genotypic coefficient of variation obtained for yield and its important component characters were high. The highest GCV was estimated for CCS/plot (37.92), followed by stalk yield (34.33). Two of the most important components of stalk yield, namely single stalk weight and NMS/plot, also possess large amounts of variability as may be seen from their respective GCV estimates of 32.73 and 29.34. The existence of high variability for these characters had been reported elsewhere also[2,4,6].

Stalk diameter and stalk length presented low to moderate genotypic coefficients of variability, diameter recording a low estimate of 12.33 and stalk length a moderate value of 18.84. As for the quality attributes, the estimates of GCV were low, 7.88 for Brix in juice and 11.92 for sucrose % juice. Reporting on a hybrid sugar cane population, Mariotti[6] has also shown that low variability exists for stalk diameter, stalk length and quality attributes in cane.

Heritability (broad sense) estimates ranged from moderate to high for all characters. NMS/plot recorded the highest heritability estimate (86.94), while number of tillers/plot (85.51), single stalk weight (83.33) and stalk yield/plot (72.77) also maintained high levels of

1 Allam, Schilling & Koonce: *Sugar J.*, 1974, **36**, (10), 35-37.
2 Balasundaram & Bhagyalakshmi: *Indian J. Agric. Sci.*, 1978, **48**, (5), 291-295.
3 Brown: *Proc. 12th Congr. ISSCT*, 1965, 754-759.
4 Brown, Daniels & Latter: *Theor. Appl. Genet.*, 1968, **38**, 361-369.
5 Khairwal & Babu: *Sugarcane Breeders' Newsletter*, 1976, **37**, 32-38.
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7 Rao, Krishnamurthy & Natarajan: *Indian Sugar*, 1967, **17**, 153-161.
8 "Statistical methods for agricultual workers" (ICAR, New Delhi) 1967.
9 *Agron. J.*, 1951, **43**, 409-417.
10 *ibid.*, 1955, **47**, 314-318.
11 *ibid.*, 1949, **41**, 353-359.

Table I. Mean, range, phenotypic and genotypic coefficient of variation, heritability (broad sense) and expected genetic advance in *Saccharum officinarum* L.

Character	Mean ± SE	Range	PCV	GCV	Heritability in broad sense	Genetic advance (% of mean)
No. tillers/plot	14.67 ± 3.600	7.0 to 29.0	25.82	23.88	85.51	45.48
NMS/plot	13.54 ± 4.071	4.7 to 28.0	31.46	29.34	86.94	56.35
Stalk diameter (cm)	2.32 ± 0.307	1.43 to 3.09	14.79	12.33	69.56	21.21
Single stalk weight (kg)	0.700 ± 0.2366	0.23 to 1.43	35.86	32.73	83.33	61.57
No. of internodes/stalk	25.61± 3.869	16.67 to 35.40	17.21	13.94	65.59	23.25
Stalk length (cm)	172.38 ± 35.261	75.07 to 252.33	23.36	18.84	65.07	31.31
Brix in juice	17.34 ± 1.499	12.34 to 20.68	9.99	7.88	62.30	12.82
Sucrose % juice	15.09 ± 1.948	9.92 to 19.23	14.68	11.92	65.92	19.93
Stalk yield/plot (kg)	9.184 ± 3.3441	2.61 to 19.08	40.25	34.33	72.77	60.36
CCS/Plot (kg)	0.954 ± 0.3873	0.29 to 2.07	45.41	37.92	69.76	65.17

heritability. For the rest of the characters, moderate heritability was estimated.

The expected genetic advance (at 5% selection intensity) was of a low order for stalk length (31.31), stalk diameter (21.21), sucrose % juice (19.93) and Brix (12.82). A moderate estimate of genetic advance was obtained for number of tillers/plot (45.48), while characters showing high genetic advance were CCS/plot (65.17), single stalk weight (61.57), stalk yield (60.36) and NMS/plot (56.35).

For achieving the desired improvement in a particular character, it should possess high levels of heritability, variability and genetic advance. This being the case, the results of this study indicate that yield by itself provides substantial scope for improvement as also do two of its components – single stalk weight and NMS/plot. But stalk diameter and stalk length, which also contribute to yield, registered only moderate heritability, possess only limited variability and show low genetic advance. Evidently, there remains little scope for improvement of these characters.

This need not impose any serious limitation on breeding for yield, however, since these two characters contribute directly to stalk weight, while stalk weight by itself permits substantial improvement. This indicates that stalk density may bè an important component contributing to stalk weight and the role of density needs looking into. Similar results were obtained for quality attributes, *i.e.* moderate heritability in association with low genetic variability and low genetic advance, indicating thereby the difficulty in improving them. It also becomes evident from the results that the existence of high or moderate heritability for a character need not necessarily ensure a corresponding genetic advance also, whereas genetic advance tends to be high wherever genetic variability is high.

The results indicate the possibility of achieving significant improvements in sugar yield (CCS/plot) and stalk yield through selection, by virtue of the genetic parameters associated with these characters. For the same reasons it is evident that sucrose selection will not be effective in *S. officinarum* clones as they have already attained higher sucrose levels owing to selection from prehistoric times.

Acknowledgements

The authors are grateful to the Director, Sugarcane Breeding Institute, for the facilities provided. Thanks are also due to Mr. A.R. Balasundaram and Mr. C. Viswanathan for their help.

Summary

126 genotypes of *Saccharum officinarum* were studied for genetic variability, heritability and genetic advance of ten characters and the results are reported. Sugar yield (CCS/plot), stalk yield and two of its important components (single stalk weight and MNS/plot) recorded high levels of heritability, genetic variability and genetic advance. Stalk diameter, stalk length and quality attributes possessed moderate heritability, but genetic variability and expected genetic advance for these characters were low.

Variabilité génétique, faculté héréditaire et progrès génétique de *Saccharum officinarum* L.

126 génotypes de *Saccharum officinarum* ont été étudiés du point de vue variabilité génétique, faculté héréditaire et progrès génétique de dix caractères et les résultats sont communiqués. La teneur en sucre (ccs/lot), le rendement en tiges et deux de ses composantes importantes (poids d'une tige individuelle et NMS/lot) ont atteint des niveaux élevés de faculté héréditaire, de variabilité génétique et de progrès génétique. Le diamètre de la tige, sa longueur et les attributs de qualité possèdent une faculté héréditaire modérée, mais la variabilité génétique et le progrès génétique probable de ces caractères sont faibles. [ccs = sucre de canne commercial; NMS = nombre de tiges broyables.]

Genetische Variabilität, Erblichkeit und genetischer Fortschritt von *Saccharum officinarum* L.

126 Genotypen von *Saccharum officinarum* wurden auf ihre genetische Variabilität, Erblichkeit und genetischen Fortschritt in zehn Merkmalen untersucht, und die Ergebnisse werden hier berichtet. Zuckerertrag (ccs-Kurve), Stengelertrag und zwei seiner wichtigsten Komponenten (Einzelstengelgewicht und NMS-Kurve) zeigten hohe Raten der Erblichkeit, der genetischen Variabilität und des genetischen Fortschritts. Rohrstengeldurchmesser, Stengellänge und Qualitätsmerkmale zeigten mäßige Erblichkeit, dagegen waren genetische Variabilität und zu erwartender genetischer Fortschritt für diese Merkmale gering. [ccs – kommerzieller Rohzucker; NMS – Zahl der mahlbaren Stengel.]

Variabilidad genética, heredabilidad y avance genético en *Saccharum officinarum* L.

126 genotipos de *Saccharum officinarum* se han estudiado en términos de variabilidad genética, heredabilidad y avance genético de diez carácteres y se presentan las resultas. Rendimiento de azúcar (azúcar comercial por parcela), rendimiento de tallos y dos de su componentes las más importantes (peso de un sólo tallo y número de tallos capaz de molerse por parcela) demuestran altos niveles de heredabilidad, variabilidad genética y avance genético. Diámetro del tallo, largo del tallo y carácteres asociado con calidad tienen heredabilidad mediocre, pero variabilidad genética y avance genético esperado estuvieron bajo.

SUGAR CANE AGRONOMY

Influence of filter cake on nitrogen fertilization of sugar cane. G. A. C. de Albuquerque and M. L. Marinho. *Brasil Açuc.*, 1979, **94**, 110-115 *(Portuguese)*. — Two series of N fertilizer trials were carried out over 7 years in Alagoas to determine the optimum dosage of N, in one series provided at 0, 50, 100 and 200 kg.ha^{-1} and in the other at the same rates but with the addition of 4 tonnes.ha^{-1} of filter cake. There was a significant interaction between the filter cake and N fertilizer but the effect of the former did not extend beyond the first harvest. There was a response of cane yield to all levels of N but the use of filter cake permitted the same response from about two-thirds of the N level in its absence.

Louisiana sugar cane: higher yields, higher prices or horticulture. J. E. Irvine and C. A. Richard. *Sugar Bull.*, 1979, **57**, (9), 8, 10-13. — While there is need for increased cane yields in Louisiana if cane growing is to continue in the state, the point is made that higher yields are of little value unless the amount delivered to the factory is also greater, so that care in harvesting, transloading and transportation is necessary. Arguments that high yields are not possible in Louisiana because of the short season, unsuitable varieties and poor soils are countered by evidence from southern Iran, where the season is of the same length as in Louisiana and the same varieties are grown, yet yields are double those in Louisiana. This is attributed to cloudless skies and hence high light intensity in Iran, which promotes growth, whereas in Louisiana frequent occurrence of rain clouds reduces light intensity; moreover, the use of a 6-ft row spacing in Louisiana (perhaps the widest in the world) results in much of the sunlight falling on bare ground. The contribution that narrower row spacings could make to increased yields is discussed; wide furrows or widely separated double drills have been found to give high yields. Discrepancies between results achieved in small plots at an experiment station and those obtained on a plantation are attributed to the unsuitability of the techniques used on a small scale for large-scale agronomy, although improvements in yield can still be achieved by applying newer tested techniques.

Experiments in sugar cane fertilization. I. Plant cane. F. A. Fogliata. *La Ind. Azuc.*, 1978, **85**, 342-349 *(Spanish)*. — Work since 1969 has been carried out on the response of the main varieties cultivated in Tucumán to fertilizers under the different climatic and edaphic conditions applying in the province. Plant cane responds positively to applied N where the soil nitrate content is below 5 ppm but not where it is above 15 ppm. For addition of 60 kg.ha^{-1} of N the response of cane yield varied between 196.45 and 246.7 kg of cane per 100 m of row. The average economical dose was 69.44 kg.ha^{-1} of N, equivalent to 153 kg.ha^{-1} of urea, while the best return in terms of net cash was attained with 79.94 kg.ha^{-1} of N. No effect on juice quality was observed as a result of N, P or K application, and no cane yield increase was found with application of 100 or 200 kg.ha^{-1} of P or 50 and 100 kg.ha^{-1} of K except in the case of NA 56-79 in one location where a response to the lower level of K was observed.

The control of Johnson grass and other weeds in Louisiana sugar cane, spring 1979. L. L. McCormick, E. R. Stamper and R. Millhollon. *Sugar Bull.*, 1979, **57**, (10), 12-19. — Detailed recommendations are given on chemical control of Johnson grass in plant and ratoon cane, the latter by both ground and aerial application of herbicides, as well as of Raoul (itch) grass, brown top panicum and Bermuda grass. The common, trade and chemical names of the herbicides referred to are listed.

Behaviour of sugar cane under different irrigation regimes. O. P. Aragão and J. R. Pereira. *Brasil Açuc.*, 1979, **94**, 162-179 *(Portuguese)*. — Trials were made using CB 45-3 cane variety and applying irrigation under four different regimes (accumulated evaporation of 103, 184, 265 and 346 mm), plant density of 13 and 18 buds per metre, and three levels of N (70, 140 and 210 kg.ha^{-1}). The plot sizes were also different, which affected the coefficient of variation of the results (between 6.4% for the parcels and 8.3% for the sub-parcels). There was a significant interaction between N and irrigation effects. Unexpected distribution of moisture in the soil profile indicated the possibility of errors in the theory of movement of water in such vertisols. After full canopy was reached, maximum and minimum demand was observed for an evapotranspiration:pan evaporation ratio of 0.86 and 1.04, respectively. The relationship between production and evapotranspiration for the whole crop cycle was 0.009 kg of cane per litre of water.

Sulphur-coated urea as a source of nitrogen for sugar cane. D. Eastwood. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 60-68. — Surface applications of 60 and 120 lb. acre^{-1} of N as sulphur-coated urea, ammonium sulphate and urea were compared. All increased yields, the effects of the first two forms being equal and greater than that of urea at the same N level, and this difference being greater in coarse textured soils than fine clays. The soil S status indicated that the better response to S-coated urea and $(NH_4)_2SO_4$ was not due to their S content. If the price of S-coated urea is comparable to that of $(NH_4)_2SO_4$, the former is an attractive alternative.

Farming systems — A report on various inter-row systems as a production factor in sugar cane. L. C. Goberdhan, W. I. N. Washington and H. Pulwarty. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 84-86. — Field trials are reported on comparison of cane growing in cambered beds, 27 ft wide, with no cultivation after harvest, and three ridge and furrow treatments, one with no inter-row tillage on ratoons, another with annual moulding with disc cultivators, and the third with annual subsoiling with chisel tines to depths of 10-14 inches. Over two years, no significant difference was observed but it is felt that some system of inter-row tillage may be desirable.

