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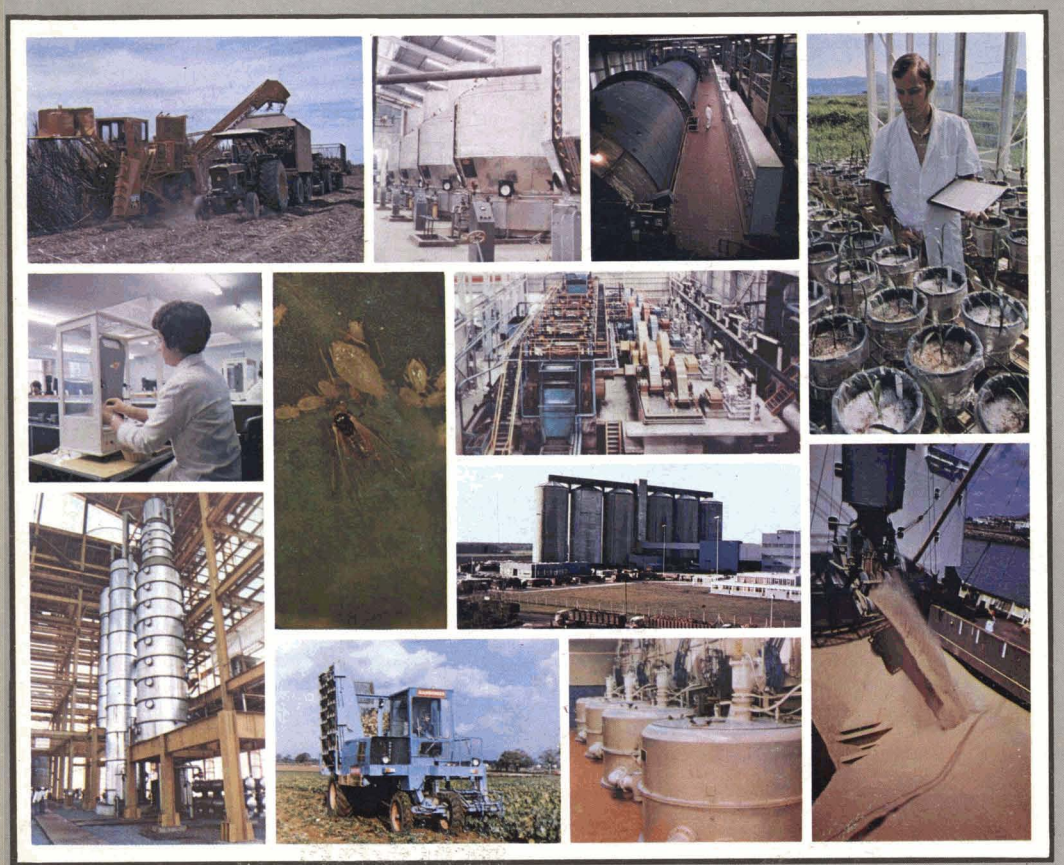

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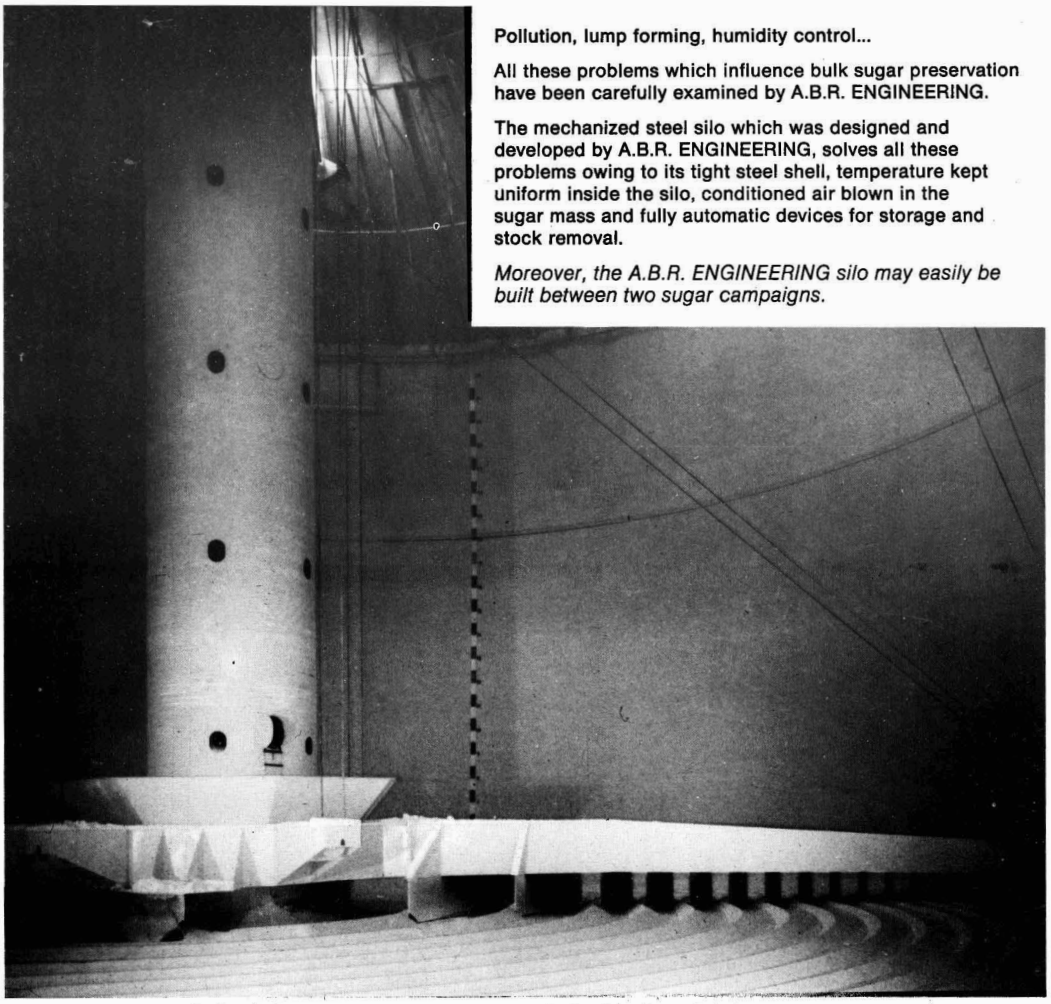

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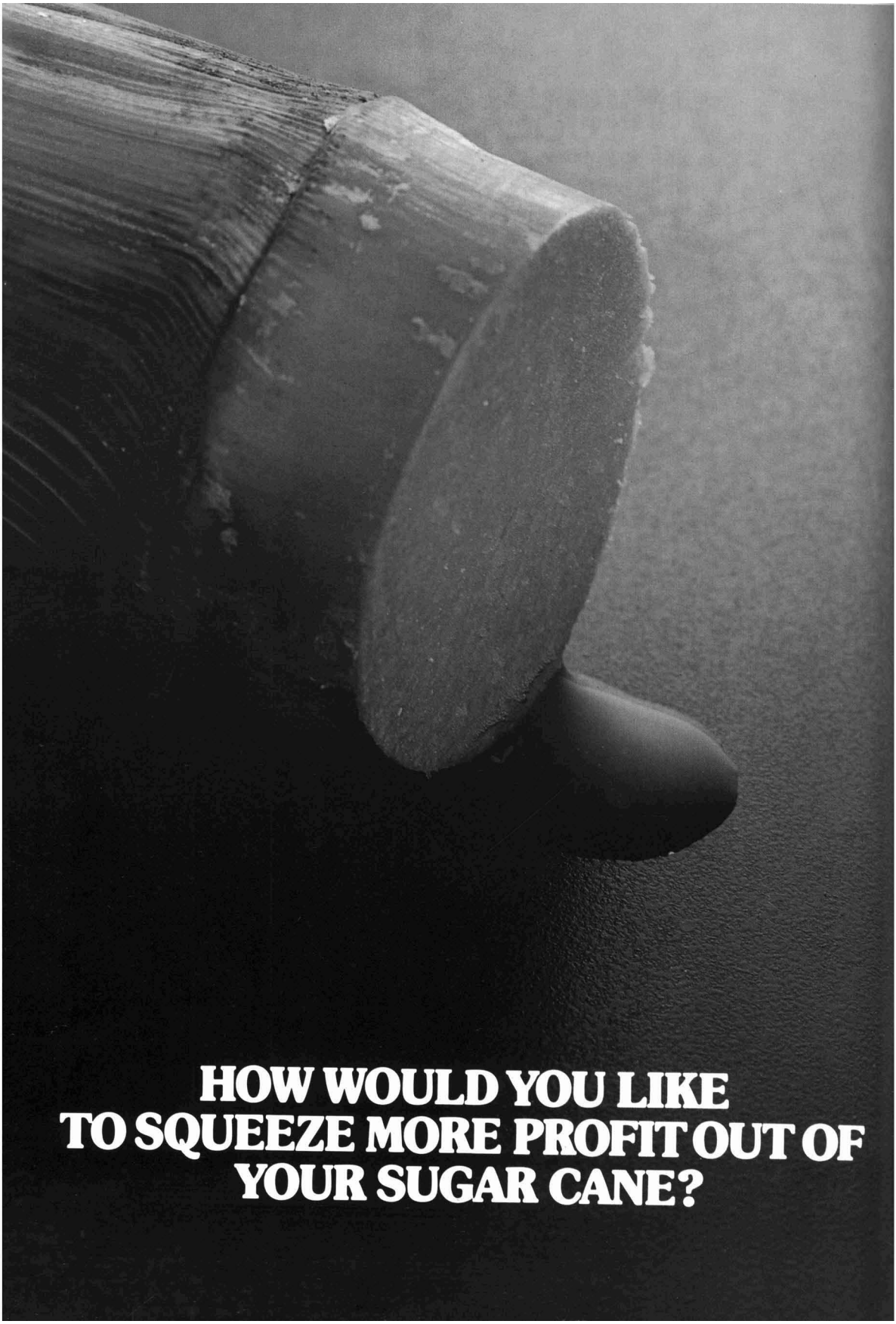
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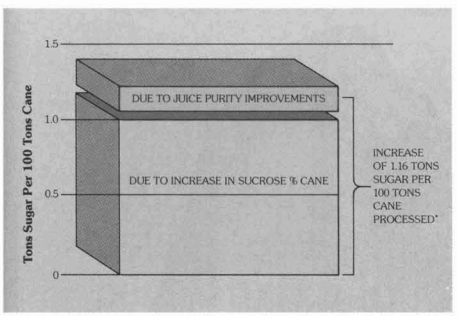

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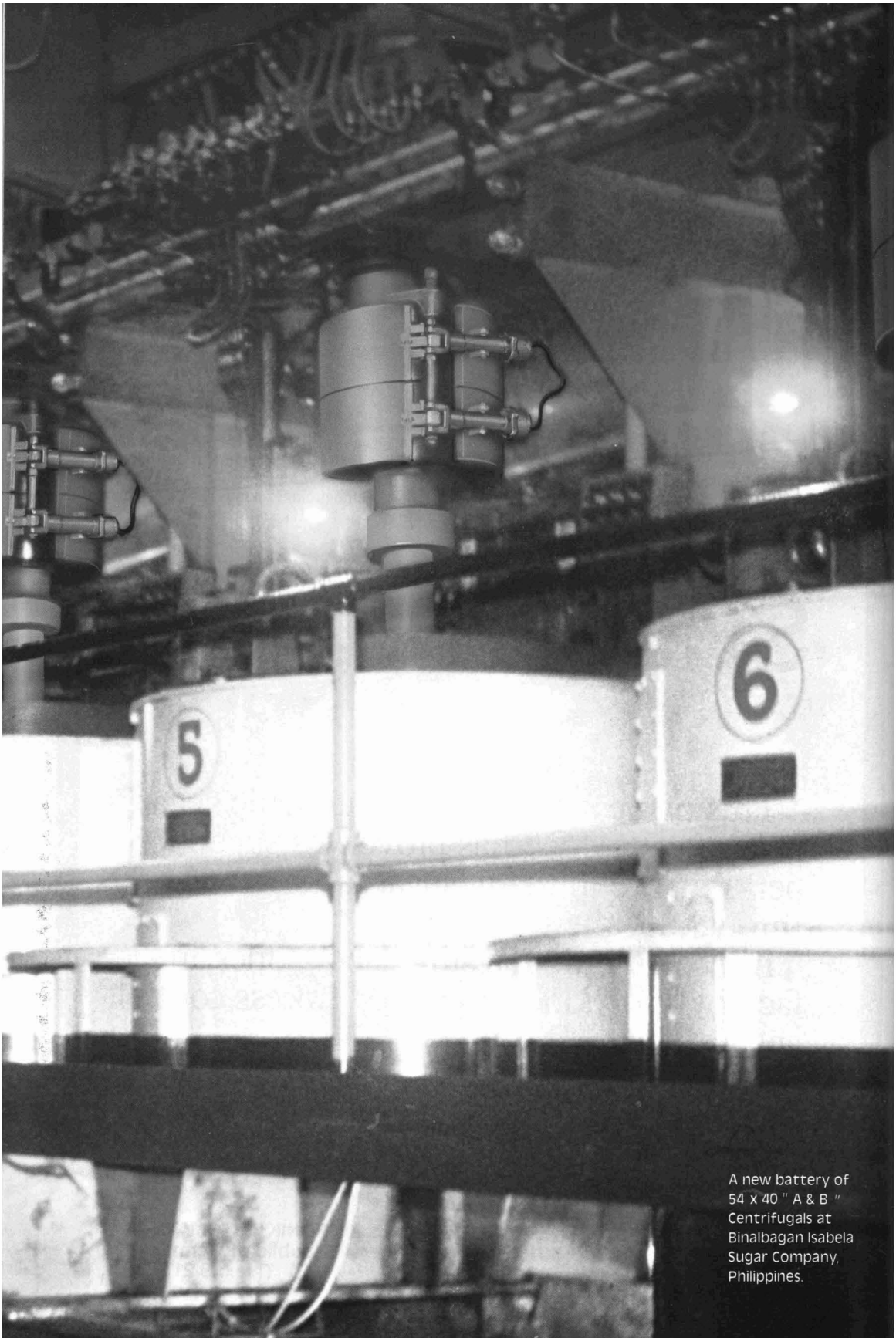

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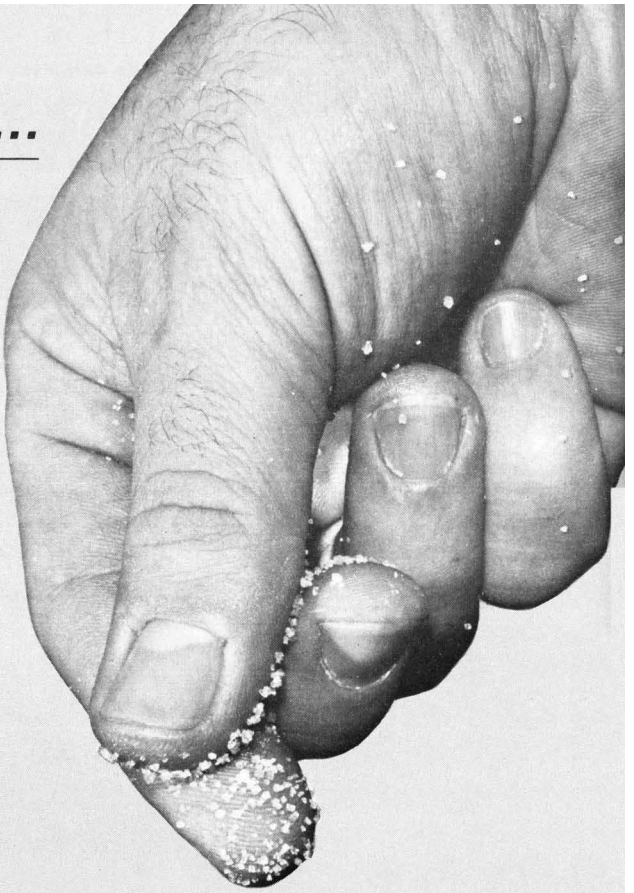

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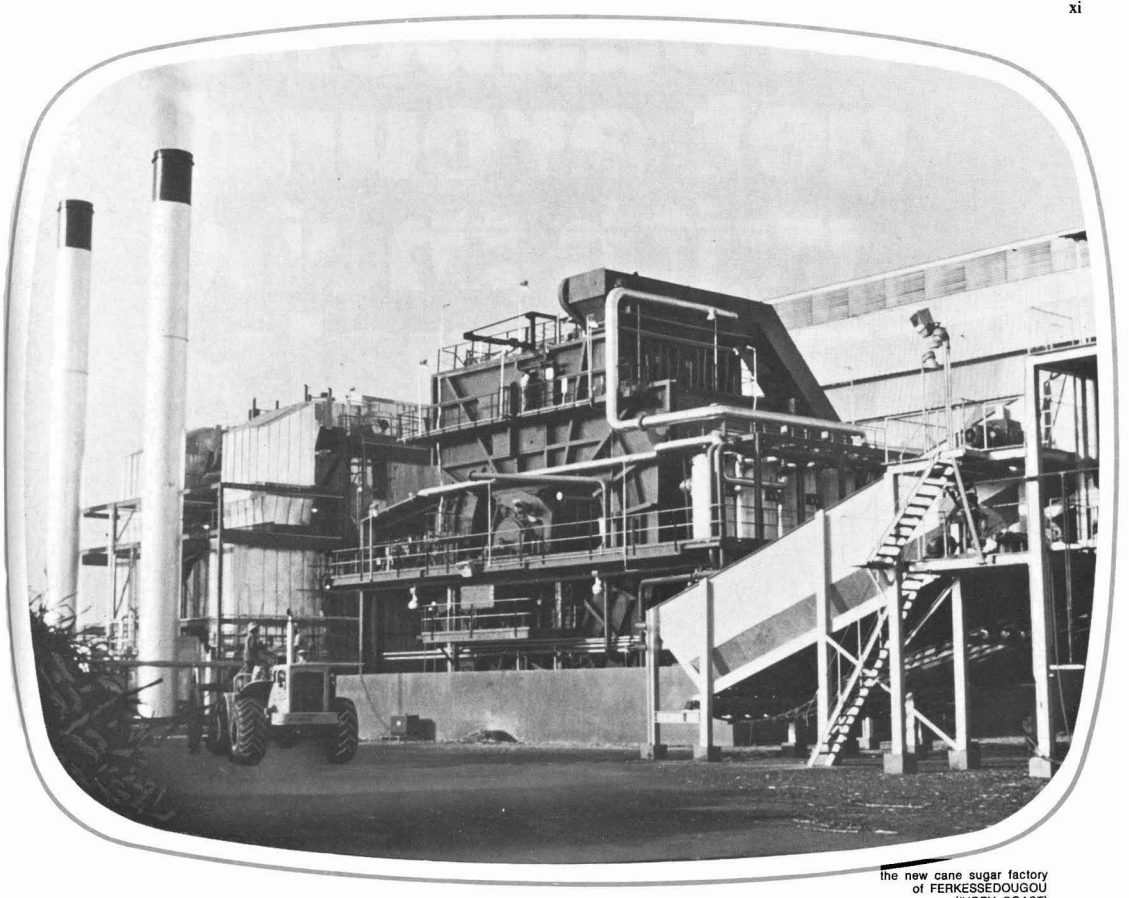

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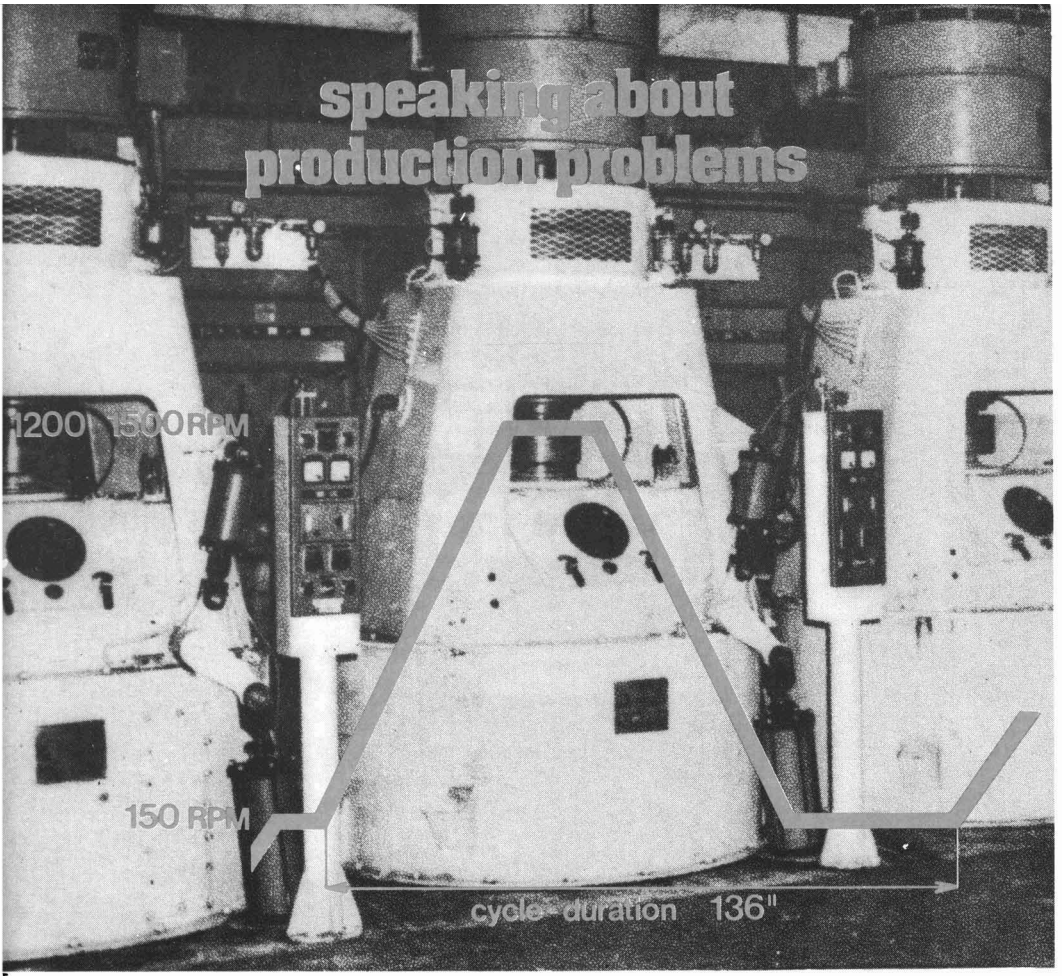