Monsanto's research on sucrose enhancers. R. M. Sacher. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 156-159. A brief account is given of work at Monsanto on growth regulation of sugar cane and the development of Polaris. New chemicals have been developed which have better performance under some conditions, and these are being evaluated.

SUGAR CANE MECHANIZATION

Wheels within wheels — controlled compacting. C. A. Rehbein. *Cane Growers' Quarterly Bull.*, 1979, **42**, 88. Use of a hydraulically loaded or water-filled press-wheel over the furrow after planting provides controlled compaction to break down clods and compress sett cover when soil moisture is limited.

Economic evaluation of different variants of cane transport. V. González E. *ATAC*, 1978, **37**, (3), 45-54 *(Spanish)*. — The costs per tonne and per tonne-km were worked out for a 7-tonne road truck and for a tractor hauling two trailers having a combined load of almost 12 tonnes, over distances between 2½ and 20 km; the truck was slightly more economical for all distances over about 4 km, with the tractor having an advantage below this distance in costs per tonne.km. Installation of cane cleaning stations is recommended to increase the efficiency of transport by separation of non-millable cane, which also improves processing quality, and new ideas must be sought to improve transfer, storage, etc., so as to minimize the interval between cutting and milling.

Transport — agroindustrial phase of the cane sugar process. M. Cordovés H. *CubaAzúcar*, 1979, (Jan./March), 9-11 *(Spanish)*. — Requirements for a cane transport system are reviewed as are the characteristics which it must possess and world trends in cane transport. The system characteristics depend largely on the system of harvesting employed, but the modern tendency is to transport the cane in road trucks.

Automatic billet planting in Australia. W. P. Kerr. *Sugar y Azúcar*, 1979, **74**, (3), 51-54. — A survey is presented of automatic cane planters developed in Australia.

Mechanical planters. C. Richard. *Sugar Bull.*, 1979, **57**, (10), 10-11. — Reference is made to two basic types of cane planter used by US farmers — the carrier type and drum type — as well as to the older Julien type, or derivatives of it, still used by some growers. Advantages attributed to the drum-type planter, which appears to be built in greater numbers than the carrier type, are the existence of fewer moving parts and hence greater durability, while the carrier type is considered to have greater versatility in planting designs and a better contact area with the cane bed. There are many opinions among farmers regarding rake shape and spacing and spiral design, but it is emphasized that the farmer buying a specific planter can incorporate modifications and improvements in it to suit his requirements.

Mechanical harvesting of whole-stalk cane. P. G. R. de Freitas, J. M. Lorenzetti and J. Jacomini. *Brasil Açuc.*, 1979, **94**, 145-152 *(Portuguese)*. — Details are given of whole-stalk mechanical harvesting of sugar cane at Usina São José, Mácatuba, SP, which accounted for 16.26% of the total cane harvested. The figures for each month are given with notes on variety, age of ratoon, erectness, soil type, etc., and the results compared with data from the literature. The machine, a Brasil-Artoli EG.500 type 103, cut an average of 25.2 tonnes.hr^{-1} and the field loss was 1.09 tonnes.ha^{-1}. Tables are presented of the operational time of the machine and an analysis of causes of stops. It is concluded that the harvesting of whole-stalk is viable, with advantages over chopper cane; it is better in crops of 50-80 tonnes.ha^{-1} but is affected by the shape of the fields, cane area roads, and topography.

Determination and investigation of the volumetric weight of cane. C. Iglesias and A. Beleavtzev. *ATAC*, 1978, **37**, (4), 46-52 *(Spanish)*. — The density of cane is a factor involved in the design of cane harvesting and transport equipment and is governed by a number of factors. The weight of 369 loads of cane in a 15 m^3 trailer was measured and related statistically to the various factors, using a single variety. Equations were developed relating the weight per m^3 and degree of filling of the trailer to cane yield per ha, and relations studied between these characteristics and the length and diameter of the stalks and the presence of impurities. The coefficients of the volumetric weight equation depend also on the shape and volume of the trailer, i.e. on the dimensions of the bed of cane being examined.

Machinery replacement: economic considerations. E. A. Simms. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 32-36. The Perrin mathematical model[1] for machine replacement is modified to specify that a currently owned machine should be replaced when the marginal cost of keeping it another year is equal to or exceeds the annual marginal opportunity cost of not replacing it immediately. An example of the application of the model is provided and other influencing factors are discussed.

Payload capabilities of infield haulage systems. D. F. Howson. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 69-81. — An account is given of field trials of cane haulage in Guyana soils under wet conditions using four kinds of 4-wheel-drive tractor and various types of trailer. It is concluded that a medium-powered tractor with a weight-transfer trailer, if possible with a hydraulic power drive to the trailer axle, is best and could operate when ground conditions became soft.

Loading cane mechanically on steep land. G. R. Randoll. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 82-83. The author's farm is good cane soil but includes slopes of 10-30°. In a first step toward mechanization, loading was tried using a McConnel Loadster cane loader, mounted on a Caterpillar D-4 tractor and provided with a tilt mechanism and stabilizer legs; positioning takes about 12 seconds, and at each position the loader handles about 1½ tonnes of cane. It is considered that it can fill twenty 5-tonne trailers per day, successfully coping with gradients up to 30°.

Wide furrow sugar cane production system. B. J. Cochran and R. Ricaud. *Sugar J.*, 1979, **41**, (10), 15-18. — Advice is given on planting and harvesting cane in a 3-ft wide furrow, with photographs and descriptions of equipment modifications necessary for the operations. Mention is made of various harvesters evaluated for their suitability on wide furrows. Results from experiments in 1977 and 1978 showed substantial increases in plant and ratoon cane grown in wide furrows by comparison with conventional V-shaped furrows.

[1] *Amer. J. Agric. Econ.*, 1972, **54**, (1), 60-67.

CANE PESTS AND DISEASES

Ratoon stunting disease in imported sugar cane varieties after hot air treatment. R. A. Bailey, G. R. Béchet and S. R. Richardson. *Sugarcane Pathol. Newsletter*, 1978, (21), 16-17. — Imported varieties are grown for two years in a glasshouse followed by one year in open quarantine before release for evaluation trials, and were originally treated with hot water (2 hr at 50°C) after the first year. Because of establishment problems, this treatment was changed in 1972 to hot air (8 hr at 54°C) and the observation of ratoon stunting disease in some varieties after release has cast doubt on the efficacy of hot air treatment. Phase-contrast microscopy has permitted positive diagnosis of the disease in 35 out of 83 varieties which have passed through quarantine since 1972, although they did not show nodal symptoms. This shows the value of the technique for diagnosis and also indicates that hot air treatment has been ineffective; the system has now reverted to hot water treatment.

An improved method of xylem-sap extraction using positive pressure for the rapid diagnosis of ratoon stunting disease. S. R. Richardson. *Sugarcane Pathol. Newsletter*, 1978, (21), 17-18. — A new technique involves the application of air at about 100 kPa to one end of a cane stalk sample via a rubber adaptor, and collection of drops of xylem sap from the other end with a dropping pipette. The number of bacteria in undiluted sap is relatively high, so that centrifugation before examination on a microscope slide is unnecessary. The method is rapid, and examination of 20 stalks takes only 30 minutes.

Branched forms of the organism associated with ratoon stunting disease. C. Ricaud and J. C. Autrey. *Sugarcane Pathol. Newsletter*, 1978, (21), 19-21. — Microcolonies of the ratoon stunting disease-associated organism having branched forms were reported by Kao & Damann[1]; examination of a number of diseased varieties in Mauritius showed that several branched forms, but not many, were present in variety CP 68-1026 but were rare in M 438/59.

Efficacy of surfactants in smut inoculation. F. T. Gargantiel and F. C. Barredo. *Sugarcane Pathol. Newsletter*, 1978, (21), 21-25. — At Victorias Milling Co., testing for smut resistance involves dipping in a suspension of spores, but the waxy nature of the bud scales hinders wetting of the surface, and a number of surfactants were tested as additives to the suspension; they were found to increase the infection of a known susceptible variety, so that assessment by the method became comparable to that using the pin-prick paste method employed by the Philippine Sugar Commission.

Red stripe in Central America. A. L. Fors. *Sugarcane Pathol. Newsletter*, 1978, (21), 25-26. — New symptoms observed in B 4362 cane infected with red stripe include red blood-coloured blotches on stalks in the region of the root primordia, extending towards the internode in the form of thick red lines. These have not previously been reported, while the sunken water-soaked areas in the internode in the well-developed stalk is becoming a more frequently observed symptom in Central America.

Growth of pineapple disease and red rot fungi on various potato-dextrose agar media. C. C. Ryan, R. G. Birch and L. J. Lopez. *Sugarcane Pathol. Newsletter*, 1978, (21), 27-28. — Use of commercially prepared dehydrated potato-dextrose agar media for culture of the two fungi is easier but their poor growth compared with that on media prepared from fresh potatoes by the method described in the CMI Plant Pathologists Pocketbook[2] renders them unsatisfactory for routine isolation and inoculum production.

Improvement of the technique for screening against red rot at the seedling stage. H. N. Singh, S. C. Gupta, S. B. Singh and M. P. Singh. *Sugarcane Pathol. Newsletter*, 1978, (21), 29-31. — A technique for screening seedlings against red rot disease is described. The seedlings raised on open beds were sprayed with a thick suspension of *Colletotrichum falcatum* conidia in the evening; within 7-15 days, symptoms on infected shoots were visible, including red to brown spots on the leaf sheath, long midrib lessions, oval dark red spots on leaf laminae and sheaths or small chlorotic spots on the leaf blade or sheath. The procedure allows early elimination of susceptible seedlings from a large population.

Population dynamics of nematodes in relation to nematicides and moisture in Fijian soils. R. Narian and -. Krishnamurthi. *Sugarcane Pathol. Newsletter*, 1978, (21), 32-34. — Trials are reported on nematode counts in soils treated with three levels each of Furadan 3g and Temik 15g and an untreated control, over a period of 6-7 months. Counts varied during the period but were generally lower in treated plots, best results appearing to be with 30 $kg.ha^{-1}$ of Temik 15g which gave an overall low nematode population and a better stand of cane than in the other plots.

The IISR fly (parasite) rearing cage. J. Chandra. *Indian Sugar Crops J.*, 1979, **6**, 4-5. — A description is given of a modified cage for rearing of parasitic flies which permits maintenance of humid conditions and feeding of the flies from outside, without need to disturb them.

Effect of delay in sett treatment and planting on the development of pineapple disease in sugar cane. S. Kumaraswamy. *Indian Sugar Crops J.*, 1979, **6**, 6-7. Uninoculated 3-budded setts of cane variety Co 419 were treated with Agallol-3 immediately after cutting, while setts inoculated with a spore suspension of *Ceratocystis paradoxa* were treated with the fungicide after intervals of 6, 24 and 48 hours. All four groups of setts were planted on the third day. No disease was found in the uninoculated setts, while its incidence in the inoculated setts rose, and germination and final cane yield fell, with increase in the delay before fungicidal treatment. Moreover, the group treated after 48 hours exhibited very severe damage from the disease. Apart from the rapidity with which the disease spreads once the fungus has entered the sett, it is also possible that the method used to treat setts (4-5 seconds' dipping in a 0.5% solution) is not sufficient to allow the fungicide to penetrate deeply into the tissues.

[1] *Phytopathology*, 1978, **68**, 545-551.
[2] Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England, 1968.

CANE BREEDING AND VARIETIES

Studies on quantitative variations in leaf characters in species and commercial clones of *Saccharum*. S. Rita and S. S. Narayanan. *Indian J. Sugarcane Tech.*, 1978, **1**, 92-101. — Leaf characteristics of 6-weeks old plants of 24 *Saccharum* genotypes were examined quantitatively to identify special features, if any. Modern varieties, especially those maturing early, showed increased blade length, breadth, surface area and thickness. Efficiency in commercial canes is also associated greatly with greater width of vascular bundles as bundle sheath chloroplast and parenchyma layers rather than the number of vascular bundles per unit length, since these are the sensitive areas of the internal structure of the leaf which are actively involved in the C_4 pathway of photosynthesis. The size of vascular bundles, chloroplast width, leaf blade area and thickness appeared to contribute to varietal differences. The study indicates that these might be considered as attributes of superior plant types for selection purposes.

Phenotypic stability of some exotic and Indian sugar cane (*Saccharum* sp. hybrids) varieties. B. K. Tripathi, A. S. Ethirajan and R. K. Shukla. *Indian J. Sugarcane Tech.*, 1978, **1**, 119-125. — Phenotypic stability of nine Indian and five imported varieties was studied using four years' data. The partitioning of genotype x environment interactions indicated that the major portion was accounted for by the linear component. The number of millable canes and stalk height recorded highly significant variety x environment (linear) interaction while girth of cane, yield and sucrose % did not show significant interactions. Of fourteen varieties, Co 1148 showed highest yield as well as average stability; it was followed by Co 975 and Co 1007. Varieties B 37172, CP 44-101 and Co 997 had high sucrose % juice, moderate yield and above-average stability for yield. Variety N:Co 310 showed above-average stability for yield, sucrose content and other yield-contributing characters except for millable canes. Among yield-contributing characters, stability of millable canes and stalk height appeared to be more important than that of stalk girth under sub-tropical conditions in India.