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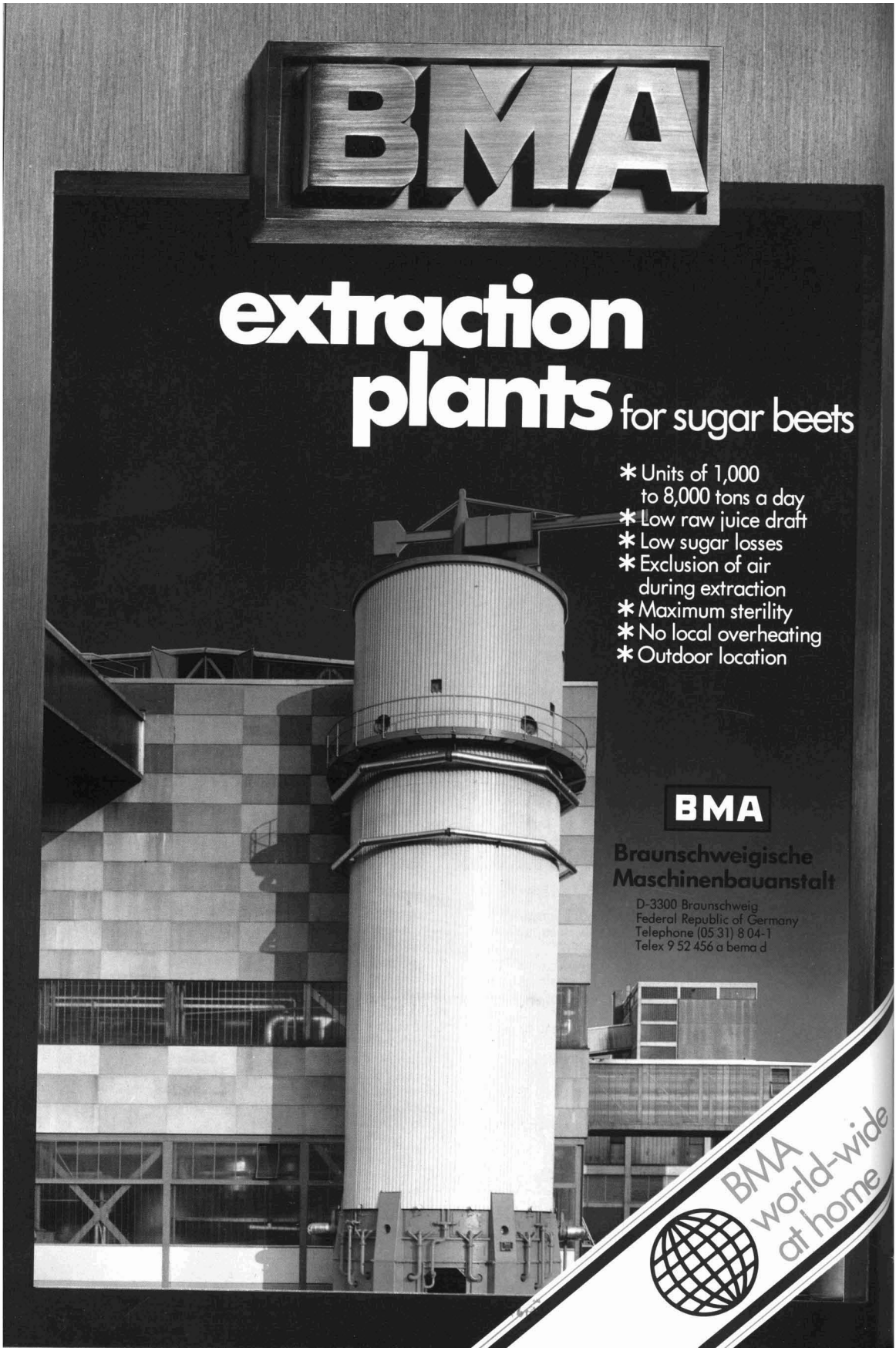
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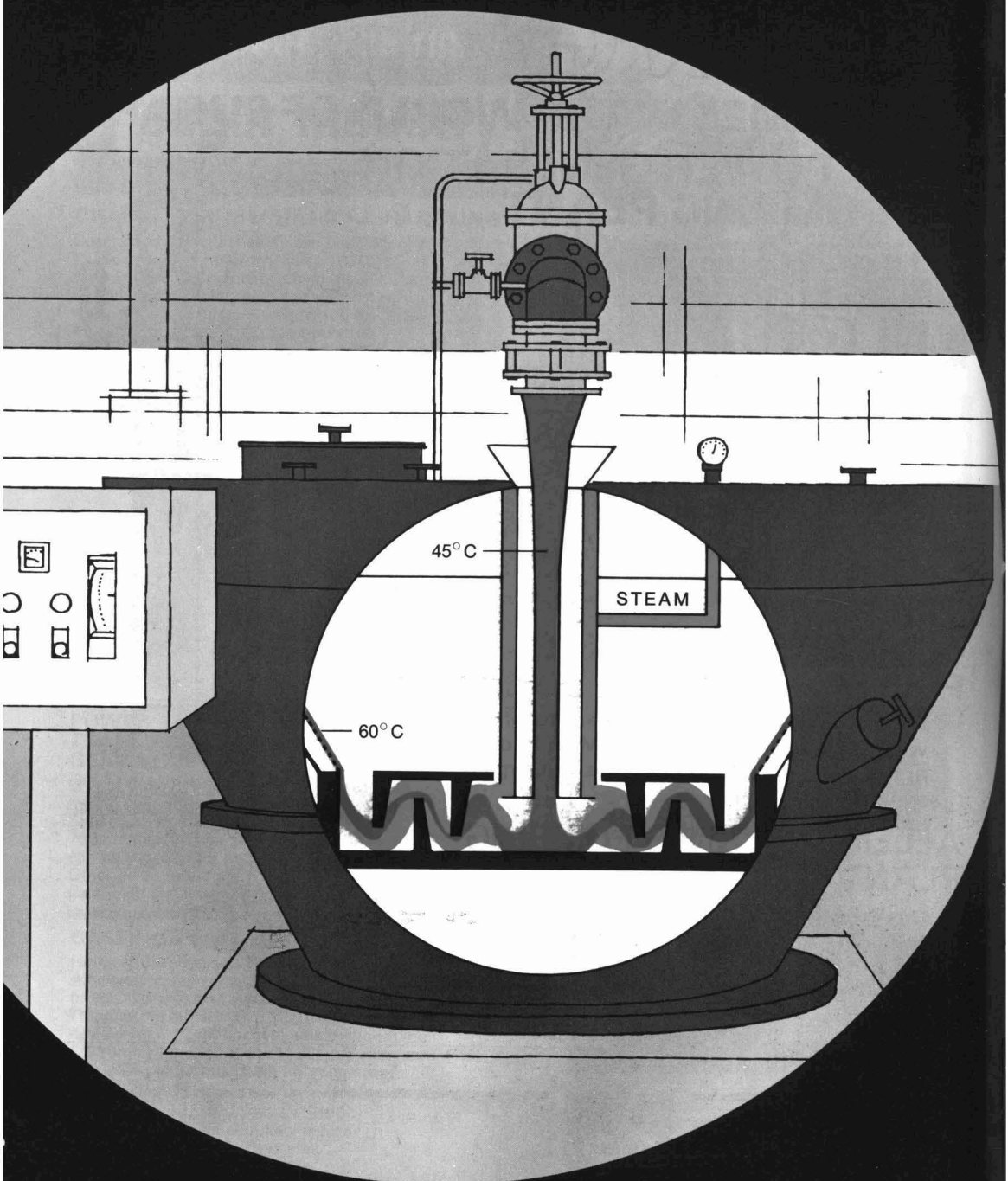

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NOTES AND COMMENTS

World sugar balance 1977/78

F. O. Licht KG have published[1] their first estimate of the world sugar balance for the crop year September 1977/August 1978 as reproduced below:

	1977/78	1976/77	1975/76
	(tonnes, raw value)		
Initial stocks	26,104,000	20,575,000	17,449,000
Production	91,292,000	88,589,000	82,806,000
Imports	25,573,000	26,559,000	23,634,000
	142,969,000	135,723,000	123,889,000
Exports	25,965,000	26,950,000	23,400,000
Consumption	85,696,000	82,669,000	79,914,000
Final stocks	31,308,000	26,104,000	20,575,000
„ „ % Consumption	36·53	31·58	25·75

The figures show the dramatic rise in stocks during the period and it may be mentioned that the corresponding figure for August 1975 was only 17,449,000 tonnes. Of course some minimum stocks are essential and Licht has made a country-by-country assessment of these, from which he derives a total of 17,535,000 tonnes. The excess stocks are thus 14,166,000 tonnes and not all of these will be available to the world market because some will be of insufficiently high quality, some will be retained because of low world prices, some are excess stocks held in importing countries and some will be sold for export in the following year. But nevertheless it is clear that the surplus is huge.

After consumption increases of 2·91% and 3·45% in the previous two years, it is expected by Licht to rise by 3·66% in 1977/78 over the previous year. This will not be sufficient to meet even the production level of 1976/77, never mind that of 1977/78; however, the rate of increase in production, set at 6·98% in 1976/77, is expected to be smaller at 3·05%. It is to be hoped that, with outlets limited by quota under the new ISA and by import limitation rules by members from non-member producers, producers will seek to maintain rather than increase their crops so as to allow consumption to catch up production levels and restore a balance which will bring price levels within the target band of the Agreement.

Malaysian-Australian sugar price talks

Officials from both countries resumed talks on the long-term purchase contract for Australian sugar by Malaysia[2] on 2nd February and on the 10th reached agreement on new terms which, however, have not been made public, it is believed at Australian insistence in order to protect her bargaining position in regard to possible re-negotiation of long-term contracts with other customers.

EEC sugar policy

F. O. Licht KG have recently published an article[3] describing EEC sugar policy as being "at the cross-roads". At the end of 1974 the Council of Ministers decided on a new policy which opened the way for a substantial increase in beet sugar production within the Community. Increases in the basic quotas were as follows:

	1974/75	1975/76	*Increase,*
	Thousand tonnes, white value		%
Belgium/Luxembourg	550	680	23·6
France—Metropolitan	1,934	2,530	30·8
—Overseas Territories	466	466	0·0
	2,400	2,966	24·8
Germany, West	1,750	1,990	13·7
Holland	550	690	25·5
Italy	550	680	23·6
Original "Six"	6,480	7,586	17·1
Denmark	290	328	13·1
Ireland	150	182	21·3
UK	900	1,040	15·6
New members	1,340	1,550	15·7
Community of Nine	7,820	9,136	16·8

The substantial increase in these basic *A*-quotas, due mainly to the sharp increase in prices on the world market and supply difficulties during the 1974/75 season, was agreed only with difficulty. Community officials were haunted by the prospect of surpluses, difficult to reabsorb, and the fear of being accused by developing countries of sabotaging the objective of ensuring a sane and harmonious organization of international trade in agricultural products. While committing themselves to a policy of expanding production, the EEC countries at the same time offered the African, Caribbean and Pacific sugar producers a purchasing contract for 1·3 million tonnes over a seven-year period and at a price close to the Community price. At the time a warning was sounded that the policy of expanding internal production and at the same time concluding a long-term contract did involve considerable risks.

The EEC Farm Ministers were apparently gambling on the assumption that world consumption of sugar would increase in coming years at least as quickly as world production. The supply/demand pattern of the past two years demonstrates, however, that the Ministers were far too optimistic. Furthermore, the rigidity of the EEC sugar regime, mainly due to political factors, did not allow for quick adjustments, but the estimated surplus for 1977/78 demonstrates clearly that measures will have to be taken to reduce Community sugar output.

EEC sugar production in 1977/78 will be substantially higher than the previous season despite a reduction in the area sown to sugar beet. Latest estimates point to a production level of 11·2 million tonnes, white value, to which must be added 350,000 tonnes from the French Overseas Territories. ACP sugar imports are estimated at 1,305,000 tonnes so that total availability for 1977/78 is set at 14·5 million tonnes. Consumption is estimated by Brussels at 9,310,000 tonnes, which leaves a surplus of 5,230,000 tonnes. From this must be deducted *C*-sugar production [sugar produced outside the maximum (*A*+*B*) quota which has to be exported to the world market and which does not benefit from a price or sales guarantee].

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[1] *International Sugar Rpt.*, 1978, **110**, (6), 1–5.
[2] See *I.S.J.*, 1978, **80**, 66.
[3] *International Sugar Rpt.*, 1978, **110**, (2), 1–4.

The surplus to be exported with Community aid will be in the region of 2,810,000 tonnes. Export refunds during December/January were around 221 units of account per tonne. If world prices do not improve markedly during the remainder of the sugar economic year 1977/78, funds necessary to export the 2,810,000 tonnes will amount to some 621 million units of account. Part of this, however, will be paid by EEC beet farmers and sugar producers as a levy paid on sugar produced against the *B*-quota, amounting to approximately 181 million U.A., so that the net burden on the compensating funds (FEOGA) will therefore be some 441 million U.A., certainly substantially more than the Farm Ministers envisaged when the new policy was formulated.

Of course, the estimated cost in exporting surplus EEC sugar may be substantially changed if EEC consumption should expand during 1977/78 or if substantial quantities are earmarked for stocking in accordance with the intentions of the new ISA, but in any case the financial burden for EEC taxpayers will be heavy.

The Commission consequently favours reduction of beet sugar output in 1978/79 and has proposed a cut in *B*-quota from 35 to 20% of the basic quota, as well as a minimal rise in the guaranteed price[2], and raising of the production levy to 30% of the intervention price, its highest possible rate.

It cannot be questioned that there will be a huge surplus in 1977/78 which will have a depressing influence on world prices regardless of the existence of the new ISA. All the same, it should be remembered that the record production of 1977/78 was brought about by a number of favourable factors which are not likely to recur in 1978/79. A fall in world sugar production in 1978/79 can therefore not be excluded; this would alleviate the EEC's sugar problems although the high level of world stocks will prevent prices reaching exorbitant levels. The low prices now ruling on the world market may, moreover, discourage expansion of sugar output and at the same time give a stimulus to consumption.

It is therefore not outside the realm of possibility that a deficit could occur in three or four years from now and that EEC production capacities would be needed to cover world demand. The necessary cut in EEC sugar output in 1978/79 should therefore be of limited extent in order not to provoke the closure of numerous factories. On the other hand, the EEC sugar industry will need to adapt output to changing supply/demand situations. Hence Licht's reference to it being "at the crossroads".

US sugar imports in 1978[1]

The organization of American States (OAS) has forecast 1978 sugar imports at about 4 million short tons, compared with 6·1 million tons last year. Major factors in the predicted decline are higher US import duties and increasing use of corn sweeteners by industry. It is estimated that by 1980 demand for sugar in the US could reach 13 million tons but that 4·5 million tons could be provided by HFCS and 5·5 million tons from domestic sugar producers, leaving only about 3 million tons to be imported.

The OAS also said that Latin American and Caribbean countries which exported 3·5 million short tons to the USA last year are seriously concerned about the higher US tariffs and see them as part of an increasing trend towards protectionism. OAS experts foresee difficulties for producers in 1978, especially because of the high volume of sugar reserves in the importing countries, particularly the USA and Japan.

ACP/EEC sugar price negotiations for 1978/79

The representatives of the African, Caribbean and Pacific sugar exporters who supply sugar to the European Economic Community under the Lomé Agreement were to meet in the middle of March to negotiate the price to be paid for the supplies in 1978/79. Under the Agreement, the EEC is committed to import 1·3 million tonnes of raw sugar per year up to 1981, at a price to be agreed annually.

ACP producers met in February to agree a joint policy and it was announced that they would seek an increase to take into account a 10·6% rise in production costs over the past year. Details of the price claim will be settled once the EEC has set prices for its domestic sugar production; the EEC Commission recently proposed increases of only just over 1% so that, if these proposals are accepted by the Council of Ministers, it would seem unlikely that they would agree to a larger increase for the ACP suppliers.

However, the Commission's proposals have yet to be accepted, and there is pressure from European farmers for a larger increase. Against this, taxpayers do not welcome the need to subsidize exports of surplus European white sugar as well as the sugar from the ACP countries, so the outcome may well be an increase slightly higher than the Commission's proposals but not as much as wanted by the beet growers. This would not give scope for a large increase for ACP sugar as such, but opportunities for giving a better return lie in removal of the storage levy charged on ACP raw sugar shipped to Europe and compensation for the freight costs.

World sugar prices

Only limited movement in the London Daily Prices for raw and white sugar has occurred during the past two months, the LPD varying between £104 and £114 while the LDP range was £111–£119. In January there was little interest in purchases by the major importers who had stocked up before the end of the year; however, rumours and reports of buying by both the USSR and China helped to keep the prices firm. The lack of interest by final buyers, aided by the fear that the recently-introduced import fees on sugar to the USA would result in more sugar going to the world market, gave a downward trend during February, but further reports of heavy rain hampering harvesting in Cuba, and an announcement that Brazil would be out of the market until the latter half of 1978, had a strengthening effect toward the end of the month. The LDP at the close of the month was then £106 per tonne, against £107 at end-December, while the LDP(W) was £115 against £112.

Holly Sugar Corporation diversification[3].—Holly Sugar Corporation is to construct a corn wet milling plant at its Tracy, California, factory in order to produce high fructose corn syrup by the middle of 1978. The Corporation is also to modify its Santa Ana factory in California so as to be able to refine raw cane sugar. Capacity is to be 400 tons of raw sugar per day.

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[1] *I.S.J.*, 1978, **80**, 65.
[2] *Public Ledger*, 14th January 1978.
[3] *Sugar y Azúcar*, 1977, **72**, (10), 7.

Nitrogen metabolism in the sugar cane plant and defoliation

By ZIAD A. MENSHAWI
(Hawamdieh Sugar Refinery, Hawamdieh, Egypt)

Introduction

IT IS WIDELY accepted that leaves are the plant organs which perceive the critical daylengths and respond by producing a stimulus which is essential for floral induction. The floral stimulus is translocated from the leaf to the apex where it accumulates.

In sugar cane, various investigators su chas Burr[1], George[2], Coleman[3], Julien[4] and Panje *et al*[5]. have contributed to elucidating the role of the cane leaf in the flowering process. The results obtained from such studies revealed that the plant's response depends on:

(*a*) the specific leaves removed,
(*b*) the flowering stage when defoliation was performed,
(*c*) the number of defoliation treatments, and
(*d*) the flowering inclination of the treated cane variety.

In the present study, the cane variety 65/12-19, a locally bred (♀ 54B480 × ♂ 64/1-13) and profuse bloomer, was chosen. The various defoliation treatments tried, the flowering response and nitrogen metabolism in such a variety when repeatedly topped during the critical early flowering stages are discussed.

Materials and methods

Cuttings of the variety 65/12-19 were planted in pots on 22nd September 1976, and transplanted in the field on the following 2nd April. The growing plants were given adequate cultivation and water supplies to maintain full active growth. The canes perceived and flowered in response to the 18 autumn inductive daylengths which extend at the experimental site (30°02'N.) from 10th to the 27th of September.

The various flowering stages and their approximate dates of onset with a normal deviation of ±5 days had been classified as follows:

Flowering stage	*Date*
(*a*) Induction	10th August
(*b*) Stimulus accumulatory	1st September
(*c*) Initiation	15th September
(*d*) Maturation	1st October
(*e*) Elongation	15th October
(*f*) Emergence	20th November

Full-grown primaries were given the following defoliation treatments:

(*a*) topping once on 31st August, at onset of the stimulus accumulatory phase,
(*b*) spindle, +1 leaf left (control),
(*c*) topping twice on 15th and 31st August, in early induction and at onset of the stimulus accumulatory phase.

In cases (a) and (c) all the upper unfolded, visible and inner leaves were removed. Cutting was done slightly above the terminal growing point.

The following parameters were periodically recorded:

(*a*) The flowering behaviour of the treated canes; *stalks which failed to exhibit inflorescences were* dissected on 30th November.
(*b*) Amino acid levels in the apices of such treated canes were determined on 23rd August, 8th September, 15th September, 24th September, and 10th October. The sample consisted of 6 upper stalk tips; each tip consisted of the topmost elongating joints, including the terminal growing point with a length of 4 cm, termed here as the plant apex or terminal meristem.

The free amino acids were extracted from the fresh apex tissues with 96% ethanol. The bound acids were determined in the dry residue which was hydrolysed with 6N HCl. The technique followed was a normal descending one-dimensional paper partition chromatography on Whatman No. 1 paper[6]. The solvent system used was 4:1:5 *n*-butanol:glacial acetic acid:water, with 3 runs. The chromatograms were treated with 0·2% ninhydrin in absolute ethanol. The acids were quanti-

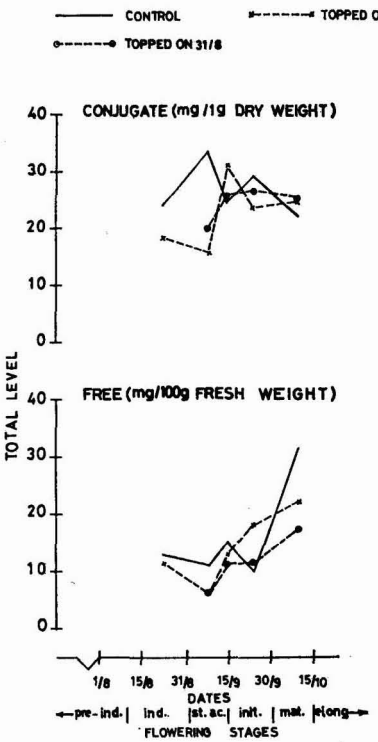

Fig. 1. Total level of amino acids in apices of control and topped plants of variety 65/12-19 during 23rd August–10th October, a period critical for its flowering

[1] *Hawaiian Sugar Tech.*, 1950, **9**, 47–49.
[2] *Ann. Rpt. Mauritius Sugar Ind. Research Inst.*, 1959, 31–43.
[3] *Proc. 12th Congr. ISSCT*, 1965, 813–818.
[4] *Proc. 13th Congr. ISSCT*, 1968, 976–983.
[5] *ibid.*, 468–475.
[6] Block, Durrum & Zweig: "A Manual of Paper Chromatography and Paper Electrophoresis" (Academic Press Inc., New York), 2nd Edn., 1958.

tatively determined after elution, using a Unicam spectrophotometer model 600, at a wavelength of 550 nm for all acids and 495 nm for proline.

The amounts of free and bound acids were expressed as mg/100 g fresh sample and mg/1 g dry sample, respectively. Their amounts in the plant apex estimated periodically during floral evocation were statistically analysed using the Student t-test of significance-pairing[7].

Results and discussion

Flowering response.—The canes which were topped twice and were consequently deprived of their young perceptive leaf-tissues during the stimulus accumulatory phase remained vegetative (Table I).

Topping the plants once at the onset of the stimulus accumulatory phase impeded tassel development. Consequently, on 30th November the mean inflorescence length in the control plants reached 70·3 cm as compared with 32·5 cm in the topped stalks. Apparently, re-growth of the cut leaf tissues during the month of September enabled these topped plants to perceive a sufficient amount of floral stimulus during the inductive day-lengths which prevail till 27th September.

Table I. The flowering behaviour of the variety 65/12-19 when topped at various floral stages

Treatments (*visible and inner leaves cut*)	*A*	*B*	*C*
Flowering stage: Emergence %	80	0	0
Maturation %	0	0	0
Elongation %	20	100	0
Initiation %	0	0	0
Reproductive apices %	100	100	0
Date of first flag stage	12/11	—	—
Date of first tip-emergence	23/11	—	—
Mean length of arrow, cm	70·3	32·5	0·0

(*A*) None (with *S*, +1 leaf left control)
(*B*) Topping once at onset of stimulus accumulatory (31/8)
(*C*) Topping twice in early induction and onset of stimulus accumulatory (15/6 & 31/8)

It is noteworthy that topping was observed to shorten the substantial internodes to about one-tenth of their normal lengths. A similar effect of defoliation upon internode growth has been reported by Panje *et al.*[5]

Total amino acids and amides in the cane apex.—A sudden rise in the amounts of apical free amino acids was recorded on 15th September, and accompanied the accumulation of the floral stimulus in the control 65/12-19 apex (Fig. 1). In addition, the bound acids increased in amount while the floral primordia were differentiating, i.e. till 24th September, followed by their decrease during the maturation stage.

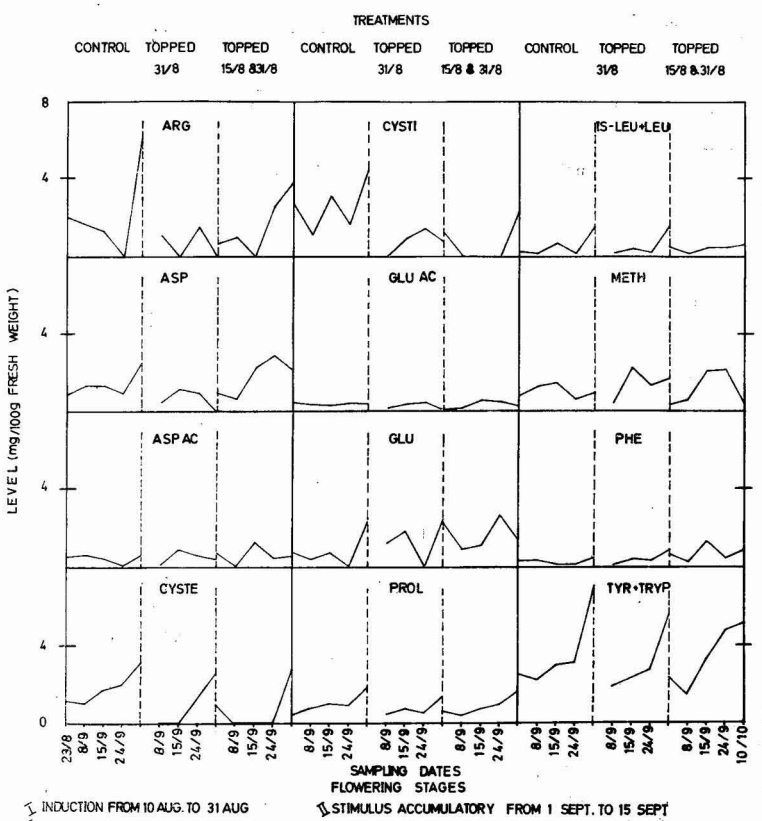

Fig. 2. Free amino acid level in apex of variety 65/12-19 topped once on 31st August and twice on 15th and 31st August when flowering in response to natural daylengths

Topping reduced the total amounts of amino acids and amides in both pools. In this respect, Tso & McNurthey[8] reported that topping resulted in a decrease in the amounts of free and conjugate amino acids in tobacco plants. Repeating the treatment caused a comparatively greater reduction in the amounts of bound acid from their normal trend of accumulation in the control cane apex (Fig. 1). Thus, repeating topping impeded to a large extent the incorporation of the free acids into the various nitrogenous compounds such as protein—the conjugate pool —which are usually formed at a faster rate in the apices of cane that grow and flower normally.