New varieties for Bundaberg. Anon. *Australian Sugar J.*, 1978, **70**, 444. — Five new varieties — Q 103, Q 108, Q 109, Q 110 and Q 111 — have been released for growing in the Bundaberg area of Queensland. All are resistant to Fiji disease, the first less than the others.

Morphology of the root system of the varieties C 8571 and B 4362. S. Botta and F. Volf. *ATAC*, 1978, **37**, (2), 38-45 *(Spanish)*. — Humbert has stated[1] that knowledge of the cane root system is necessary in order to ensure that agronomic practices are adopted which are correct and provide for the roots a medium favourable for their development and so ensure high yields. Studies were therefore carried out on two varieties grown in Cuba with this aim; they are reported, with details of the soils, cultivation methods and climatic data for the experimental area. The vertical distribution of the root systems of both varieties is tabulated and the two different types of system described and discussed.

Preliminary report on screening for sugar cane smut resistance in Florida. D. G. Holder and J. L. Dean. *Sugar J.*, 1978, **41**, (7), 16. — The resistance of 895 clones or varieties of cane is under test at the Canal Point Field Station in Florida by immersing the cane in water containing a suspension of smut spores, planting, and assessing the degree of infection after five months. The grades for 37 varieties after only three months have been announced; in most cases, no infection was (yet) apparent, but CI 49-200, CI 54-334 and CI 61-205 were considered susceptible or intermediate.

Q 96 — a management challenge. E. A. Pembroke. *Cane Growers' Quarterly Bull.*, 1979, **42**, 80-81. — In view of the potential trouble with disease where a high proportion of the cane area is planted to a single variety — N:Co 310 — other approved varieties should also be cultivated, and the characteristics of Q 96 are considered in this respect. Some growers have obtained good yields with this variety while others have had disappointing ratoon crop yields. Recommendations are given on methods of cultivation to avoid such disappointments.

Varietal changes meet changing requirements. J. Harbison and P. K. Makepeace. *Cane Growers' Quarterly Bull.*, 1979, **42**, 84-85. — A review is presented of the changes in the pattern of varieties grown in Queensland since 1942 to meet variations in conditions, and these changes are illustrated in the form of a graph.

Achievements in sugar cane breeding in Taiwan. Taiwan Sugar Research Institute. *Taiwan Sugar*, 1979, **26**, 26-28. Information is given on distribution of commercial varieties by area in Taiwan in 1977-78 and on crossing and selection work at the Institute. Varietal trials are reported, and mention is made of additions to the Miscanthus collection.

Response of Clewiston (CI) varieties to Polaris in Florida during the 1978-79 season. D. G. Holder and R. P. DeStefano. *Sugar J.*, 1979, **41**, (9), 21. — Eight varieties in the CI series were tested for their response to Polaris applied at 3 lb.acre^{-1} six weeks before harvesting for juice analysis. Results showed that treatment caused large and significant increases in juice Brix, sucrose content and purity, while yield was increased by 10-33% according to variety. The results are tabulated.

Sampling for selection for quality in sugar cane. J. Scandaliaris and J. A. Mariotti. *Rev. Ind. Agríc. Tucumán*, 1978, **55**, (2), 33-37 *(Spanish)*. — A comparison was made between the representative nature of samples collected by individual operators according to their own criteria, by completely random selection and by systematic selection of stools in the border and middle of the plots. The results showed that individual operators employed different criteria and that selection of stools from the plot border was acceptable as a sampling procedure; it has thus been adopted on a tentative basis for sampling in the breeding program at Tucumán Experiment Station.

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[1] "El cultivo de la caña de azúcar" (CECSA, Mexico), 1974, pp. 35-45.

SUGAR BEET AGRONOMY

Investigations on assurance of field emergence of sugar beet. E. Flake and W. Brinkmann. *Zuckerind.*, 1979, **104**, 199-206 *(German)*. — Investigations over two years were aimed at establishing how to achieve a level of field emergence comparable to that achieved in the laboratory. Requisite for maximum emergence were: (i) rapid warming of the seedbed, (ii) accessibility of water to the seed, (iii) availability of oxygen, and (iv) only shallow covering of the seed with soil, especially where mudding or crusting may occur; immediately after emergence, the seedlings should be protected against wind. Since it had been found that hand drilling of seed gave better emergence % than did mechanical drilling, the intention was to develop a mechanical system that would approximate to a manual one. A single-seed drill was developed which has a wheel carrying 16 piston-type seed droppers passing through the circumferential flange. As the wheel rotates, the droppers also pass through the seed box; force is exerted by a cam section indirectly extending from the wheel centre toward the arc of the circumference corresponding to the seed box. As each dropper is forced into the seed box, a seed is taken up under suction and is then pressed into the soil to a depth of 3 cm at a distance of 11.5 cm from the previous seed. Pressure is maintained on the piston until complete retraction under the action of the wheel's rotation, so that no soil enters the dropper. Results of tests showed that seed sown by the new drill in the period April 7-11, 1978, emerged to the extent of 90% compared with 90.7% for manually sown seed, 83.9% for seed sown by a Unicorn drill equipped with a double star wheel (for pressing and furrow covering) and 77.9% for a basic Unicorn drill; on the other hand, the relative emergence of seed sown by the new drill in April 25-26 was 99.2% compared with 95.4% for hand-sown seed, 91% for seed sown by the modified Unicorn drill and 80.1% for the basic Unicorn drill.

Storage of sugar beet treated with Ethrel. M. Z. Khelemskii *et al. Sakhar. Prom.*, 1979, (4), 45-49 *(Russian)*. Three-year trials are reported in which beets were sprayed with Ethrel solution before 106 days' storage. Results showed that treatment retarded sprouting and rotting and so reduced daily sugar losses and contributed to maintenance of processing quality. Optimum dosage rate was 3-4 litres of 0.3% solution per tonne of beet.

The effect of urea formaldehyde foam plastic on the sugar beet root during storage. N. M. Ignatov and G. V. Gritsinin. *Sakhar. Prom.*, 1979, (4), 49-51 *(Russian)*. While urea formaldehyde has found application as a means of protecting beet piles in recent years, it does have some adverse properties; apart from having a high moisture absorption capacity, it has been found to cause reddening of the surface tissue, followed (within 2-3 days) by darkening of the parenchymatous tissue below and subsequent necrosis, accompanied by a fall in sucrose content. In view of this, it is recommended to spray the pile with milk-of-lime before applying a 2-3 cm layer of foam plastic. It is also recommended to apply polyurethane latex to the foam plastic to form a moisture barrier.

Questions regarding the quality of raw material in the sugar industry. I. Basic problems arising with variable raw material quality. E. Waleriańczyk. *Gaz. Cukr.*, 1979, **86**, 25-27. **II. Major factors determining the economic value of sugar beet.** *Idem ibid.*, 49-53 *(Polish)*. I. The relationship between beet pol, sugar recovery and losses is examined mathematically and graphs constructed showing how more than 80% of the sucrose in beets is recoverable in the factory when the initial content is at least 16.3% (the recovery increasing to 86.7% at 18.8% sucrose content), but that the losses increase in proportion to the fall in sucrose content, so that under Polish conditions of 15 million tonnes of beet processed during 80-85 days, a difference between 15% and 17% in beet sucrose content may be equivalent to 400,000 tonnes of sugar. Factors causing low sucrose contents are briefly examined.
II. Agronomic factors affecting the chemical composition of beets are discussed, and the importance of increasing quality by improvement in farming techniques is stressed; a rise in quality would permit a reduction in the campaign length and thus help reduce processing costs.

Study for the introduction of mechanization in beet agriculture in the Doukkala region. -. Anba. *Sucr. Maghrébine*, 1978, (23), 4-10 *(French)*. — The prospects and economics of beet mechanization in the Doukkala region of Morocco are discussed, and limiting factors listed. The nature of the soil and agricultural practices are described, and the possible techniques and types of equipment to apply in both drilling and harvesting are examined.

Post-emergence weed control. J. M. Belien and J. F. Salembier. *Le Betteravier*, 1979, **13**, (130), 12-14 *(French)*. — Advice is given on chemical weed control using post-emergence herbicides either applied fractionally or in a single dose; emergency application of post-emergence herbicides where there is considerable late weed growth is also mentioned.

Economics of nitrogen use in sugar beet. S. K. Tewari. *Indian Sugar Crops J.*, 1979, **6**, 16-17. — On the basis of root yield and N cost, the author has established the most profitable N application rate for the years 1971-78. The price paid for the beets per tonne was constant over the period, and root yield varied only slightly with application of between 210 and 230 kg N per ha.

A hormonal mechanism regulating sucrose accumulation in the sugar beet. S. M. A. Moustefa and A. H. A. el Gharbawy. *Agron. Trop.*, 1978, **33**, 370-376 *(French)*. Variations in sucrose accumulation in beet roots with time have been found to be associated with changes in the degree of activity of a phenolic inhibitor which appears to be formed in the leaves and then transported to the extremities of the roots. This inhibitor also has a retarding effect on invertase activity in root tissue. It is suggested that there is a mechanism regulating sucrose storage in the root which involves changes in the invertase system under the effect of the inhibitor.

Late weed growth in sugar beet. W. Garburg. *Die Zuckerrübe*, 1979, **28**, (3), 26-28 *(German)*. — Advice is given on chemical control of late-developing weeds in beet fields.

CANE SUGAR MANUFACTURE

The sugar industry in Maharashtra in 2000 AD. S. N. G. Rao and N. C. Varma. *Maharashtra Sugar*, 1979, **4**, (6), 9-23. – The authors calculate the possible amount of cane and factory capacity needed in Maharashtra by the year 2000, assuming that the sugar production in the state remains approximately one-third of the total Indian sugar production. Land and irrigation requirements, the number of new factories required, by-products utilization, surplus power generation for sale to the public grid and chemicals requirements are considered as well as other factors only briefly mentioned.

Reduced recovery and efficiency considerations. P. K. More. *Indian Sugar*, 1978, **28**, 411-421. – The boiling house recovery formulae developed by Deere, Gundu Rao and Patil & Chavan are examined, and a formula developed by the author for calculation of the Virtual Boiling House Efficiency (E) is presented:

$$E = 10{,}000\ \frac{(Jm\text{-}Mv)}{(100\text{-}Mv)\ [Jm\text{-}K\ (100\text{-}Jm)]}$$

where Jm = mean reduced juice purity, Mv = purity of virtual molasses (purity of total waste solids) and K = total waste solids exhaustibility constant. The formula is claimed to have a wider range of application than the other formulae.

Sushira – the bagasse loss reducer. S. S. Sirohi and N. K. Garg. *Indian Sugar*, 1978, **28**, 447-451. – See *I.S.J.*, 1980, **82**, 122.

A correction suggested to present reduced mill extraction formula for taking into account the effect of variation of pol % cane on mill extraction. C. M. Ugale. *Maharashtra Sugar*, 1979, **4**, (7), 35-38. – It is suggested that comparison of the milling performances of factories on the basis of 12.5 fibre % cane is incorrect in view of differences in pol % cane between factories. A correction is therefore proposed which takes the form:

$$\text{Reduced Mill Extraction} \quad \frac{(7 + \text{standard pol per unit cane})}{(7 + \text{actual pol per unit cane})}$$

where the standard pol % cane is taken as 12.5.

Evaporation station – efficiency, expansion and steam economy. G. G. Kakade and V. G. Khilari. *Maharashtra Sugar*, 1979, **4**, (7), 39-45. – The advantages and disadvantages of juice preheaters, vapour line juice heaters and vapour cells as adjuncts to a multiple-effect evaporator are discussed. While use of a preheater does not save any steam, it does accelerate the evaporation rate and the heating surface requirement is lower than in the case of a 1st evaporator effect used instead of a preheater. Vapour line juice heaters pose cleaning problems and can suffer from tube leakage, which adversely affects evaporator operation; moreover, use of 2nd or 3rd effect vapour to heat juice in a normal heater is as good as use of a vapour line juice heater as regards steam consumption. While a vapour cell will not significantly reduce steam consumption by comparison with a separate quadruple-effect set, it is less costly to install than a separate set and requires less maintenance and cleaning.

Need to match the colour of Indian sugar with international standards. P. J. M. Rao. *Maharashtra Sugar*, 1979, **4**, (7), 49-56. – While the Indian standards for white sugar specify only a minimum pol and maximum moisture content, the Codex Alimentarius Commission and EEC standards lay down specifications for other parameters, including colour. The Braunschweig, Paris and ICUMSA procedures for colour grading are mentioned, and factors responsible for sugar colour are explained. It is stressed that every effort should be made to raise the quality of Indian sugar by improvement in processing and use of modern machinery.

A new process of filtration of 1st carbonatation juice. S. S. Sirohi and J. K. Mehta. *Indian Sugar*, 1978, **28**, 537-544. – Mud was discharged from a filter-press without washing and with only 1-2 minutes' steaming, and then mixed with hot water at 50-55°C to give a Brix of $\geq 55°$ before filtration on a belt-type vacuum filter. Filtrate from this was recycled to 1st carbonatation. Performance and economics of the system were better than for the existing scheme.

Increasing the capacity of vacuum pans. A. P. Chinnaswamy and R. Nandagopal. *Indian Sugar*, 1978, **28**, 603-604. – See *I.S.J.*, 1980, **82**, 253.