The delay in flowering as a result of topping once on 31st August was characterized by a reduction in the amounts of apical free and bound amino acids. The reduction in the free pool became evident during the stimulus accumulatory phase and persisted until the initiation stage (Fig. 1). Amino acid levels in the conjugate pool parallelled those in the control plants from mid-

[7] Snedecor & Cochran: "Statistical Methods". (Iowa State University Press, Ames, Iowa), 6th Edn., 1967.
[8] *Plant Physiol.*, 1960, **35**, 865–870.

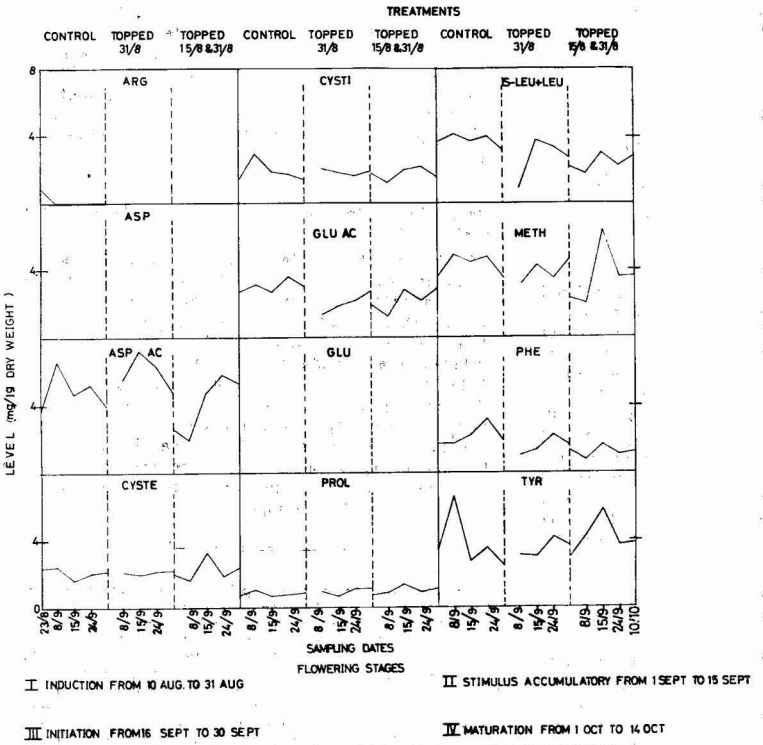

Fig. 3. Conjugate amino acid level in apex of variety 65/12-19 topped once on 31st August and twice on 15th August and 31st August when flowering in response to natural daylengths

September. This time lapse can be attributed to the time needed for the re-growth of enough cut leaf tissues which were needed for perceiving the inductive photoperiods that prevail till the end of September. This delay in stimulus accumulation of almost two weeks, besides the substantially lower amounts of photosynthates, may account for the delay in the development of the differentiated inflorescences in such defoliated stalks.

Table II. The mean differences in individual apical free and bound amino acids between defoliated and normal 65/12-19 plants, determined periodically from 23rd August to 10th October

	Free pool (*mg/100g fresh weight*)		*Conjugate pool* (*mg/g dry weight*)	
Date of topping:	31/8	15/8 & 31/8	31/8	15/8 & 31/8
Arginine	—1·64	—0·64	Traces	Traces
Asparagine	—0·90	0·39	—	—
Aspartic acid	0·05	0·18	0·82	—0·77
Cysteine	—1·02*	—1·07*	0·04	0·12
Cystine	—1·81*	—1·92*	—0·17	—0·13
Glutamic acid	—0·10	—0·04	—1·07*	—0·76
Glutamine	0·55	0·82	—	—
Proline	—0·33*	—0·10	0·12	0·18
Isoleucine+Leucine	—0·04	—0·10	—1·03	—1·27*
Methionine	0·36	0·16	—0·50	—0·62
Phenylalanine	0·15	0·38	—0·69*	—0·94*
Tyrosine+Tryptophane	—0·72*	—0·16	—0·35	0·40

* Significant at the 5% level.

Distribution of individual amino acids and amides.—The mean amounts of each amino acid in both pools determined from periodical samples which were taken during the interval from the 23rd August to 10th October, a period critical for 65/12-19 flowering, are given in Table II and Figs. 2 and 3.

In the free pool, topping resulted in an increase in the amounts of glutamine, phenylalanine, aspartic acid and methionine. A significant decrease occurred in cysteine and cystine, coupled with a decrease in proline, isoleucine+leucine, tyrosine+tryptophane, arginine and glutamic acid (Table II).

In the conjugate pool, topping resulted in a significant decrease in phenylalanine, glutamic acid and isoleucine + leunine, coupled with a fall in cystine and methionine. It also resulted in a slight increase in cysteine and proline.

The increase in the amounts of certain acids, such as cysteine and proline in the conjugate pool, was accompanied by their corresponding depletion in the free pool. This seems to indicate that they were intensively incorporated in the synthesis of various necessary nitrogenous compounds. On the other hand, the rise in free aspartic acid, methionine and phenylalanine coupled with their decrease in the conjugate pool can be considered as an indication of a decline in their rate of incorporation in the synthesis of these necessary compounds or an enhancement of their hydrolysis (Table II).

The appreciable quantitative alterations in both pools, observed later on when topping once on 31st August (Figs. 2 and 3), may be attributed to the accelerated re-growth of the cut leaf tissues, coupled later on with the accumulation of the floral stimulus. On the other hand, the changes observed in the apices of the twice-topped plants were mainly due to the re-growth of the cut leaves, since they did not flower. In this context, topping caused a general initial fall in the amounts of the free acids, followed by their appreciable rise about a week later, apparently because of their enhanced synthesis (Fig. 2).

Topping induced an initial increase in glutamine which persisted in twice-topped canes until the 10th October (Fig. 2). So it seems that topping impeded the normal sequence of transamination reactions necessary for amino acid formation within the apex. This is indicated by the higher amounts of glutamine which were coupled with lower amounts of almost all the other free amino acids. Moreover, it can be further assumed that topping enhanced the hydrolysis of various nitrogenous compounds, since the topped apices contained smaller amounts of bound acids (Fig. 3). The released acids might have been deaminated and the resulting ammonia

stored in the form of glutamine. These biochemical interactions were notably obvious in the apices of plants sampled on 8th September, at a time when the prevailing daylengths started to be inductive.

Topping tended also to reduce notably the amounts of the sulphur-containing amino acids such as cysteine and cystine which were virtually absent from the free pool till the 24th of September in the twice-topped plants (Fig. 2).

Conclusions

Floral evocation in the cane apex may be considered as a metabolic constructive process. Hence, flowering in the control plants was accompanied by a concurrent rise in the amounts of apical free and bound acids. Quite obviously, a deviation from the normal distribution in the amino acid complement found in the control apices was noted in the topped canes. The changes in both pools depended on the degree of compensation obtained from re-growth of the cut leaf tissues during a sequence of inductive daylengths which were sufficient to provide enough floral stimulus needed for flowering. In this context, glutamic acid and glutamine seemed to play an intermediary role between inorganic N and the proteinogenic amino acids as a group.

Summary

Topping, i.e. removal of all unfolded visible and inner leaves, impeded flowering in cane of variety 65/12-19 which is normally free-flowering; cutting was done slightly above the terminal growing point. The flowering inhibition in the treated plants was accompanied by a fall in amounts of apical free and bound amino acids, the extent of which was governed by: (*a*) repetition of the topping treatment, (*b*) the specific flowering stage when topping was carried out (the stimulus accumulatory phase being most critical in this respect) and (*c*) the degree of compensation resulting from regrowth of the cut leaf tissues.

Le métabolisme de l'azote dans la plante de canne à sucre et la défoliation

L'étêtage, c.à.d. l'élimination de toutes les feuilles visibles non déployées et intérieures, freina la floraison de la canne de la variété 65/12-19 qui normalement fleurit librement; la coupe a été pratiquée légèrement au-dessus du point de croissance terminal. L'inhibition de la floraison des plantes traitées était accompagnée d'une chute des quantités d'acides aminés libres et liés dans le sommet, dont l'importance était déterminée par: (*a*) la répétition de l'étêtage, (*b*) le stade de floraison spécifique au moment de l'étêtage (la phase d'accumulation du stimulant étant tres critique a cet égard) et (*c*) le degré de compensation résultant de la recroissance des tissues foliaires coupés.

Der Stickstoffstoffwechsel der Zuckerrohrpflanze und das Entblatten

Das Entblatten, d.h. die Entfernung aller noch nicht entfalteten sichtbaren und inneren Blätter, verhinderte die Blüte bei Zuckerrohr der Sorte 65/12-19, die normalerweise gut blüht; das Schneiden erfolgte knapp oberhalb des obersten Wachstumspunktes. Das Verhindern der Blüte wurde von einem Abfall der in den Wachstumsspitzen vorkommenden freien und gebundenen Aminosäuren begleitet. Die Stärke dieses Abfalls wird bestimmt (a) dadurch, wie oft entblattet wurde; (*b*) vom jeweiligen Entwicklungszustand der Blüten im Augenblick des Entblattens (in dieser Beziehung ist die Phase am kritischsten, in der ein gewisser Schwellenwert bei der Anhäufung überschritten wird); (c) vom Kompensationsgrad durch das Nachwachsen des entfernten Blattgewebes.

Metabolismo de nitrógeno en la caña de azúcar y deshojamiento

Deshojamiento, es decir eliminación de todas las hojas visibles y internas, impidió floración en caña de la variedad 65/12-19 que normalmente florece libremente; se ha cortado la caña un poco sobre el punto terminal de alargamiento. El inhibición de floración en las plantas tratadas se acompañaban por una caída de las cantidades de amino-ácidos libres y liados del ápice, siendo el alcance de la caída gobernado por: (*a*) repetición del deshojamiento, (*b*) la etapa específica de floración cuando se ha deshojado la caña (el fase de acumulación de estímulos es el más crítico en este respecto) y (c) el grado de compensación que resulta de revegetación de los tejidos cortados de hoja. □

Ecuador domestic sugar price[1].—The Government of Ecuador has permitted a rise to 300 sucres per quintal for refined sugar on the domestic market. The domestic price, controlled by the Government since 1945, had been fixed at 220 sucres since December 1975 in spite of repeated requests from the industry for an increase. The refiners declared unilaterally an increase to 345 sucres a quintal in early August but, having experienced strikes in May, the Government was unwilling to give in and imprisoned several sugar company executives. The executives maintain (and independent analysts agree) that the alternative would have been bankruptcy, and the industry would presumably begin a slowdown that could well result in a need to import sugar whereas self-sufficiency and exports had previously been the case. In the end, the Government yielded to the industry's managers but, as was the case with the previous price increase, the gain may well be eaten up by inflation and demands by the industry's workers.

Brazil sugar exports, 1977[2].—Total exports of sugar from Brazil during 1977 amounted to 2,486,587 tonnes at various prices which averaged overall $181.96 per tonne. Deliveries during November and December alone from the ports of Recife, Maceio, Santos and Itajai amounted to no less than 740,000 tonnes.

Colombia sugar situation[3].—In 1977 Colombia had to discontinue sugar exports owing to a shortage on the domestic market. To cover requirements, sugar was imported from the world market, a quantity of 99,722 tonnes having been imported in the period January–July 1977. This contrasts with average annual exports during 1974–76 of 142,000 tonnes, raw value. Current consumption and production forecasts indicate that the country will again be exporting sugar in 1978; production is forecast at 934,400 tonnes against 849,500 tonnes, raw value, in 1977. According to the USDA, Colombia expects to export 70,000 tonnes of sugar in 1978, which implies a consumption level of around 865,000 tons, well below the 1976 level. This does not seem unrealistic, however, as sugar prices have been increased in order to reduce domestic consumption.

Puerto Rico sugar industry contraction[4].—By 1979 the cane growing area of Puerto Rico is to be reduced from its present 120,000 acres to 70,000 acres and the land so released devoted to other crops. As a consequence four of the existing 11 sugar factories are to be closed. The remaining factories will produce about 200,000 tons of sugar per year.

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[1] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (1), 10.
[2] C. Czarnikow Ltd., *Sugar Review*, 1978, (1371), 11.
[3] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (1), 10.
[4] *Zeitsch. Zuckerind.*, 1977, **102**, 831–832.

BMA's 125th Anniversary

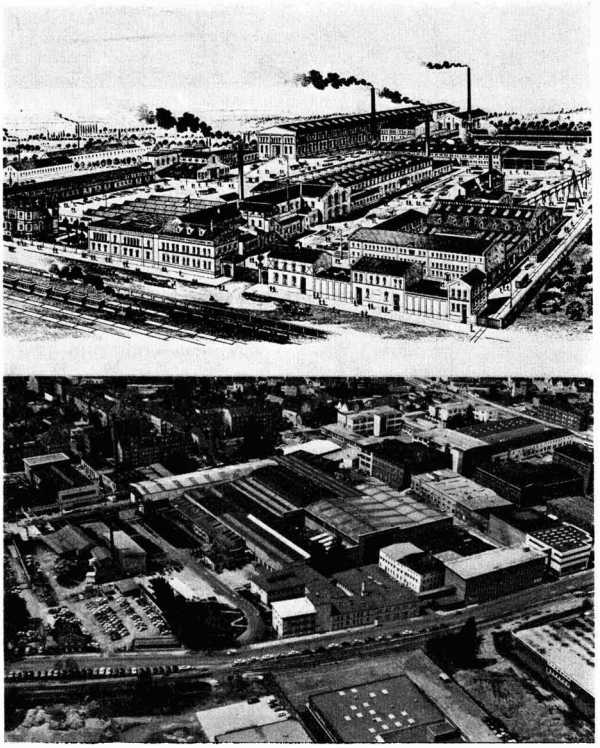
THE 12th April 1978 will be the 125th anniversary of the day when four Braunschweig citizens named Schöttler, Seele, Pommer and Hasenbalg founded a company "for the purpose of running a machine and car building factory" by the name of F. Seele & Comp. The young enterprise, which in the first few years of its existence was engaged in railroad car construction, soon transferred its emphasis to the manufacture of machinery, equipment and apparatus, especially for the sugar industry. This development was favoured by its location within one of Germany's most important beet growing areas.

In 1857, the first sugar factory was erected at Barum. Good market conditions and a persevering technical and commercial management boosted the enterprise's business. By the courage of the founders and the energy of the employees of the company, not only the Braunschweig industry but the whole of German industry were given great impetus. As early as in the sixties of the past century, the company employed more than 1000 hands and, in addition to the manufacture of individual machines, built up to five sugar factories per year. In the prime of this development, the enterprise was converted on 1st April 1870 into a joint-stock company and carried on under the name of Braunschweigische Maschinenbauanstalt.

A better financial footing then paved the way to large exports. Besides beet sugar factories for the European area, cane sugar factories were supplied to many countries; in addition, BMA began to manufacture plants for the alcohol industry and for the starch and glucose industries.

At times, the export ratio was 85% of the total sales. Based on high-quality workmanship, reliability, extensive development work and an internationally accepted know-how, BMA quite early established a high reputation in its special fields of activity. By the turn of the century, the trade name BMA had become familiar to the international sugar industry.

As a result of the Great Depression and the change in ownership, hard times came to BMA. After many years of stagnation, in 1940 the majority of the shares finally passed into the possession of C. Deilmann Bergbau GmbH—now C. Deilmann AG, Bentheim. The improved financial basis and the progressive-minded management of the Deilmann company led to a new growth. In 1953, when BMA celebrated its centenary, most of the war damage had been cleared away. Then it was a question of developing the works in every respect and of coming up again to international market requirements. BMA's market position was considerably strengthened by new technical and technological developments, e.g. BMA extraction plants for sugar beets and sugar cane, the Braunschweig 65 juice purification system, as well as continuous and fully automatic centrifugals. This work was very much supported by the German and international sugar industries and has been carried out in close cooperation with leading institutions, in particular the Institute of Agriculture and Sugar Industry of the Braunschweig Technical University.



The BMA works (above) in 1900 and (below) today

BMA played a decisive role in developing the world's sugar industry: Chile's six sugar factories were built by BMA; three beet sugar factories for the Soviet Union were milestones of economic processing. Factories built in Pakistan, Sudan, Greece, Rumania, Morocco, Iran, the USA and in the Philippines bear the quality label of Braunschweigische Maschinenbauanstalt.

In the course of the past few years it has become necessary to respond to a stiffer international competition entailing greater risks, which included an expansion of the supply line to enlarge the basis and to even out seasonal cycles and employment fluctuations which are quite common in large-scale plant construction.

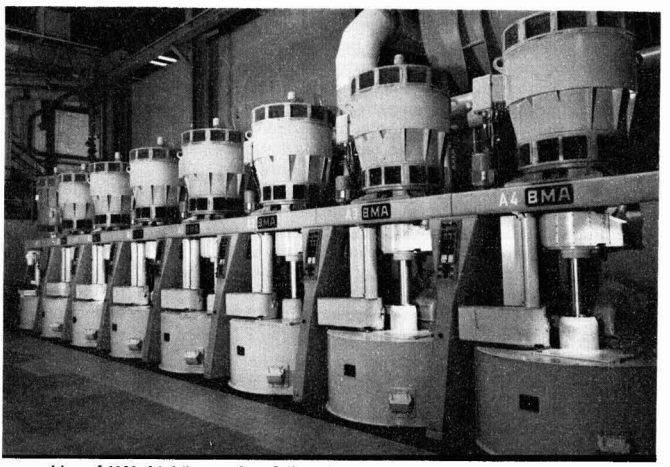
This applies to plant construction for chemical process engineering, construction of general apparatus and machines and airport ground equipment. Along with it has gone an intensification of marketing efforts and an improvement of engineering and service facilities. Quality control of the products made at the work-

shops and confinement to products of a high quality and a high labour content, as well as a streamlined organizational structure and an increased efficiency in all fields round off BMA's modern image.

Based on its advanced technology, BMA is presently building four sugar factories (two each to process sugar beets and sugar cane), while its subsidiary Starcosa GmbH, in a consortium with other firms, is building a maize starch factory in Algeria.

BMA's supply line is steadily being completed. Balco-Filtertechnik GmbH (manufacturers of micro-screens, especially for centrifugals), Starcosa GmbH (planning and supply of factories for the production of starch and starch derivatives, carbonic acid and dry ice plants, etc.), and TAG—Trocknungs-Anlagen-Gesellschaft mbH, Berlin (planning and construction of drying plants of all kinds), with all their business interests, belong to the BMA group. The executive board of BMA is composed of Dipl.-Ing. Reimar von Achten (engineering, marketing) and Dr. jur. Edmund Pfadler (controlling, logistics, finance).

Entrepreneural spirit, courage and willingness to take risks, technical progress and reliability, good workmanship and an efficient staff are the fundamentals of BMA's 125-year old high reputation. □



BMA centrifugals: (left) a belt-driven machine of 1900, (right) a modern fully-automatic "Variant"-type battery

Corrections to the refractive index of sucrose solutions at high temperatures

By D. BASKER* and M. SHIMSHONI†

A TABLE has been published of corrections to be applied to the refractive index of aqueous sucrose solutions at high temperatures[1]. To enter this table, the sucrose content % w/w must be known or at least first estimated. It has been suggested that the corrections would be easier to apply if a table were prepared in a format permitting entry with the actual readings obtained.

For this purpose, interpolations are required of the refractive index values on the Brix scale (Reference 1, Table II).

Zero-order approximations to the interpolated values may be obtained graphically from a plot of the sucrose content % w/w against the refractive index readings (Brix scale) at each experimental temperature. First-order approximations to the corrections required may then also be obtained graphically, from plots of the sucrose content % w/w against the refractometer corrections (Reference 1, Table III).

However, better approximations may be obtained algebraically, from Reference 1, Table II. The calculated corrections to be added to the refractometer readings are detailed in Table I opposite. □

Table I. Corrections to be added for determining the percentage of sucrose in aqueous solutions by a refractometer

Refractometer reading	*Temperature, °C* 30	40	50	60	70	80	90	95
5	0·6	1·5	2·7	3·9	5·4	6·9	8·6	9·5
10	0·7	1·5	2·7	3·9	5·4	6·9	8·5	9·3
15	0·7	1·7	2·7	3·9	5·4	6·8	8·4	9·2
20	0·8	1·7	2·8	3·9	5·3	6·7	8·3	9·1
25	0·8	1·8	2·8	3·9	5·3	6·7	8·2	8·9
30	0·9	1·8	2·8	3·9	5·2	6·6	8·0	8·8
35	0·9	1·8	2·8	3·8	5·2	6·5	7·9	8·6
40	0·9	1·8	2·7	3·7	5·1	6·3	7·7	8·4
45	0·9	1·7	2·7	3·7	5·0	6·2	7·6	8·3
50	0·9	1·7	2·6	3·6	4·8	6·1	7·4	8·1
55	0·8	1·6	2·5	3·5	4·7	5·9	7·2	7·9
60	0·7	1·6	2·4	3·4	4·6	5·7	7·0	7·6
65	0·6	1·4	2·3	3·2	4·4	5·5	6·8	7·4
70	0·5	1·3	2·2	3·1	4·2	5·3	6·5	7·2
75	0·3	1·1	2·0	2·9	4·0	5·1	6·3	6·9
80	0·2	1·0	1·8	2·6	3·8	4·9	6·0	6·6
85	0·0	0·8	1·6	2·4	3·5	4·6	5·7	6·3

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[1] Basker: *I.S.J.*, 1976, **78**, 359–360.

The role of charged colloids in floc formation

By EARL J. ROBERTS and MARY AN GODSHALL

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Introduction

IN RECENT publications[1,2] we have shown that one of the chief components of acid beverage floc (a feathery precipitate which occasionally forms in carbonated beverages and acidified syrups) is a heterogeneous polysaccharide. This polysaccharide is indigenous to sugar cane, is found in all sugar cane products including refined sugar, and is believed to be implicated in floc formation.

Protein has also been identified in acid beverage floc by Roberts & Carpenter[2], Stansbury & Hoffpauir[3] and Liuzzo *et al.*[4]. Cohen *et al.*[5] observed that all acidified refined sugar solutions will floc if protein is present and suggested that acid floc arises by aggregation of macromolecules in the form of a protein-polysaccharide complex.

Roberts & Martin[6] reported the average protein content of 30 samples of raw cane juice to be 0·6% on solids. They also found that 80% of that protein is removed during juice clarification. It has been generally assumed in the literature that most of the remaining 20% of the protein is eliminated during the crystallization of the raw sugar and in the refining process. For this reason, and because of the lack of a suitable method to measure such small quantities, little attention has been given to the protein in raw or refined sugar.

Protein estimation from the total nitrogen multiplied by the factor 6·25 is not dependable because of the presence of non-protein nitrogenous constituents such as melanoidin compounds in the sugar. The development of gel electrophoresis has made available an excellent method for the separation and determination of small amounts of a variety of proteins.

Gel electrophoresis is a separation technique that involves the migration of charged particles in an electric field through a porous but rigid electrophoresis medium. Separation of the charged molecules occurs because of their differing sizes, shapes, and charges under the experimental conditions. Because of the amphoteric nature of proteins, buffers of differing pH values can be used to manipulate the charge on the protein and thus to control the direction of migration.

The electrophoretic medium is polyacrylamide gel, which is formed inside glass tubes from a mixture of the monomer acrylamide and a crosslinking agent such as N,N'-methylene bisacrylamide. Polymerization is effected by a variety of oxidative procedures to give a firm, transparent gel. As an alternative, photopolymerization can be initiated in the presence of an activator such as riboflavin.

The amount of acrylamide determines the stiffness or porosity of the gel and can be varied to suit the type of protein being analysed. Usually two gels are used. The separating gel is the medium in which the separation takes place; it occupies the major portion of the electrophoresis tube. On top of this gel is a shorter, more porous, stacking or spacer gel which concentrates the sample proteins into narrow starting zones before they enter the separating gel. This step greatly improves the sharpness and reproducibility of the separation.

After electrophoresis, the gels are removed from the glass tubes and placed in a solution containing a fixative and a protein dye. Excess dye is removed from the background gel with an appropriate solvent, leaving the stained protein bands clearly visible.

This paper describes what we believe to be the basic cause and mechanism of floc formation in acidified cane sugar solutions along with a method for the separation and quantitative estimation of the protein in raw and refined sugar.

EXPERIMENTAL

Materials and methods

The sugars used were raw sugars from various sources, as well as fourth, third, second and first strike refined sugars, and commercial refined blends. The tests used to determine the flocculating characteristics of the sugars were the Coca Cola test[7] and the beverage test[8]. In both tests an acid solution of the sugar is examined visually for many days for the onset of floc. The proteins were separated by a modification of the disc electrophoresis method of Davis[9] and quantitative estimations were made by a spectrophotometric determination of dye eluted from stained gels. The indigenous sugar cane polysaccharide (ISP) was prepared as described by Roberts *et al.*[10] from fresh sugar cane by a method designed to exclude most of the starch and dextran.