Dextran in raw juice. H. R. Iglesias, J. N. Fernández, O. de la Torre, C. Menéndez, M. M. Machado and R. Biart. *ATAC*, 1978, **37**, (4), 26-33 *(Spanish)*. – The dextran measurement method of Nicholson & Horsley[1] was applied at three sugar factories in Cuba for daily measurements during 60 days of dextran in mixed juice and in 10-day composite samples of sugar. The method was found to have good precision and repeatability for both products. The results from two factories were close and significantly above those of the third. The ratio between dextran in sugar and that in mixed juice was not significantly different for all three factories, however, and the higher dextran levels for the two factories correspond to a higher proportion of mechanically harvested cane crushed in them.

Calculations for rotary vacuum filters with perforated plate partition. L. Berriz and J. Marinello. *ATAC*, 1978, **37**, (4), 53-65 *(Spanish)*. – A series of equations governing the filtration of a turbid liquid through a rotary vacuum filter are presented and these used to derive others for assessing the performance of the filters by a graphical method.

Planned maintenance at Wales Estate. S. N. Changlee and G. H. E. James. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 160-175. – In Guyana in 1972 it was decided to adopt an improved planned maintenance scheme in order to achieve better plant utilization and increased production at minimum cost. Details are provided of the system which was instituted in 1973; it includes use of a number of history and record cards, forms, checks and reports which are described with their use. Application of the system has resulted in a distinct reduction of time lost for total and mechanical reasons and a very slight reduction in electrical downtime.

[1] *I.S.J.*, 1968, **70**, 355.

Cane preparation studies. J. Jaddoo. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 176-185. – A survey of factory control data, supplemented by bagasse pol analyses using a Jeffco disintegrator, shows that pol extraction in Jamaican sugar factories is only about 91% while cell breakage in the cane preparation equipment averages only some 46%. If the latter figure could be raised, it would provide advantages in higher crushing rates for the same power, better pol extraction, bagasse of greater heating value which would reduce the need for supplementary oil fuel, and greater availability of bagacillo as filter aid.

Cane knife hardfacing. H. Manifold, C. A. Sylvester and J. M. Ragnauth. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 186-191. – The cost of knives used in cane preparation increased from G$55 each in 1969 to G$145 in 1975, while supply difficulties were also experienced. Methods introduced to extend the life of a knife include drilling another fitting hole to allow use of four cutting edges instead of two, and hardening the knife edges with welding electrodes and powders.

A method of determining extraction changes due to variations from assumed conditions. R. E. O'Neal. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 192-209. – A method of predicting changes in extraction due to variations in mill settings and deviation from assumed operating conditions, using easily measured variables, is derived from accepted milling theory and the Farrel method of calculating mill settings.

The four roller mill in Guyana. L. L. Heath-London and C. A. Sylvester. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 210-216. – An account is given of the conversion of the first mills of the Albion and Enmore Estate tandems from having an underfeed system to the type of four-roller mill as employed in South Africa in order to increase milling capacity. The increase has been achieved, as has stage extraction, although the latter has not reached expectations and further modifications are to be attempted to improve performance.

Laboratory results in clarification and ion exchange of sugar juices. S. J. Clarke and J. R. McFarlane. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 217-220. – A new clarification technique was described by the authors at the 1975 Meeting of the Jamaican Association of Sugar Technologists and further aspects of the process are discussed. It operates at ambient temperature and uses a cationic polymer which encourages the precipitation of protein along with other materials such as calcium phosphate during clarification. Experiments are also continuing on demineralization of the clarified juice with a view to making liquid sugar.

Preliminary studies on the use of natural products as flocculants in juice clarification. W. A. Mellowes. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 221-231. – Extracts of two natural products, *Opuntia* sp., a cactus, and fruits of the ochro plant *(Hibiscus esculentus)* were prepared and tested as flocculants by comparison with Separan AP-30 synthetic flocculant. Both were effective in improving the settling of clarification juice, but less so than Separan.

Some parameters affecting operation of a vibratory filter. W. A. Mellowes. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 237-247. – Trials were made on a system of whole-juice filtration after liming instead of settling; 3.75 g of a bagacillo-Dicalite mixture was used as filter aid per litre of juice and a candle filter was employed which was provided with a mechanism for longitudinal vibration to remove the cake formed. A number of parameters were varied to determine the best results; Dacron or Nylon filter cloth is recommended, when no back wash water is needed. A frequency of 9 Hz and amplitude of 4 mm are recommended with 2-5 psi air when the vibration is employed in a cyclical manner; when the filter is vibrated continuously a frequency of 13 Hz and amplitude of 5 mm give better results. Colour and turbidity removal were better at lower frequencies, and colour removal was maximum at 3-4 mm amplitude.

Methods adopted to investigate and control the colour problem at Albion Estate. B. Persaud. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 248-260. – Colour in raw sugar from Guyana was high and attracting penalties, so that a study was made to determine the causes by a comparison of operation at the best (Wales) and worst (Albion) factories. Differences include use of supplementary phosphate at Wales, insufficient use of bagacillo for mud filtration at Albion, mud liming at Wales, use of flocculants at the Wales clarifier station, insufficient attention to mud levels at Albion, more frequent clarifier liquidation at Wales, use of "Hydros" and less recirculation of low-grade material at Wales. These all produced a more uniform control of mixed juice pH. Corrective measures were applied and are described; these have resulted in an acceptable quality of sugar and a number of other benefits such as higher heat transfer rates; better recovery, etc.

An approach to computer simulation of a raw sugar factory operation. D. R. McGaw and W. A. Mellowes. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 275-280. It is suggested that, in the development of a computer simulation of raw sugar factory operation, the various transfer processes which take place can be programmed separately as sub-routines for each particular operation in the factory and these sub-routines put together in a manner appropriate to the desired calculation. This approach may be used, for instance, to examine the effects of raw material inputs, plant operation conditions and plant processing routes on the overall operation of the factory under consideration. It may also be used to optimize the use of steam and water. Sub-routines have to date been developed for the mill tandem, pre-heaters and evaporator system and have been applied to a particular factory operation in order to optimize the vapour bleed arrangement for minimum evaporator steam requirement, and to determine the reduction in evaporator steam requirement when the condensate from the last effect is returned to process as imbibition water.

Vacuum pan automation. G. R. Moller and E. Knovl. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 292-300. Aspects of the DDS system of pan boiling automatic control are described, including a new system of preparing seed crystal slurries in polyethylene and polypropylene glycols which are non-toxic, water-miscible, less volatile than *iso*-propanol and do not dissolve sugar.

Horizontal tubular pan. P. Baudon and C. Ebeling. *Brasil Açuc.*, 1979, **94**, 225-243 *(Portuguese)*. – See *I.S.J.*, 1980, **82**, 60.

BEET SUGAR MANUFACTURE

Washing mud off disc filters, used for polish filtration of 1st carbonatation juice, with raw juice. A. P. Lapin. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (10), 5-9 *(Russian)*. – The practice used in most Moldavian factories, whereby the filter mud is removed with raw juice and pumped to the preliming tank, requires regulation of the quantity of unfiltered 1st carbonatation juice recycled to preliming. At Chervonoznamensk the mud is normally washed off with filtered 1st carbonatation juice and sent to preliming; if the beet quality falls, leading to turbid decantate from the clarifiers and increased load on the filters, the interval between mud discharge is reduced, so that the quantity of suspension sent to preliming becomes such as to have an adverse effect on purification and reduce factory throughput. By using raw juice for backwashing, the interval between mud discharges has no effect on preliming, while juice alkalinity is maintained throughout purification, and the amount of 1st carbonatation juice recycled to preliming is halved. Tabulated data are given showing juice alkalinities in a 10-day period in 1975.

Investigation of electroflotation treatment of flume-wash water in a pilot plant. N. A. Arkhipovich and V. A. Lagoda. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (10), 9-13 *(Russian)*. – Electroflotation was carried out in a horizontal, 4-compartment vessel provided with graphite anodes and stainless steel mesh cathodes. Aluminium sulphate was added as coagulant and milk-of-lime for maintenance of alkalinity. Scum formed on the surface was scraped by mechanical rakes into a collector and subsequently reduced by ultrasonic defoamer. Optimum conditions were preheating to 18-20°C, addition of 0.15 mg.cm^{-3} $Al_2(SO_4)_3$, liming to pH 11, and use of a current density of 200 A.m^{-2} in the 1st and 3rd compartments and 80-100 A.m^{-2} in the 2nd and 4th compartments. Under these conditions, BOD_5 was reduced by 55-65% and the bacterial population by 93-98%.

Methods for raising the degree of CO_2 utilization. Yu. G. Goncharov, E. A. Pugachev, L. N. Dobrovol'skaya, P. P. Pavlov and N. I. Starushenko. *Nauch.-Tekh. Ref. Sbornik Sakhar. Prom.*, 1976, (11), 5-8 *(Russian)*. CO_2 utilization efficiency was raised by treating defecation juice at a height of 2 and 3 m in an experimental gas-lift absorber (A) before 1st carbonatation. The juice, of 1.2-1.6% CaO initial alkalinity and flowing at 0.18-0.45 m.sec^{-1}, was reacted at 60-80°C for 12-47 sec with a model gas containing 7-15% CO_2 (equivalent to that leaving a 1st carbonatation vessel) and flowing at 1.24-1.95 m.sec^{-1}. In all cases, CO_2 absorption was already 100% at a juice height of 2 m. Tabulated data for juice treatment in an absorber (B) with a continuous bubbled layer showed that CO_2 utilization rose with height of the juice layer, and was 48-59% at 2 m, 72-82% at 3 m, and 100% at 4 m. For a sufficiently high CO_2 utilization without raising the juice layer height, a three-stage 1st carbonatation system is recommended: Stage 1 involves reacting the defecation juice with partially used gas in a type (A) absorber for 45 sec; in Stage 2, the juice is reacted with partially used carbonatation gas in a type (B) absorber for 135 sec; and in Stage 3, the juice is reacted with carbonatation gas for 7 min in the type (B) absorber.

A raw juice preliming method. L. P. Reva and V. V. Pyshnyak. *Nauch.-Tekh. Ref. Sbornik Sakhar Prom.*, 1976, (12), 1-6 *(Russian)*. – Details are given of a prototype vertical progressive preliming vessel installed at Globino sugar factory. It is divided into a number of compartments by horizontal partitions provided with orifices for juice flow from bottom to top of the vessel. Milk-of-lime is fed into each compartment from individual lateral branch pipes. The hollow vertical rotary shaft is provided with a concentric steam jacket (the steam being fed at the top) and an inner concentric tube for discharge of condensate. Snaked elements in each compartment are fixed, at right angles to the central shaft, so that their upper end is connected to the steam jacket and the lower end to the condensate pipe. The elements thus act as heaters as well as agitators. In tests, in which the total residence time was 10-15 min and the temperature was progressively taken to 85°C, the final juice colour was 58°St, compared with 53°St in cold preliming and 75°St in hot preliming. Marked invert sugar degradation was observed only in the final stage of the process. Purity rise was 2.2 units, compared with 2.4 and 1.5 units, respectively, in cold and hot preliming, while colloid removal was 32.6%, compared with 21.1 and 37.9%. The filtration time for the treated juice (to which carbonatation mud had been added) was 5.4-6.0 min, compared with 5.0-5.5 for hot preliming and 4.0-4.5 min for normal factory predefecation juice. Cold preliming gave a juice of much poorer filtration properties.

Pilot trials of partial anion removal from clarified beet juice. R. Pieck and J. DeGeest. *Sugar J.*, 1979, **41**, (9), 8-11. – See *I.S.J.*, 1980, **82**, 62.

The optimum number of feed apertures in the working chamber of an electrodialyser for sugar manufacture. L. D. Bobrovnik, P. P. Zagorodnii and V. A. Zhurakhovskii. *Izv. Vuzov, Pishch. Tekh.*, 1979, (1), 77-81 *(Russian)*. – A mathematical procedure is used to determine the optimum number of supply apertures for e.g. molasses solution, based on a given range of aperture dimensions and a flow velocity through them which is 25-35 times that in the chamber. Optimization of the number minimizes power consumption, ensures regular distribution of liquid streams in the cells and eliminates dead zones, thus providing for better utilization of the active surface of membranes.

Optimization of the system of forced recrystallization in vacuum pans. V. O. Shtangeev. *Izv. Vuzov, Pishch. Tekh.*, 1979, (1), 94-97 *(Russian)*. – A series of 1st massecuite strikes were boiled in a modified vacuum pan in an investigation of the effects of changes in the parameters involved in the system described earlier[1,2]. After results indicated that the use of forced re-crystallization, under the effect of imposed periodic pressure (and, hence, temperature) changes at amplitudes A and frequencies f which were constant throughout the boiling period,

[1] Shtangeev *et al.*: *I.S.J.*, 1976, **78**, 185.
[2] Idem: *ibid.*, 217.

did not give the desired improvement in crystal size distribution, a mathematical model was used to calculate values of A and f at which crystal mean size was maximum and the non-uniformity coefficient minimum. Computerized processing of the equations gave values which were applied to 1st and low-grade boiling; for the former, A was increased in two stages from zero (at nucleation) to 3.9 and finally 5.0 kPa, and f was reduced from 6 to 3 and then to 1.2 hr^{-1}, while for low-grade boiling A was increased from 3 to 7 kPa and f reduced from 3 to 1 hr^{-1} in only one step.

Regulable parameters in sugar extraction from beet with pulp press water recycling. A. I. Fel'dman, O. V. Stratienko, L. V. Zotkina and V. M. Lysyanskii. *Izv. Vuzov, Pishch. Tekh.*, 1979, (1), 119-121 *(Russian)*. Mathematical examination of the diffusion process where recycled press water is fed into the diffuser together with fresh water showed that automatic control must allow for regulation of two parameters, viz. cossette dimensions and fresh water quantity.

Heat transfer, residence times, viscosity pattern and mathematical control in cooling crystallization of low-grade massecuite. T. Cronewitz. *Zuckerind.*, 1979, **104**, 265-274 *(German)*. — Investigations are reported which were conducted on the BMA vertical crystallizer installed at Rain sugar factory of Süddeutsche Zucker-AG for the 1976/77 campaign. Details are given of an improved version of the crystallizer introduced in 1978. The studies concerned the effect of viscosity on torque under conditions of increasing crystal content and reducing temperature. Typical was a drive shaft torque range of 25-30,000 daNm at a viscosity of 15-20,000 dPas, a temperature of 40°C and a shaft speed of 1 rpm. Measurements made by BMA indicated that, for economical drive operation, shaft speeds of 0.9 rpm and 0.53 rpm were optimum for massecuite feed temperatures of 55° and 40°C, respectively; lower speeds would adversely affect heat transfer. Linearity was established between torque and V_B, where $V_B = R_2/R_1$, R_2 = sucrose:non-sugar ratio at saturation and R_1 = sucrose:non-sugar ratio at 45°C and a non-sugar:water ratio of 2.8. The increase in crystal content was then calculated as 25.88 - 21.89 x V_B at a correlation coefficient of 0.73. Studies on heat transfer in a continuous crystallizer battery at Waghäusel factory and in two batch horizontal crystallizers at Rain as well as in the vertical crystallizer showed no essential difference in the value of the heat transfer coefficient k between the crystallizers studied. Values obtained for four vertical crystallizers operating in series at Regensburg confirmed increase in k with increasing massecuite temperature and hence reducing viscosity, but showed that k was completely independent of crystallizer design, being governed by only two parameters: mean logarithmic temperature difference and massecuite consistency. Determination of massecuite retention time showed that this was extremely long, but was drastically reduced by modifications to the crystallizer, which gave satisfactory values comparable to those obtained in the vertical crystallizers at Regensburg. The crystallization rate corresponding to a residence time of 19 hr and a cooling rate of approx. 1°C.hr^{-1} was 6.2-7.3 $mg.m^{-2}.min^{-1}$, compared with values in the range 3-30 $mg.m^{-2}.min^{-1}$ at various factories of Süddeutsche Zucker-AG. No clear relationship was found between crystallization rate on the one hand and crystal content, cooling rate and massecuite air content on the other. A balance can be drawn up, for which only knowledge of the initial and desired discharge temperatures and the purity drop in mother liquor is required. This is illustrated for a residence time of 19 hr. For cases where water is added during crystallization, empirical values of m and b in the Wiklund equation for saturation coefficient have been established, and from these sucrose solubility tables produced for normal molasses and molasses after Quentin ion exchange.

Discussion contributions on the theme "Low-grade working with vertical crystallizers" at the Meeting of the German Sugar Technologists' Association (VDZ). *Zuckerind.*, 1979, **104**, 274-277 *(German)*. — A number of participants at the 1978 Meeting of VDZ contributed to a general discussion on vertical crystallizers for low-grade massecuite cooling, with mention of experience gained with Selwig & Lange, DDS and RT vertical crystallizers (descriptions being given of the first two) and examination of various aspects of low-grade crystallization.

Recent operational results from the 1978/79 campaign with BMA vertical crystallizers. Anon. *Zuckerind.*, 1979, **104**, 277-278 *(German)*. — Brief mention is made of results obtained with the modified BMA crystallizer mentioned in the article by Cronewitz (see abstract on this page). Residence time was determined by means of a tracer such as LiCl fed directly into the suction pipe of the massecuite feedline. Some 70% of the tracer was recorded at the discharge port after a calculated mean residence time of 12 hr. Since the heat transfer coefficient k is dependent on massecuite consistency, the position of individual crystallizers within a battery is of decisive importance. Several sets of measurements showed that for a complete crystallizer station the product $k.\Delta t$ (where Δt is the mean logarithmic temperature difference) has a value of 600 $kcal.m^{-2}.hr^{-1}$ (700 $W.m^{-2}$). This would mean, e.g., a value of k of 30 $kcal.m^{-2}.hr^{-1}$ and hence a value of Δt of 20°C between massecuite and cooling water. A high cooling gradient averaging 2°C.hr^{-1} eliminates the risk of fines formation and gives an additional molasses purity of up to 4 units in contrast to conventional operation of horizontal crystallizers with identical cooling times, and thereby considerably increases the amount of sugar recovered. Requisite for this is an optimum non-sugar:water ratio, which should be higher than with conventional crystallizers, and an associated increase in crystal content during crystallization.

Protection of inactive turbines and boilers with the dry air process. H. J. Riesterer. *Zuckerind.*, 1979, **104**, 288-290 *(German)*. — Advice is given on how to remove residual moisture from turbines and boilers when they are not in operation by injecting dry air and thus preventing corrosion.

Pumps for the sugar industry of high-wear-resistant Norihard. R. Dittrich. *Zuckerind.*, 1979, **104**, 404-407 *(German)*. — The wear-resistant properties of Norihard, a chromium-molybdenum alloy developed by KSB Klein, Schanzlin & Becker AG for pump manufacture, are discussed and references made to its advantages over other hard wearing materials for pumps used to handle highly abrasive substances such as flume and beet wash water, thick mud and milk of lime. In all cases mentioned, the pumps made from Norihard have shown little wear after a given time, whereas other pumps have exhibited marked deterioration.

NEW BOOKS

Sugar beet: a grower's guide. 60 pp; 15 x 21 cm. (Sugar Beet Research and Education Committee, c/o The Library, Broom's Barn Experimental Station, Higham, Bury St. Edmunds, Suffolk IP28 6NP, England.) 1980. Price: £1.75.

The Sugar Beet Research and Education Committee directly funds three-quarters of sugar beet research in the UK from contributions made by growers and processor, and also helps in the remaining quarter of the program through the Agricultural Research Council. The present work is the result of collaboration between staff at various organizations concerned with agricultural research, and is a comprehensive guide to beet agriculture divided into sections covering all aspects from seedbed preparation to harvesting, including choice of variety, a beet crop calendar and lists of agricultural chemicals. The text is interspersed with colour illustrations, and the clarity of type plus the neat layout and the considerable amount of very useful information combine to make this a most valuable yet inexpensive guide.

Prospects and planning of the sugar industry in Pakistan. S. M. Alam. 29 pp; 22 x 28 cm (Dadu Sugar Mills, Sind Sugar Corporation Ltd., P.O. Box 11, Dadu, Pakistan.) 1979.

The work is a bound copy of a paper presented at the 16th Annual Convention of the Pakistan Society of Sugar Technologists in 1979. The author is Production Manager of Dadu Sugar Mills and is concerned that Pakistan is facing a shortage of centrifugal sugar despite an increase in the number of sugar factories, since farmers have been supplying cane for manufacture of gur and khandsari. The Pakistan Government has increased the price of cane in order to encourage diversion of the cane to the factories, and has also decided to import sugar, as well as raising the price of sugar. However, the author is of the opinion that the problems facing the industry are such that improvement will only come about by more detailed approach to the fundamentals of cane agriculture and processing, including training of personnel, factory planning, promulgation of information and a pricing strategy, etc.

Grupo de Países Latinoamericanos y del Caribe Exportadores de Azúcar (GEPLACEA). 32 pp; 23.5 x 21 cm. (GEPLACEA, Avenida Ejercito Nacional 373, Primer Piso, Mexico 17, D.F.).

This publication explains the objectives and functions of GEPLACEA, which represents Latin-American and Caribbean sugar exporters, and gives details of projects carried out in 1977 and 1978 with finance from various sources (including UNCTAD), statutes, regulations, working plan and budget, financial contributions and coordination of the Group. The information service operated by GEPLACEA, meetings held, the importance of the Group in the world sugar economy, program of technological cooperation, the administrative organization of the Group and the composition of the secretariat and officers elected to it for 1979-82 are also indicated. The booklet is in English and Spanish and will be of interest to those readers wishing to know more about what has become a major sugar trading group.

Sugar Philippines. 96 pp; 21 x 28.5 cm. (National Sugar Trading Corp., Manila, Philippines.) 1980.

By means of numerous colour illustrations accompanying the text, this book gives a brief sketch of the Philippines followed by a description of the Philippines sugar industry in all its aspects. A map showing the locations of sugar factories and refineries is followed by a directory of sugar and associated organizations, sugar factories and refineries and distilleries. For readers interested in one of the leading sugar economies of south-east Asia, this book makes worthwhile reading.

The Mauritius Chamber of Agriculture President's Report 1978-1979. 46 + xxxii pp; 20 x 26.5 cm. (Mauritius Chamber of Agriculture, P.O. Box 312, Port Louis, Mauritius.) 1979.

The first 17 pages of this Report are devoted to the sugar industry, including an outline of the 1978 season, by-products manufacture and exports, progress with the bulk sugar terminal under construction at Port Louis and various cane agricultural aspects as well as items concerning world sugar trading.

Informe Anual 1979. 67 pp; 21.7 x 27.8 cm. (Instituto de Investigación Agropecuaria de Panamá, Apartado 58, Santiago, Veraguas, Republic of Panama.) 1980.

The IDIAP was established under a law passed in 1975 and this annual report is an account of its activites in the period October 1978 – September 1979. The Institute is concerned with a variety of crops as well as raising and feeding of animals so that relatively little concerned directly with sugar and cane is described. Mention is made, however, of work on the feeding of cane to dairy cattle, of fertilizer trials carried out at La Victoria, and of nematode control experiments.

Bibliografía No. 1 –Caña de azúcar. F. G. de López and O. de Robles. 10 pp; 20.8 x 27.9 cm. (Instituto de Investigación Agropecuaria de Panamá, Apartado 58, Santiago, Veraguas, Republic of Panama.) 1980.

A list of 121 references is given to articles (by alphabetical order of the authors) concerning sugar cane to be found in the library of the institute.

Mauritius Sugar Industry Research Institute Annual Report 1978. 81 pp; 21 x 29.5 cm. (Mauritius Sugar Industry Research Institute, Réduit, Mauritius.) 1979.

Of this report, 59 pages are devoted to the sugar industry; these cover various aspects of the 1978 crop, including cane breeding and varieties, agronomy and plant physiology, field mechanization, diseases, pests, weeds, sugar technology and by-products utilization.

Technical report 1975-1976 ICA, Cuba. 121 pp; 14 x 20 cm. (Instituto de Ciencia Animal, Carretera Central, km 47½, Catalina, Habana, Cuba.)

This is a report of the Animal Science Institute, covering the various departments grouped under ruminants, non-ruminants, pasture science, biochemistry and applied mathematics. It gives details of the scientific staff, courses and works published in the Cuban Journal of Agricultural Science and elsewhere. As regards the sugar industry, the main importance of the ICA is its work on use of cane by-products as animal fodder.

LABORATORY STUDIES

Laboratory research and development in South Africa. Anon. *Ann. Rpt. Sugar Milling Research Inst.*, 1978.

Mud filtration: Since small-scale laboratory simulation of clarifier mud filtration is hampered by design difficulties, investigations were conducted with a capillary suction apparatus designed for the water purification industry. It comprises a Perspex (polymethyl methacrylate) jig in which a slurry-filled reservoir rests on a special filter paper which draws filtrate out of the slurry under capillary action. The time taken for the circular water front to advance through a fixed distance between two concentric rings marked on the jig is measured electronically and is known as the capillary suction time (CST); this is related to the specific resistance to filtration of the slurry, given a number of constant factors. Preliminary trials showed that individual readings could vary by ± 10% from the mean, and that changes slowly occurred in CST with time from mud sampling (probably a result of changes in the mud slurry), the degree of change varying between samples. It was found that CST depended directly on the % mud solids in the slurry, so that correction to a common value is necessary for purposes of comparison. Flocculant addition to mud gave contradictory results, possibly as a consequence of the degree of adsorption of the flocculant and hence of flocculation; unadsorbed, dissolved flocculant can itself lead to a rise in CST, as did addition of lime to a slurry, indicating a decrease in filtrability. In all the experiments, the mud had first to be cooled to room temperature, since the apparatus has no provision for high-temperature runs.

High-pressure liquid chromatography: HPLC was used to determine levulose, dextrose and sucrose in molasses and juice. A Particil 10 PAC column proved unsatisfactory because of a very weak solvent mixture required to give acceptable resolution between the two monosaccharides, resulting in a late and poorly shaped sucrose peak; a Carbohydrate μBondapak column gave a far better chromatogram, however. Precision and accuracy tests using a standard mixture of the three sugars, with trehalose as internal standard, showed satisfactory results for levulose and sucrose but not for dextrose, average relative standard deviations for 17 injections being ± 1.0 for sucrose, ± 1.4 for levulose and ± 3.6 for dextrose. Some of the molasses samples gave an interfering peak between the dextrose and levulose peaks, which could not then be quantified. Attempts to identify and eliminate the interfering peak proved unsuccessful. Values of sucrose determined by HPLC in four molasses samples were identical with ICUMSA mean values in two cases and close to them in the other cases, and were generally closer than were values obtained by gas-liquid chromatography at the SMRI and another laboratory. Since the HPLC column became irreversibly fouled, investigations were to be carried out on the suitability of an ion exchange column for sucrose determination.