Polysaccharide

Nature of the charge on sugar cane polysaccharides. Twenty-five cm³ of 0·1M phosphate buffer was placed in a U-tube. A solution of 0·5 g of ISP in 25 cm³ of the same buffer was carefully added through the bottom of the U-tube so that the boundary between the turbid ISP solution and the non-turbid buffer was clearly visible in both arms of the U-tube. An electrode was placed in each arm of the U-tube, a DC potential of 200 volts was applied across the tube, and the boundary between the ISP solution and the buffer was observed. The experiment was repeated with several buffers of pH value ranging as low as pH 3·0. In each case, ISP solution moved quickly toward the positive electrode, indicating a strong negative charge on the ISP.

Precipitation of polysaccharide by positively charged compounds.—Ten cm³ of saturated solution of "Basacryl Orange FL" dye (a strong positively-charged basic

[1] Roberts *et al.*: *I.S.J.*, 1976, **78**, 163–165.
[2] Roberts & Carpenter: *Proc. 6th Tech. Session Cane Sugar Refining Research*, 1974, 39–50.
[3] *J. Agric. Food Chem.*, 1959, **7**, 353–358.
[4] *Proc. Soc. Soft Drink Technol.*, 1975, 93–102.
[5] *Proc. 29th Meeting Sugar Ind. Technol.*, 1970, 123–165.
[6] *Proc. 6th Tech. Session Bone Char*, 1959, 67–98.
[7] Eis *et al.*: *Ind. Eng. Chem.*, 1952, **44**, 2844–2848.
[8] Miki *et al.*: *I.S.J.*, 1975, **77**, 67–69.
[9] *Annals N.Y. Acad. Sciences*, 1964, **121**, 404–427.
[10] *Proc. 1st Tech. Session Cane Sugar Refining Research*, 1964, 76–84.

dye) was added to 100 g of floc-positive sugar dissolved in 100 cm³ water, without pH adjustment. Floc formed in six hours. It was also found that the addition of 10 cm³ of dye solution to a solution of 0·2 g of ISP in 100 cm³ of water caused immediate precipitation of polysaccharide.

Protein

Separation of protein from sugar by ion exchange.—A 500 g quantity of floc-positive sugar was dissolved in 1500 cm³ of deionized water. The solution was percolated through a 20 mm i.d. column containing 100 g of "Dowex-2" anion exchange resin in the base form. The resin was washed with 1000 cm³ of deionized water to remove sugar, and then with 500 cm³ of 10% sodium chloride solution to recover the protein. The sodium chloride was removed by dialysis for 72 hours against toluene-saturated deionized water.

Floc formation with isolated protein and ISP.—The protein isolated from 500 grams of floc-positive sugar by ion exchange, as described above, was dissolved in 2000 cm³ of water. To one-half of this solution was added 0·2 g of ISP and to the other half of the solution was added 0·2 g of ISP and 100 g of floc-negative sugar. The pH of each solution was adjusted to 2·0 with phosphoric acid. After two days, floc formed in both the sugar solution and the sugar-free solution.

Separation and determination of protein by gel electrophoresis

Preparation of the gels.—The gels were photopolymerized inside glass tubes of 1 mm wall thickness, 5 mm i.d. Two lengths were used: 7·5 cm tubes for the ribonuclease standard curve, and 10 cm tubes for determining protein content of the sugar samples.

Tubes were washed in detergent, thoroughly rinsed and soaked about 30 minutes in water containing a few drops of "Triton X-100", and dried. (Use of "Triton X-100" facilitated the removal of the gels from the tubes after electrophoresis.)

The bottoms of the tubes were temporarily sealed with a paraffin film ("Parafilm") and set into a supporting rack. The gel solutions were made up immediately before using, but the stock solutions were kept indefinitely in the refrigerator. All solutions were brought to room temperature prior to use.

The formulations for the gel stock solutions are listed in Table I. The solution for making a 10% separating gel consisted of one part solution *A*, one part *B*, and two parts *C*. The solution was carefully pipetted into the tubes, a drop of water layered on top to flatten the meniscus, and the filled tubes placed in front of a 12W "Cool-White" fluorescent light (strong 365 nm emission) for 15 minutes to polymerize.

The water layer was removed from the polymerized gel with a wick of absorbent tissue paper and the stacking gel solution layered on top. The formulation for this gel consisted of one part each of solutions *D*, *E*, and *F* and four parts distilled water. The meniscus was again flattened out with a water drop and the gel polymerized by exposure to the light for 45 minutes.

Preparation of the sample for electrophoresis.—Before electrophoresis, the protein was separated from the sugar by dialysis. One hundred to two hundred grams of solids was dialysed in regenerated cellulose tubing (molecular weight cut-off of 12,000) for about 108 hours (4½ days). Microbiological contamination was inhibited by dialysing the samples against toluene-saturated distilled water. The solution remaining in the dialysis bag was concentrated under reduced pressure below 60°C to a small volume and freeze-dried.

Table I. Gel stock solutions

A.	Acrylamide	40 g
	"Bis"	0·8 g
	Water to 100 cm³; filter	
B.	1N HCl	24 cm³
	"Tris"	18·1 g
	"Temed"	0·12 cm³
	Water to 100 cm³	
C.	Riboflavin	1 mg
	Water to 100 cm³	
D.	1N HCl	48 cm³
	"Tris"	5·98 g
	"Temed"	0·46 cm³
	Water to 100 cm³	
E.	Acrylamide	28 g
	"Bis".....	0·75 g
	Water to 100 cm³; filter	
F.	Riboflavin	4 mg
	Water to 100 cm³	

"Tris": Tris (hydroxymethyl) aminomethane or 2-amino-2-hydroxymethyl-1,3-propanediol
"Bis": N,N′-methylene-bis-acrylamide
"Temed" N, N, N′, N′-tetramethylethylenediamine

The sample of the freeze-dried solids to be analysed was weighed into a 2 cm³ volumetric flask and brought up to volume with the buffer to be used during electrophoresis. The solution was stirred with a 7-mm "Teflon"-coated stirring bar until a uniform suspension was obtained.

A drop of 0·1% aqueous methyl green dye was placed on top of the gel to act as an acidic tracking dye. Bromphenol blue (0·01%) was used as a basic tracking dye. The desired volume of protein sample was pipetted into the tube; the remainder of the tube was filled with buffer, and a 1 mm slice of 10% gel was placed on top of the tube to prevent loss of sample into the buffer reservoir. Care was taken at all times to avoid bubbles. The paraffin film seal was removed before inserting the tubes into the apparatus.

Electrophoresis was performed in a Canalco disc electrophoresis apparatus containing open buffer reservoirs.

The prepared tubes were pushed up into numbered grommets, unused apertures were closed off, and enough buffer added to both reservoirs to cover the ends of the tubes and the electrodes. Table II shows the stock buffer formulations. Prior to use, 100 cm³ of the buffer stock solution was diluted to 1000 cm³.

Table II. Buffer stock solutions

pH 3·5	*pH* 8·9
Glycine.....14·1 g	Glycine ..... 28·8 g
Acetic acid ..... 10·8 cm³	"Tris" ..... 6·0 g
Water to 1000 cm³	Water to 1000 cm³

The separation was carried out in the refrigerator to avoid damage to the samples from heat build-up. A constant current of 3 mA per tube was applied, across a potential difference of about 300 volts. The pH of the buffer determined the placement of the electrodes: In an acid electrophoresis, the negative electrode was placed at the bottom reservoir; in a basic separation, the leads were reversed.

Five hours or more of electrophoresis were required for good separation in an acid buffer system and one to two hours in a basic buffer.

When the separation was completed, the gels were removed from the tubes by reaming the ends of the tubes with a blunt needle attached to a distilled water supply so that a gentle stream of water was emitted to help dislodge the gel from the tube. The gels were placed at once in 0·05% "Coomassie Brilliant Blue R-250" (C.I. 42660) in 12·5% trichloroacetic acid overnight. The next day, the dye solution was discarded and the gels washed gently once in 50% ethanol to remove insoluble dye that adhered to the sides of the gel and the test tube and to enhance destaining. Absorbed background stain was removed in 10% trichloroacetic acid with several solution changes per day for two days. The proteins appeared as distinct blue bands against a clear background when destaining was completed.

Measurements of the protein in the bands.—A colorimetric method based on the elution of the protein-complexed dye from the gels was developed for the determination of the protein in the bands. Each stained band was carefully cut from the gel with a stainless steel razor blade, sectioned into small pieces, and dropped into a 2 cm^3 volumetric flask. About 1 cm^3 of eluting solution was added (95% DMSO—5% acetic acid v/v), and the stoppered flasks put on a wrist-action shaker overnight. The next day the solution in the flasks was brought up to volume and the absorption read at 590 nm on a Beckman DB Spectrophotometer. The protein values relative to ribonuclease were taken from the ribonuclease standard curve.

Ribonuclease standard curve.—Ribonuclease A, molecular weight 13,700, from Iso-Labs was used as a standard protein. The calibration curve was done at pH 3·6 and all subsequent quantitative electrophoresis was done at this pH.

Stock solutions containing 1 $mg.cm^{-3}$ of ribonuclease in buffer were used to make a series of dilutions to obtain the desired quantity of protein per gel, from 1 to 100 μg. The procedure outlined earlier for electrophoresis and elution of the dye was used with the exception that volumes of 5 cm^3 of DMSO-acetic acid as well as 2 cm^3 were used for elution of the dye. The absorbance of the different eluting volumes per weight of protein was related by determining total absorbance units by the following formula: Total absorbance units = (absorbance of sample $_{590nm}$) (cm^3 of eluting solvent).

Removal of floc-causing material from sugar solutions. Several solutions were prepared by dissolving 500 g of floc-positive sugar in 500 cm^3 of water. Each solution was filtered at 25°C through a 10-mm mat of "Celite" analytical filter aid at pH values ranging in steps of 1 pH unit from 1·5 to 8·5. The pH was then adjusted to 1·5 to 2·0 with phosphoric acid. If, after ten days, no floc had formed, it was assumed that the floc-causing material had been removed by the tight filtration.

A solution of 500 g of floc-positive sugar in 500 cm^3 of water was centrifuged at 40,000 *g*. The pH of the effluent was adjusted to 1·5 to 2·0 with phosphoric acid. If, after ten days, no floc had formed, it was assumed that the floc-causing material had been removed.

RESULTS AND DISCUSSION

Colloidal nature of floc-causing materials from sugar

The fact that the floc-forming materials can be removed by filtration and centrifugation show that these substances are colloidal in nature rather than in true solution: their presence accounts for at least part of the turbidity in sugar solutions. Analysis of the materials removed by these methods shows their composition is similar to that of isolated floc[2].

One of the major components common to all of these products, including isolated floc, is the heterogeneous polysaccharide which is indigenous to sugar cane (indigenous sugar cane polysaccharide, or ISP).

Polysaccharide factor

Nature of the charge on ISP.—For many years it has been known that the colloids in cane juice carry a negative charge at normal juice pH. Since both isolated floc and the floc-causing material removed from floc-positive sugar by centrifugation or filtration contained ISP, it was of interest to determine the charge on isolated ISP.

When a potential difference was applied across a U-tube containing ISP solution, ISP migrated toward the positive electrode. Fig. 1A shows the position of the boundaries between the ISP solution and the buffer before electrophoresis. Fig. 1B shows the boundaries after electrophoresis. The direction of the boundary change indicates that the ISP carries a strong negative charge over a wide pH range. This conclusion was substantiated by precipitation of ISP by compounds carrying a strong positive charge such as "Basacryl Orange FL" dye.