Determination of dextrose and sucrose in final molasses using an automated enzymatic method: Recovery of sucrose added to final molasses solutions was significantly improved, as was reproducibility, by modifications to the automatic enzymatic method of dextrose analysis. Whereas the "enzyme buffer" solution, containing peroxidase, dextrose oxidase and 4-amino antipyrin, had originally been added to the already dialysed sample, so that low dextrose values were obtained, addition of the solution to the dialysing solution resulted in immediate reaction between dextrose and the reagents, preventing loss of dextrose due to side reactions. Increasing the path length of the flow-through tube of the colorimeter to 50 mm allowed the sizes of the sample pick-up tubes to be altered so that full scale deflection on the recorder was obtained over the range 0-500 ppm, thus increasing response sensitivity. On 32 replicate analyses of a molasses sample, a standard deviation of ± 3.65 and a C.V. of ± 1.91% were obtained for an average dextrose value of 190.6 ppm. Recovery of added dextrose was 99.2%; this was increased to 100.9% after enzymatic hydrolysis.

Brix measurement: After a Maselli precision refractometer, based on measurement of the angle of reflected light and calibrated to give a digital read-out to two decimal places, gave statistically significant differences between Brix values for filtered and unfiltered samples (whereas the design theory should ensure similarity between both sets of values), the effect of particles on Brix measurement was investigated with a Bausch & Lomb instrument using reflected and transmitted light; measurements were also made with reflected light after filtration of the solutions through Whatman No. 2 paper and Millipore filters. Preliminary results showed that when pure sucrose solutions of 1-5°Bx were measured, closed agreement was obtained with both forms of light, addition of bentonite or Celite 505 making little difference to the readings. However, the Brix values measured after use of filter paper or Millipore filters were slightly higher. When a 1:5 diluted molasses sample was tested, the values obtained for the sub-samples with reflected light were always higher than with transmitted light, irrespective of whether the sub-samples were filtered, unfiltered or centrifuged; still higher values were usually obtained after filtration, but bentonite or kieselguhr had little effect on the values. Hence, it seems that either the nature or the particle size distribution of material suspended in sugar solutions is responsible for the interference, and further work is needed to clarify the position.

Development of sugar colour: Laboratory clarification was applied to diffuser and mill juice from Tongaat. Although the colour of diffuser juice was higher than of mill juice, there was little increase in colour during clarification, and clear juice colour was slightly lower than at two other factories. Centrifuging of juice instead of filtration, to ensure that offending colouring matter was not removed together with turbidity, was less efficient than filtration as regards turbidity removal, so that the apparent juice colour levels were higher. However, a smooth trend in the plot of colour *vs.* centrifuge speed indicated the probable absence of any particular offending substance. (At the same time, it was found that trashed cane fed to the diffuser gave higher juice colour than burnt cane, indicating the effect of leaves on colour and colour precursors in the juice.) While the colour of *A*- and *C*-molasses at Tongaat was lower than at the other two factories, sugar colour was higher. The much greater colour contents in molasses than in clear juice or syrup indicated that the major

increase in colour occurs during boiling, but no relationship has been found between *A*-molasses colour and sugar colour, suggesting that colour is not simply distributed between molasses and sugar during boiling, but that a more specific mechanism is involved. Analysis of a wide range of sugar samples for phenolics yielded a correlation between phenolics content and sugar colour at 560 nm. An attempt to correlate phenolics in sugar with those in juice or syrup was unsuccessful, indicating that the phenolic colorants in sugar crystals are either produced during boiling, possibly by chemical degradation of polymeric species, or are chemically specific.

Determination of organic acids: An attempt has been made to develop a gas-liquid chromatographic method for determination of hydroxy- and dicarboxylic acids in cane juice. Optimum conditions have been established using a 2-m column packed with 3% OV17 on Gas Chrom Q; precision and accuracy were found to be acceptable for a standard mixture of glycolic, succinic, glutaric, malic, tartaric, aconitic and citric acids. The acids in juices and other factory products must first be separated by ion exchange, after which the eluant is evaporated and dried before silylation. Recoveries of acids from a standard mixture thus treated were acceptable.

Crystal elongation: The effect of kestoses on crystal elongation was investigated by measuring under a microscope the average length:width ratio of 10 elongated crystals randomly taken from a number of massecuites. The elongated crystals % total crystals was calculated and the quantities of the three kestose isomers determined in each massecuite by gas-liquid chromatography. No correlation was found between the amounts of any of the kestoses and the average L:W ratio of the crystals. Analysis of the massecuites for dextran was carried out by removing inorganic salts on a monobed of Amberlite MB1 ion exchange resin, hydrolysis of starch with α-amylase, and measurement of the "haze" at 720 nm after precipitation with 50% ethanol. Although there were considerable differences in dextran content between the massecuites from different factories, there was little correlation between dextran content and the L:W ratio. In some massecuites having sugar crystals exhibiting marked elongation, the crystals were completely dissolved by dilution with water and heating, the solution re-concentrated to supersaturation, a small amount of seed crystal added and the sugar crystallized at 40°C. The resultant crystals generally showed no elongation, and in only a few cases was slight elongation apparent. It appears, therefore, that conditions during crystallization contribute to elongation as well as certain massecuite impurities. This suggestion is supported by the experience at one factory where two vacuum pans operate on the same supply of *B*-molasses; one pan generally produces elongated crystals while the other gives normal crystal.

Grain size analysis of raw sugar: Comparison of three high-frequency shakers for grain size analysis showed that an Endecott shaker gave 3-4% absolute fewer fines than did a Fritsch shaker, while a Pascal shaker gave about 4% more fines than did the Fritsch. (Some information is given on the operating frequencies and amplitudes.) The need is stressed for laboratories to standardize on a specific instrument for purposes of comparison.

The solubility of sucrose in water. A. VanHook. *Proc. 38th Ann. Meeting Sugar Ind. Technol.*, 1979, 198-203. See *I.S.J.*, 1979, **81**, 134.

Sugar content of sugar beet and its polarimetric determination. D. Bourdon. *Sci. Agron. Rennes*, 1976, 19-36; through *Food Sci. Technol. Abs.*, 1978, **10**, (1), 1 L47. – Polarimetric methods for the determination of sucrose in beet are discussed; factors influencing the result are considered, including homogeneity of sampling, hot *vs.* cold digestion, interference by other sugars, and brei extraction conditions. Factors affecting the sucrose content of beet are discussed, with special reference to variation within individual varieties; a method for estimating this variation is described. Paper chromatographic methods for separation and determination of sucrose in the presence of other sugars, especially raffinose, are outlined.

Determination of the sucrose content in molasses by gas chromatography. J. Čopíková and F. Kvasnička. *Listy Cukr.*, 1979, **95**, 93-96 *(Czech)*. – Molasses containing 15-18 mg sucrose and trehalose (as internal standard) in a ratio of 1:1.5 to the sucrose was subjected to gas-liquid chromatography after silylation with 0.45 cm^3 hexamethyldisilazane in a mixture of 0.5 cm^3 pyridine and 0.05 cm^3 trifluoroacetic acid at 60-70°C. To the 1800 mm x 2.5 mm glass column, filled with wetted Chromaton N AW HMDS carrier of 0.125-0.160 mm particle size, was applied 0.5 μlitre of the mixture. A Chrom 3 chromatograph was used with a flame ionization detector. The values obtained for sucrose in molasses from various sources were compared with those given by direct polarization and by Clerget double polarization. The GLC method gave lowest values, followed by the Clerget values and then the direct polarization values. Statistical evaluation of the results, using the Student *t*-test and the *F*-test, confirmed the greater accuracy and reproducibility of the GLC method (demonstrated by 10 determinations on *C*-molasses) which should therefore be used as control method.

Phospholipids in sugar cane juice and their fate during the process of clarification. A. Garg. *Indian Sugar*, 1978, **28**, 423-432. – See *I.S.J.*, 1979, **81**, 200-205.

IR-spectra of polymeric molasses constituents. S. C. Sharma and P. C. Johary. *Zuckerind.*, 1979, **104**, 412, 414. – After paper chromatography of molasses from two sulphitation factories and a carbonatation factory, using 2:2:1 butanol:ethanol:water as solvent, the paper was dried and the section mostly containing the constituents of highest molecular weight was cut out and eluted with distilled water; the eluate was evaporated to dryness, the samples ground with KBr and pressed. The infra-red spectra were then recorded. Details are given of the spectra and their interpretations; the constituents included high concentrations of alcoholic and phenolic hydroxyl groups, aldehydes, intramolecular hydrogen bonds and primary and secondary amino groups.

Determination of reducing sugars in refined sugar. B. Guzmán. *Circ. Est. Exp. Agríc. Tucumán*, 1978, (208), 5 pp *(Spanish)*. – A description is given of the Knight & Allen technique[1] which has been found of great utility at the Tucumán Experiment Station. Factors found by Plews & McGrath[2] to influence the results are recorded.

[1] *I.S.J.*, 1960, **62**, 344-346.
[2] "Analytical methods used in sugar refining" (Elsevier, Amsterdam), 1970.

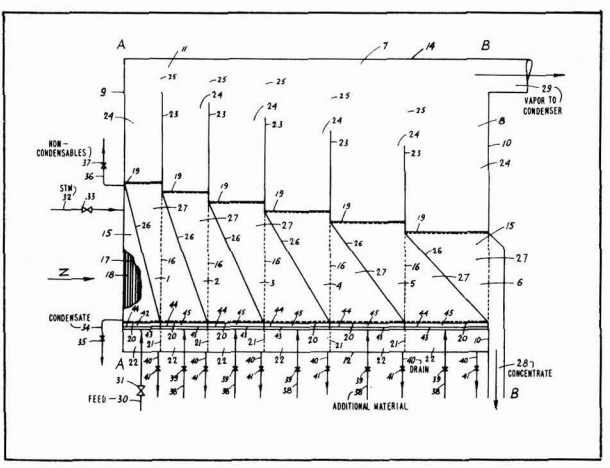
PATENTS

UNITED STATES

Sucrose derivatives. R. A. Khan, of Sonning, England, *assr.* Tate & Lyle Ltd. **4,002,609.** February 24, 1975; January 11, 1977. — 1',2,3,3',4,4',6-Hepta-O-acetyl sucrose (A) and 1',2,3,3',4,6,6'-hepta-O-acetyl sucrose (B) are prepared by tritylating sucrose (with triphenylchloromethane) to give a mixture of 4'- and 6'-monotrityl sucroses, acetylating the mixture with acetic anhydride without separation of its components, and then de-tritylating the acetate mixture with HBr in acetic acid solution, then recovering (A) by crystallization from the mixture produced. (B) is recovered by re-tritylating the residual solution (followed by successive de-tritylation and re-tritylation at least once) and subjecting to chromatography.

Medium containing molasses and soya flour for producing dextrose isomerase. K. K. Shieh, of St. Louis, MO, USA, *assr.* Anheuser-Busch Inc. **4,003,793.** February 10, 1975; January 18, 1977. — A dextrose-isomerizing enzyme is produced by inoculating an *Actinoplanes* sp. (*A. missouriensis* NRRL-33342) into a fermentation medium containing (0.4 — 7%) soya flour or soya meal and (1 — 6%) beet and/or cane molasses (and NO_3^- equivalent to 0.1 — 0.6% $NaNO_3$) [at 20° — 40°C (30° — 34°C)].

Multistage continuous vacuum pan. J. C. V. Ducasse, of Papaaloa, Hawaii, USA, *assr.* Unice Machine Co. **4,004,964.** April 18, 1974; January 25, 1977.



The pan 7 includes a feed end wall 9 and a discharge end wall 10 joined by sidewalls 11, a bottom 12 and cover 14. Within the pan are a series of transverse partitions 23 which divide the pan into compartments 22 in each of which is a heating element 17. Longitudinal plates are provided in the pan which define either central or lateral downtakes, depending on whether the pan operates by centre-flow or side-flow circulation. Within each downtake is an inclined plate 26 so that the spaces 24 above each heating element connect with the subsequent compartments 22. The space 25 above all the compartments is connected by port 29 to a vacuum condenser.

Feed syrup is admitted through pipe 30 into the first compartment and additionally, where desirable, through pipes 38 and valves 39 into subsequent compartments. Steam is admitted to the heating elements 17 (which may employ plates, coils or tubes 18) through pipe 32 and valve 33, condensate being withdrawn through pipe 34 and valve 35. The syrup is heated and concentrated in each compartment before being conducted to the next, leaving as massecuite through the discharge port 28. The sequentially reduced height of the heating elements in the compartments ensures that the temperature in each is such as to minimize caramelization, and the tube diameter is increased from the feed to the discharge end to permit easier circulation of the thickening material.

Cane planter. J. S. Faxas, of Clewiston, FL, USA. **4,005,805.** August 19, 1975; February 1, 1977.

Calcium sugar phosphates. J. Whetstone, of Woodlea, Scotland, *assr.* Imperial Chemical Industries Ltd. **4,006,134.** January 9, 1976; February 1, 1977. — Calcium sucrose phosphate, a plant and animal nutrient, is made in a unit operating on a semi-continuous principle by circulating a lime-sugar slurry continuously at a high rate through a heat exchanger as pre-cooler (to 0 — 10°C), a cooled scraped-wall reactor into which phosphorus oxychloride is injected, and then back to the holding vessel. The serious problem of gel formation of the reaction mixture on cooling surfaces is obviated by this cooling technique.

Process and (centrifugal) apparatus for continuously producing a high concentration sugar solution. W. Dietzel, S. Matusch, H. Schaper and E. Zeichner, of Braunschweig, Germany, *assrs.* Braunschweigische Maschinenbauanstalt. **4,008,098.** December 10, 1975; February 15, 1977. — See UK Patent 1,476,047[1].

Cane harvester topping mechanism. K. Ruback and R. Haines, of Bundaberg, Australia, *assrs.* Massey Ferguson Services N. V. **4,008,557.** October 10, 1975; February 22, 1977.

Continuous crystallization process. P. H. Petri, of LaPlace, LA, USA, *assr.* Godchaux-Henderson Sugar Co. Inc. **4,009,045.** April 21, 1976; February 22, 1977. A relatively low-purity sugar solution and a relatively high-purity stream are combined in a regulated ratio

[1] *I.S.J.*, 1980, **82**, 162.

to give a feed of constant, desired purity to a vacuum pan. Sugar seed crystals of relatively uniform crystal size distribution are continuously supplied to the pan and the mixture boiled continuously to provide a massecuite. Part of this massecuite is withdrawn continuously, crystals of a desired size continuously separated in a centrifugal machine and further processed, while the mother liquor and the sugar crystals smaller than the desired size are stored for later conventional processing.

Beet molasses sugar recovery. R. G. E. Vandewijer and J. T. Degeest, of Kumtisch, Vissenaken, Belgium, *assrs.* Raffinerie Tirlemontoise. **4,009,046.** November 8, 1974; February 22, 1977. – Molasses is diluted with cold water, quicklime added to precipitate a lime saccharate and this filtered off from the molasses. The cold filtrate is recycled for dilution of the molasses, the filtrate: molasses volume ratio being >3. The molasses is treated with at least 50 meq per 100 g sucrose of $CaCl_2$, $Ca(NO_3)_2$, NaCl, $MgCl_2$ or Na citrate, either before or after dilution or during quicklime addition.

Prevention of turbidity formation in non-alcoholic beverages containing sugar. P. Roos and P. J. Kühn, *assrs.* Naarden International B.V., of Naarden, Holland. **4,009,289.** February 9, 1976; February 22, 1977. See UK Patent 1,456,262[1].

Sugar-containing foodstuffs. L. A. W. Hayward, of London, England. **4,009,293.** December 27, 1974; February 22, 1977. – See UK Patent 1,459,313[1].

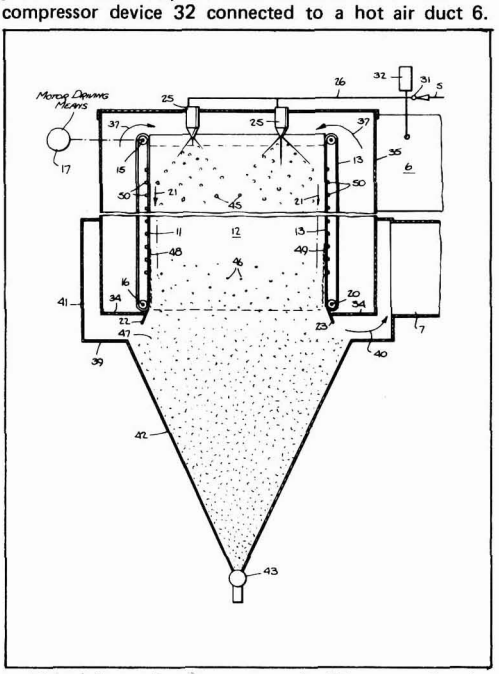
Synthetic organic flocculants to clarify raw sugar liquor. P. E. Shaughnessey, of Huntingdon Valley, PA, USA, *assr.* American Cyanamid Co. **4,009,706.** June 18, 1976; March 1, 1977. – Impurities in raw sugar liquor are flocculated by treatment with [300 – 5000 (500 – 3000) ppm of] a combination of cationic melamine: formaldehyde (in a ratio of 1:1.8 – 1:2.2) acid colloid and (1 – 25 ppm of) an anionic polyacrylamide containing 3 – 40 (10 – 30) mole % of its repeating units in the form of sodium acrylate groups and having a M.W. of at least 500,000 (10 – 20 million). In addition, about 175 ppm of phosphoric acid and up to 250 ppm of CaO are added. Clarification is carried out at 160 – 185°F.

Animal fodder containing bagasse, protein and yeast. Y. Kimura, of Naha, Okinawa, Japan. **4,011,806.** May 19, 1975; March 15, 1977. – An apparatus is described for subjecting a mixture of bagasse, *Candida utilis* or other yeast and *Trichoderma viridis* to a fermentation treatment, mixing the product with crushed and dried cane tops, adding cereals, and rolling and drying the resultant mixture into a desired shape.

Molasses impregnated bagasse pith animal feed. R. J. Fiala, T. L. Scott and K. N. Wright, *assrs.* A. E. Staley Manufacturing Co., of Decatur, IL, USA. **4,012,535.** September 3, 1974; March 15, 1977. – Animal fodder having a bulk density of at least 20 (24, 27) $lb.ft^{-3}$, containing at least 60% w/w molasses on a dry solids basis, is prepared by preconditioning a molasses adsorptive carrier (bagasse pith or, alternatively, bagasse, beet pulp, beet seeds, dried whole sugar cane, etc.) to a moisture content of < 5% (3-5%), grinding and screening it so that it passes a $\frac{1}{8}$–in ($\frac{3}{32}$–in) screen. It is then intimately mixed with preheated high-Brix (79 – 85°Bx) molasses of < 30% moisture (and 40-55% sugars) content, to give a blend containing about 10% moisture. This is pelleted at 100-130°F in the absence of steam and the pellets dried to < 4% moisture.

Cane juice concentrator. R. N. Silva, of Ridgewood, NJ, USA. **4,012,846.** July 28, 1975; March 22, 1977.

Four vertical travelling belts at right angles to each other (11, 12, 13) form a rectangular tube. The belt material (e.g. hard felt, fine pored or polytetrafluoroethylene-coated glass fibre cloth, reinforced rubber, etc.) is such as to prevent gas flow from inside the tube, and the belts are mounted on spaced rollers 15, 16, the upper ones being driven. Above the upper end of the tube are a number of spray nozzles 25 through which the juice is dispersed downwardly into the tube. Flow of juice is measured by a venturi device 31 connected to a compressor device 32 connected to a hot air duct 6.



This delivers air to an outer tube 35 surrounding the rectangular tube so that the hot air follows the direction of arrow 37 and after passage through the sprayed juice passes in the direction of arrow 40 into the duct 7. Any of the juice so concentrated which adheres to the belts is removed by the blades 22, 23 at their bottom edges which operate against the belt as it moves downwardly. The concentrated material collects in the conical hopper 42 and is withdrawn through discharge device 43.

Reduction of sucrose loss during storage of sugar beets due to reduction in respiration and invert sugar formation. A. H. Freytag and W. R. Akeson, of Longmont, CO, USA, *assrs.* The Great Western Sugar Co. **4,021,231.** May 14, 1974; May 3, 1977. – Beet respiration in storage is reduced by injecting ethylene gas into the soil between and near the middle of the rows of the growing beets at (6 ft) spaced intervals in amounts sufficient to reduce respiration and inhibit invert sugar formation in the harvested beet (3 applications of 1.4 – 2.8 lb. $acre^{-1}$), at a depth of 6 – 8 in when the beets have reached the fifth-leaf stage.

[1] *I.S.J.*, 1979, **81**, 317.
[1] *ibid.*, 1980, **82**, 96.

EEC sugar exports[1]

	1979		1978		1977	
	tonnes					
Origins	*Raw*	*White*	*Raw*	*White*	*Raw*	*White*
Belgium	31,947	496,515	52,203	311,904	42,160	338,140
Denmark	0	118,792	0	187,963	0	148,515
France	139,857	1,718,595	210,955	1,707,270	51,852	1,189,824
Germany, West	7,353	522,688	65,722	516,676	23,101	376,349
Holland	52	193,654	49	173,719	48	164,861
Ireland	0	10,599	1	3	0	12,500
Italy	0	4,841	0	182	0	5,598
UK	20,830	46,417	741	80,088	291	158,893
Total	200,039	3,112,101	329,659	2,977,805	114,247	2,394,680
Total, raw value	3,582,757		3,566,403		2,717,160	
Destinations						
Albania	0	0	0	0	0	4,300
Algeria	0	126,099	0	31,018	0	56,615
Andorra	0	3,019	43	907	0	657
Austria	0	192	0	245	0	1,233
Bahamas	0	200	0	908	0	161
Bahrein	0	12,006	0	11,565	0	10,995
Bangladesh	0	3,667	0	0	0	0
Benin	0	3,615	0	3,276	0	5,637
Bulgaria	0	6,000	0	10,630	0	0
Burundi-Rwanda	0	8,487	0	7,272	0	1,600
Cameroun	0	15,442	0	23,268	503	18,314
Canary Islands	0	0	0	1,000	0	4,750
Cape Verde Islands	0	0	0	6,003	0	2,651
Central African Republic	0	2,672	0	4,504	0	2,152
Chad	0	5,209	0	10,015	0	9,335
Chile	29	24,475	29,206	23,050	0	24,006
China	0	91,779	13,636	72,887	0	300
Colombia	0	0	0	0	0	30,300
Comores	0	1,126	0	525	0	155
Congo	0	10,780	0	6,152	0	1
Cyprus	0	19,566	0	12,126	0	18,153
Djibouti	0	483	0	35,974	0	7,257
Dubai	0	9,041	0	9,450	0	10,468
Dutch Antilles	0	1,098	0	378	0	0
Egypt	0	4,192	0	101,196	0	12,900
Faroe Islands	0	1,126	0	1,109	0	1,271
Finland	14,503	0	1	0	10,500	5,275
French Polynesia	0	4,789	0	5,552	0	4,490
Gaboon	0	7,508	0	2,807	0	6,927
Gambia	0	26,097	0	21,206	0	10,523
Ghana	0	40,280	0	25,151	0	2,198
Greenland	0	1,476	0	1,921	0	2,534
Guinea	0	5,322	1	3,208	0	3,225
Haiti	0	0	0	0	0	3,000
Hong Kong	0	834	0	720	0	2,863
Hungary	0	250	0	0	0	21,686
Iceland	10	10,357	16	9,920	13	10,064
Indonesia	20	12,995	0	14,942	0	22,334
Iran	0	564,095	0	511,187	0	153,551
Iraq	0	44,451	0	2,745	0	12,001
Israel	0	126,772	0	158,035	200	138,744
Ivory Coast	0	6,790	0	27,793	0	17,503
Jamaica	0	0	0	1	0	5,007
Japan	0	56	0	2,686	0	2
Jordan	0	66,060	0	27,867	0	12,549
Kenya	0	27,641	1,880	37,271	0	39,459
Korea, North	0	0	0	23,068	0	0
Kuwait	0	74,469	0	37,850	0	46,552
Lebanon	56,857	34,483	28,422	39,962	0	138,601
Liberia	0	6,480	0	6,015	0	7,074
Libya	0	13,150	0	0	16	0
Maldives	0	0	0	300	0	3,084
Mali	0	5,893	0	4,329	0	2,110
Malta	0	15,290	0	14,482	0	13,765
Martinique	50	2,628	22	518	13	425
Mauritania	0	31,605	0	26,376	0	30,731
Morocco	31,501	24,352	75,378	26,453	7,001	70,012
Nepal	0	0	0	0	0	4,200
New Caledonia	0	2,034	0	2,062	0	1,458
Niger	0	5,308	0	5,240	0	7,486
Nigeria	0	442,674	300	497,048	1,000	325,652
Norway	104	116,348	124	131,112	120	145,535
Oman	0	9,375	0	9,600	0	10,099
Papua-New Guinea	0	6,604	0	4,884	0	2,539
Portugal	53,650	0	32,304	17	19,391	0
Qatar	0	3,000	0	12,300	0	0
Rumania	0	4,220	0	0	74,118	0
Saudi Arabia	0	66,088	0	74,445	0	46,178
Senegal	0	150	0	80	0	2,948
Sierra Leone	0	22,901	0	26,184	0	16,810
Singapore	0	977	0	1,516	0	0
Somalia	0	1,225	0	37,282	0	34,964
Spain	0	24,605	0	26,121	48	27,636
Sri Lanka	0	230	0	59,100	0	2,552
Sudan	0	145,284	0	69,750	0	5,251
Surinam	0	3,200	0	6,728	0	4,501
Sweden	31,990	43	11,562	57	2	5,795
Switzerland	276	159,350	210	167,274	260	234,284
Syria	0	95,156	0	62,321	0	3,168
Tanzania	0	13,824	0	10,551	0	2,001
Togo	0	23,010	0	11,768	0	11,905
Tunisia	10,500	110,943	36,098	112,964	0	81,319
Uganda	0	0	0	600	0	5,750
United Arab Emirates	0	29,543	0	18,512	0	20,728
USA	40	691	59,483	15,951	44	45,275
USSR	0	225,053	40,144	1,500	600	252,872
Vatican	0	1,601	0	1,820	0	1,580
Venezuela	0	250	0	59,500	0	0
Vietnam	0	1,531	0	0	0	0
West Indies	0	1,096	0	600	0	403
Yemen, North	0	53,815	0	86,417	0	60,451
Yemen, South	0	6,028	0	33,751	0	7,245
Zaire	0	10,913	0	10,890	0	2,414
Other countries	509	20,634	829	14,037	418	12,181
	200,039	3,112,101	329,659	2,977,805	114,247	2,394,680

Yugoslavia sugar exports[2]

	1979	1978	1977
	tonnes, raw value		
Bulgaria	3,658	0	0
France	5,435	0	0
Greece	498	0	0
Italy	849	0	0
Lebanon	1,707	0	0
Malaysia	10,870	0	0
Rumania	40,522	0	0
Sri Lanka	0	0	1,087
United Arab Emirates	12,298	0	0
USSR	860	0	0
Other countries	139	235	23
	76,836	235	1,110

Nicaragua sugar situation[3]. — Nicaragua is planning to increase sugar production in the 1980/81 crop year by 10,000 tonnes from the 1979/80 estimated output of 211,788 tonnes. Most of the extra production will go for export as only a slight rise in domestic consumption is expected. Plantations and sugar mills in Nicaragua are reported to be in good condition; there was time to fertilize the fields after the 1979 revolution and a GEPLACEA program to give the country technical aid has put the industry back on a sound base, while the expected extra cane for next year can be absorbed by unused capacity in existing mills. There is some cane rust in Nicaragua but a program of replanting with resistant varieties is being carried out. At the moment about 60% of plantations are planted with rust-resistant cane and the remainder will be phased out over the next few years. Nicaragua is also hoping to introduce a program for partial substitution of petrol with sugar-based alcohol; first a mixture of 20% alcohol and 80% petrol would be used but Nicaragua is studying closely the Brazilian plan to use pure alcohol fuel and it is possible such a program could be adopted.

New Yugoslavian sugar factory[4]. — The Pomoravlje Agricultural Undertaking in Cuprija is to invest 4610 million dinars in the next five years. Among its ventures will be a new sugar factory, a corn processing plant and a factory for making ascorbic acid.

Beet sugar in Egypt[5]. — The World Bank is conducting variety trials of sugar beets in West Nubaria in anticipation of starting a sugar company in the area. Production projections are not available for the planned facility. The Delta Sugar Company, a French-Egyptian joint venture to produce beet sugar, is scheduled to start production in 1981. Beets will be sown on 6300 ha in September and should yield a crop of 200,000 tonnes from which estimated white sugar production is 25,000 tonnes; when in full production the factory should produce 100,000 tonnes of white sugar annually.

Madagascar sugar exports[6]. — Exports of sugar from Madagascar reached 21,337 tonnes, raw value, down from 24,379 tonnes in 1978 and 27,668 tonnes in 1977. Destinations were the Comoro Islands (1098 tonnes), France (11,244 tonnes) and the USA (8995 tonnes).

Australian sugar technology mission to Mexico[7]. — An Australian commercial mission has visited Mexico to promote a technological interchange in the sugar industry. Concrete proposals were presented to the National Sugar Industry Commission and to Financiera Nacional Azucarera, the official credit institution for the industry, and sufficient financing has been offered to the Mexican industry to acquire equipment. While Mexico has made important progress in developing its sugar industry, the Australian mission stressed that technical advances achieved in Australia could be used advantageously in Mexican sugar factories. Sugar industry equipment manufacturers, part of the Australian mission, provided Mexican authorities with information on cane handling and preparation equipment, treatment plants, mill machinery, harvesting and transportation equipment. Australia would also provide consultancy services.

[1] F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 349-356.
[2] C. Czarnikow Ltd., *Sugar Review*, 1980, (1498), 126.
[3] F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 277-278.
[4] *Zuckerind.*, 1980, **105**, 595.
[5] F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 280.
[6] C. Czarnikow Ltd., *Sugar Review*, 1980, (1493), 102.
[7] F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 370.

Peru sugar exports[1]

	1979	1978	1977
		tonnes, tel quel	
Canada	0	0	10,668
Chile	28,863	11,989	87,706
China	0	0	25,948
Colombia	0	0	4,501
Korea, South	0	13,650	0
Portugal	0	0	26,600
USA	148,729	240,252	256,409
USSR	3,198	0	0
	180,790	265,891	411,832

Sri Lanka sugar project. — Tate & Lyle Technical Services Limited (TLTS), the consultancy and management services subsidiary of the Tate & Lyle Group, has recently signed a contract worth approximately £700,000 with the Sri Lanka Sugar Corporation (SLSC) for the consultancy services relating to the Sevanagala Project. The project involves the construction of a new 1200 t.c.d. sugar factory and distillery and its subsequent expansion to 2000 t.c.d., together with the development of the associated agricultural and infrastructural works. The overall project, including the consultancy services, is expected to cost approximately £24 million and the major part of the foreign exchange costs are to be met by a loan from the Asian Development Bank. TLTS will be responsible for the preparation of the outline designs, equipment specifications and tender documentation for the sugar factory. It will subsequently be involved in assisting the Sri Lanka Sugar Corporation with the adjudication of tenders, contract negotiations and supervision of factory construction. TLTS will also be supplying civil/irrigation, cane agricultural and agricultural engineering inputs to assist the SLSC in the successful implementation of the project.

New Indonesian sugar factory. — Kawasaki Heavy Industries Ltd. have announced that they have won an order from Indonesia's Agricultural Corporation, Perusahaan Peruseroan P.T. Perkebunan, for a sugar factory of 4000 t.c.d. crushing capacity to be installed near Medan, Sumatra by August 1981.

New Turkish sugar factory[2]. — According to a report in the Dutch journal *Wereldmarkt*, the Chamber of Agriculture in Sivas has announced that a sugar factory with an annual production of 200,000 tonnes is to be built in Sivas.

Florida sugar crop[3]. — Florida's sugar industry produced 1,046,560 short tons of raw sugar during the 1979/80 crop, which compares with the record crop of 1,060,911 tons produced in 1975/76. The sugar yield was slightly down owing to damage when Florida was hit by a hurricane in September last. The Florida Sugar Cane League reports that the 1980/81 projected crop could easily top the record harvest of 1975/76.

Uruguay beet sugar crop, 1979/80[4]. — The 1979/80 beet campaign started on November 2, 1979 and ended on March 4, 1980, during which time 516,154 tonnes of beet, grown on 13,676 hectares, were processed to yield 59,481 tonnes of white sugar. These figures correspond to a beet yield of 37.742 tonnes.ha^{-1} and a sugar yield of 5.55 tonnes.ha^{-1}. Sugar beet is paid for in proportion to its sugar content and there is a very slight difference among the four factories, ranging from US $45 to $50 per tonne on a 14% pol basis. The beet price represents about 60% of the sugar production cost. In 1978 Uruguay was self-sufficient in sugar but adverse weather led to the importation of 20,000 tonnes in 1979 and a similar shortfall, owing to the same cause, is expected to require a similar amount in 1980. A fifth sugar factory in the country crushes cane at a rate of 3600 tonnes.per day. The 1980 crop, started in June, is expected to yield about 28,000 tonnes of white sugar.

Brazil sugar crop target 1980/81. — It has been announced[5] that the authorized Brazilian sugar crop in 1980/81 amounts to 7.8 million tonnes. This is tel quel as regards pol value and is equivalent to about 8.35 million tonnes in terms of raw value. Last season the campaign closed at around 7.15 million tonnes, raw value. The increase will be partially achieved by a cutback in alcohol production from cane but this will be much less than suggested by recent rumours, namely a cut of 100 million litres from 4200 million litres originally predicted for 1980[6]. Of the 7.8 million tonnes projected production, 5.6 million tonnes would be destined for internal consumption and 2.2 million tonnes for export in the twelve months to end-May 1981. These figures reveal that the plan does not provide for any increase in domestic consumption, as total offtake in 1979/80 is estimated at between 5.6 and 5.7 million tonnes.

Canada sugar statistics

	1979		1978	
		tonnes, raw value		
Initial stocks		422,011		451,424*
Production		133,110		122,786
Imports				
Australia	369,204		487,896	
Brazil	0		5,523	
Cuba	330,686		202,113	
Guyana	75,501		57,463	
Jamaica	33,387		11,092	
Mauritius	14,609		42,140	
South Africa	226,781		275,909	
Thailand	12,105		0	
USA	750		788	
Other countries	107		409	
		1,063,130		1,083,333
		1,618,251		1,657,543
Consumption		1,125,195		1,099,211
Exports				
Bahamas	5,189		5,615	
Bermuda	2,045		1,471	
Caribbean Islands	3,468		3,858	
Dutch Antilles	3,320		3,790	
Jamaica	367		5,817	
Trinidad & Tobago	5,688		8,772	
USA	96,535		103,946	
US Oceania	1,303		1,147	
Other countries	2,534		1,905	
		120,499		136,321
Final stocks		372,215		422,011

* Calculated

Small cane farm enterprise in Kenya. — The US Presidential Commission on World Hunger presented its report in March 1980 and made reference in it to the Mumias small cane farm enterprise. "Instead of organizing sugar production on the traditional plantation basis, the firm (Booker Agriculture International) works with farmer-suppliers (four-acre farm size) and has set aside land for food production. In addition to the 5000 farmers, the refinery (sic) employs 2500 local workers which are gradually replacing the foreigners hired to supervise them. The success of this venture has led to additional management contracts for similar projects. Thus there exists a complementarity between the imported technology and local needs that has prevented the development of a ghetto colony of landless labourers and other social problems which have often attended this type of enterprise in the past." In fact, the scheme has grown further from the size referred to in the report; there are now some 11,000 farmers involved and the Mumias Sugar Company employs some 4000 people in the factory, agricultural workshops, office, nucleus estate and on services to outgrower farmers.

Cane Sugar Refining Research. — The next Technical Session on Cane Sugar Refining Research is to be held at the Maison Dupuy Hotel in New Orleans, Louisiana, USA, during October 19 – 21, 1980. This Conference is sponsored by the Cane Sugar Refining Research Project Inc. and the Southern Regional Research Center of the Science and Education Administration, US Dept. of Agriculture, to provide a forum for an exchange of ideas related to sugar processing. Participants will assemble during Sunday October 19 and the meetings will be held during the next two days. Further details may be obtained from Dr. Frank G. Carpenter, General Chairman, at P.O. Box 19687, New Orleans, LA 70179, USA.

PERSONAL NOTES

Malcolm McKinnon, previously Principal Executive Officer with the Sugar and Horticultural Crops Division of the Australian Department of Primary Industry, has been appointed to succeed **A. Bruce Henderson** as General Secretary of the Queensland Cane Growers' Council in September following the latter's retirement.

Wayne Richardson, Jr. is President and Chief Executive of ABA International Inc. which has purchased the A & B Agribusiness subsidiary of Alexander & Baldwin, of Honolulu. Mr. Richardson joined Alexander & Baldwin Inc. in 1975 with a contract to help form the new company. Previously he had formed C. Brewer & Co. Ltd.'s International Division which became Hawaiian Agronomics Co. (International) in 1964. ABA has contracts for projects in Kuwait and the Sudan and will provide Process Engineering Company, of Switzerland, with agricultural advice in relation to its interest in alcohol production.

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1 *I.S.O. Stat. Bull.*, 1980, **39**, (3), 72.
2 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 340.
3 *Lamborn*, 1980, **58**, 61.
4 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 343.
5 C. Czarnikow Ltd., *Sugar Review*, 1980, (1497), 121.
6 F.O. Licht. *International Sugar Rpt.*, 1980, **112**, 393.

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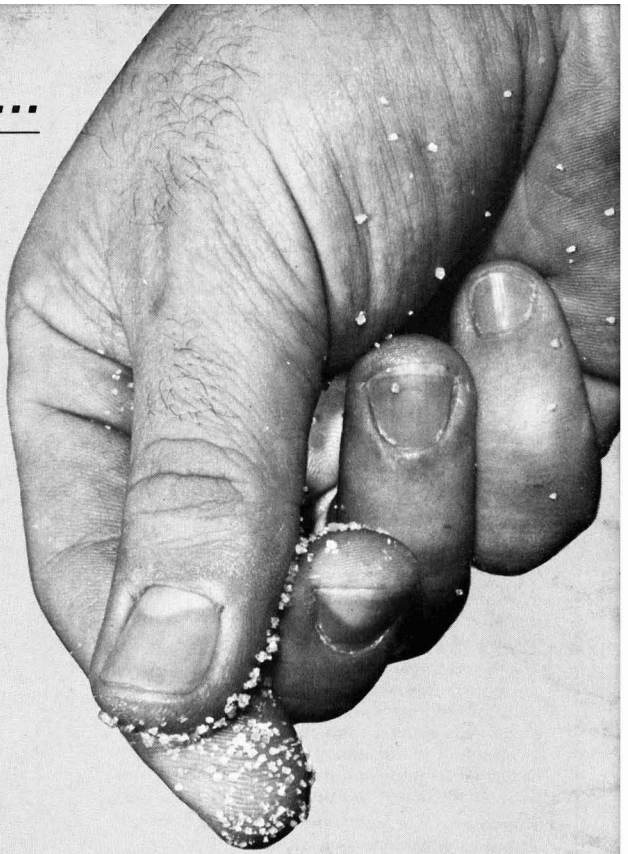

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