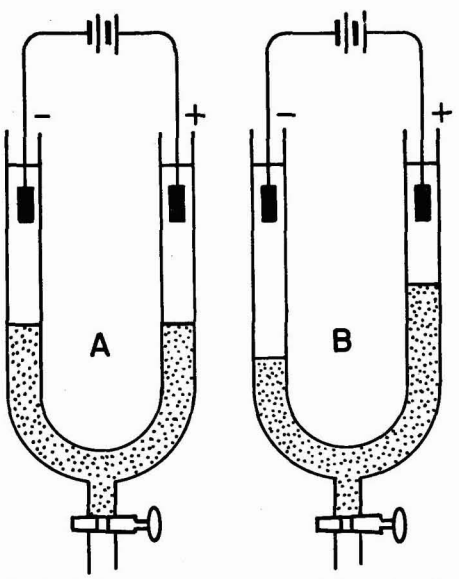

Fig. 1. A diagrammatic representation of electrophoresis

It is well known that flocculation occurs when a negatively charged colloid is mixed with a positively charged colloid. Flocculation was found to be nearly complete in those cases where the number of opposite charges were almost the same. Such reactions have been observed with a variety of systems, and may be illustrated as follows:

$$(Colloid_a)^+ + (Colloid_b)^- \rightarrow (Colloid_a)(Colloid_b)$$

Protein Factor

The fact that ISP is precipitated by compounds carrying a positive charge suggests that floc-positive sugars may contain some substance capable of changing its charge from negative in alkaline and neutral solution to

positive in acid solution. It is known that the charge on many proteins in solution will change in this manner.

Fig. 2 shows the protein from a raw sugar subjected to electrophoresis at pH 8·9 and 3·5. It can be seen that sugar protein does change its charge from negative at pH 8·9 to positive at 3·5. The two protein bands are characteristic of all raw sugars examined. The faster-moving of the two bands has been designated "protein 1" and the protein with the lesser mobility is called "protein 2". It has been found that protein 2 disappears during refining and is usually absent in refined sugars. Protein 1 is present in every refined sugar examined, including those that have undergone additional purification procedures. Fig. 3 compares a refined sugar with a raw sugar. It is evident that the single refined sugar band corresponds to protein 1 of the raw sugar.

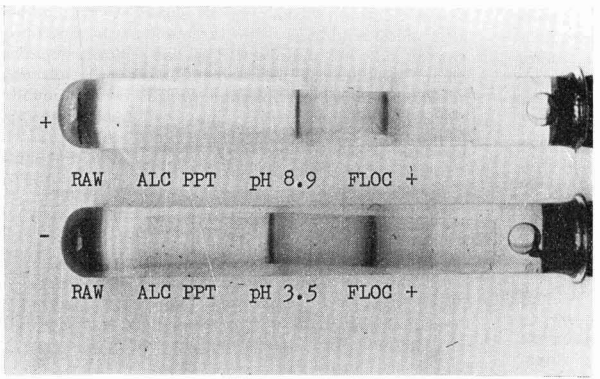

Fig. 2. Electrophoresis of raw sugar proteins at pH 8·9 and 3·6

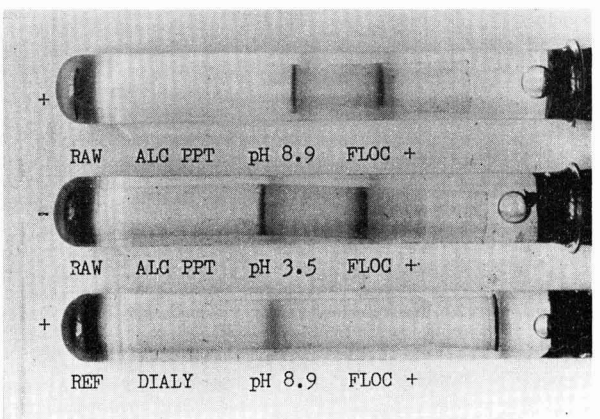

Fig. 3. Electrophoresis of protein from raw and refined sugar

Table III. Protein in raw and refined sugars measured by gel electrophoresis

Sugar	*Protein 1*	*Protein 2*
	ppm	
Panama raw	0·41	0·32
Refined sugar, commercial blend	0·12	—
1st strike sugar	0·11	—
4th strike sugar	0·032	—
Refined, Std. gran.	0·023	—
Refined, Special prep.	0·033	—
Refined sugar, commercial blend	0·041	—

Table III lists the protein values found in several sugars. Table IV lists the protein values obtained on a series of refinery samples. There is a steady decrease in protein 1; the concentration of protein 2 is less predictable. However, protein 2 was removed from the refined sugar and the run-off syrup; it is assumed that char filtration is responsible for the removal of this protein.

Table IV. Protein in refinery samples measured by gel electrophoresis

Sample	*Protein 1*	*Protein 2*
	ppm	
Raw sugar	0·66	0·58
Washed raw sugar	0·38	0·17
Melt liquor mixture	0·19	0·44
Carbonatated liquor before filter aid filtration	0·096	0·052
As above, after filtration	0·083	0·13
No. 1 syrup	0·066	—
1st strike refined	0·016	—

Protein removal.—It appears that all stages of refining are efficient to some degree in removing protein 1. The most effective stages are carbonatation and crystallization. (Phosphatated liquors were not examined.) The No. 1 run-off syrup contained 4 times as much protein as did the first strike sugar. Affination is also quite effective, removing slightly less than half of the protein. Filtration at 80°C through filter aid had little effect. Hot filtration of floc-positive sugar solutions was shown by Roberts *et al.*[1] to have no effect on preventing flocculation, whereas cold filtration did prevent floc formation.

Floc initiation by protein.—It was shown that either protein 1 or 2 will initiate flocculation. Twelve tubes containing protein from a high-protein raw sugar were subjected to electrophoresis, and the proteins eluted separately from the gels by macerating them in water; the gel was removed by centrifugation. The isolated proteins were put into two solutions each containing 0·1 g of indigenous sugar cane polysaccharide (ISP) in 500 cm^3 of distilled water at pH 1·5. Flocculation occurred within two days in both solutions, indicating that both proteins are capable of initiating floc formation. Flocculation did not occur with ISP alone in solution or with added silicate nor did it occur with protein alone in solution or with added silicate.

Some observations on protein 2.—Protein 2 gave a more diffusely stained band and was the less reproducibly quantified of the two proteins. It is assumed to be the larger protein because of its slower mobility.

"Alcan Blue" is a polysaccharide stain that has been used to determine the presence of carbohydrate in protein (i.e. glycoproteins). Two published methods[11,12] were adapted for this study to stain the proteins in raw sugar; protein 2 was very distinctly positive to "Alcian Blue" staining by both methods, indicating it is a glycoprotein or protein-polysaccharide complex. Protein 1 did not stain.

[11] Breen *et al.*: *Anal. Biochem.*, 1970, **35**, 146–159.
[12] Wardi & Allen: *ibid.*, 1972, **48**, 621–623.

Mechanism of floc formation.—Although other components present in sugar, such as silicon compounds, starch, dextran, and lipids, are negatively charged, the charges are weak and these compounds do not cause floc, as far as can be determined. However, floc formation is preceded by aggregation of oppositely charged colloids. The aggregates then coalesce to form the floc particle. As this process occurs, many of the other colloidal materials present are adsorbed onto the floc particles and are carried along with it. The nature of the colloids in the sugar may determine the appearance of the floc. For example, a high starch sugar may form "cotton ball" floc while a high silicon sugar may form a "granular" floc.

Many samples of sugar do not form floc when their solutions are acidified even though they contain both ISP and protein. In sugars of high purity the concentration of ISP and/or protein may be so low that too few collisions occur between oppositely charged particles to cause aggregation.

Deuel *et al.*[13] have shown that maximum flocculation occurs when the number of positive and negative charges are nearly equal. In solutions in which there is a preponderance of negatively charged particles the positively charged particles may become surrounded by negatively charged ones so that the overall charge on the complex particle is negative. This phenomenon is illustrated in Fig. 4. In such cases flocculation would not occur. This phenomenon may explain why some low purity sugars do not form floc. In some cases, the electrostatic characteristics or structure of the ISP or protein may be altered during the manufacture and refining of sugar, thus destroying the conditions necessary for floc formation.

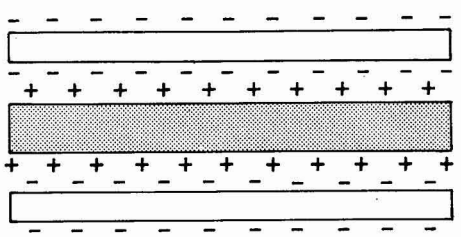

Fig. 4. A complex particle composed of one positively charged component and two negatively charged components

Summary

It has been shown that all cane sugars contain a heterogeneous polysaccharide which is indigenous to sugar cane. This polysaccharide forms a colloidal solution which carries a negative charge over a wide pH range. It was also shown that refined cane sugar contains protein which changes its charge from negative in alkaline and neutral solutions to positive in acid solutions. Methods are described for the separation and estimation of the protein. Combining solutions of the isolated polysaccharide and the isolated protein at low pH in the presence or absence of sugar results in floc formation. It is reasonable, therefore, to conclude that the indigenous polysaccharide and protein in cane sugar are the basic factors that cause floc formation in acidified sugar solutions.

Le rôle des colloides chargés dans la formation du floc

La poursuite des études des substances qui sont à l'origine du floc dans le sucre de canne a démontré qu'ils sont de nature colloidale. L'électrophorèse sur gel de polyacrylamide s'est révélée être une méthode excellente pour la détermination de la charge électrostatique sur la protéine du sucre à diverses valeurs de pH ainsi que pour l'estimation quantitative de la protéine dans le sucre brut et raffiné. A partir de mesures faites sur une large gamme de pH il a été trouvé que le polysaccharide à charge négative et la protéine à charge positive et cela à pH bas sont des facteurs clés dans la formation du floc.

Die Rolle von geladenen Kolloiden bei der Flocbildung

Weitere Untersuchungen über flocbildende Substanzen in Rohrzucker haben ergeben, dass diese kolloider Natur sind. Die Elektrophorese auf Polyacrylamid-Gel hat sich als ausgezeichnete Methode zur Ermittlung der elektrostatischen Ladung von Zuckerprotein bei verschiedenen pH-Werten und zur quantitativen Bestimmung des Proteins in Rohzucker und Raffinade erwiesen. Messungen über einen breiten pH-Bereich zeigten, dass das negative geladene Polysaccharid und das positiv geladene Protein bei niedrigem pH-Wert die bestimmenden Faktoren für die Flocbildung sind.

El papel de coloides cargados en formación de flóculos

Estudios adicionales sobre las sustancias en azúcar de caña que causan formación de flóculos han demostrado que su natura es coloidal. Electroforesis sobre poliacrilamido gelatinoso ha resultado un método excelente para determinar la carga electrostática sobre proteína del azúcar en varios valores de pH y para estimación cuantitativa de proteína en azúcar crudo y refinado. De medidas sobre una larga gama de pH se ha establecido que a pH baja el polisacarido con una carga negativa y la proteína con carga positiva son factores principales en la formación de flóculos. □

Thailand sugar targets[14].—The Government of Thailand has set sugar production during the 1977/78 season at 1·3 million tonnes of raw sugar and 500,000 tonnes of plantation white sugar (as against a total production of 2·2 million tonnes in 1976/77). As a member of the International Sugar Agreement, Thailand's basic export quota is 1·2 million tonnes, raw value, compared with the 1·6 million tonnes (worth $369·7 million) exported during 1977. Meanwhile sugar millers have assured the Government that they will produce white sugar in sufficient quantities for the domestic market and will buy cane from growers at the guaranteed price of 300 Baht per tonne. Because of over-supply, white sugar is being marketed below the controlled price of 500 Baht per 100-kg bag, according to traders.

Cuba sugar expansion[15].—According to press reports, seven new sugar factories are to be built in Cuba by 1990, while existing mills are to be modernized and to a great extent automated. The sugar cane harvest is to be fully mechanized by 1985 and, to this end, the Soviet-built plant in Holguín for cane harvester construction will produce 600 machines annually when it reaches full capacity.

[13] *Helv. Chem. Acta*, 1953, **36**, 1671–1680.
[14] *The Times*, 18th January 1978.
[15] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (2), 15.

SUGAR CANE AGRONOMY

Control of weeds in zero cultivation. Anon. *La Ind. Azuc.*, 1977, **84**, (961), 8-10 (*Spanish*).—The effects of zero cultivation on the development and species of weeds is discussed as is their control in the inter-row by means of contact herbicides and the use of residual herbicides as pre-emergence treatment of the lines in which the cane grows.

Observations on the assessment of the scope of intercropping in autumn-planted sugar cane in the Dhuri mill area. R. L. Tripathi and A. Singh. *Indian Sugar*, 1977, **26**, 753.—Trials carried out in 1973-75 using a number of intercrops showed that the most profitable was raya, which produced almost as high a yield as when grown alone, required little fertilizer and protected young cane from frost damage.

Relative tolerance of sugar cane varieties to frost. G. Singh. *Indian Sugar*, 1977, **26**, 759-761.—Trials carried out during February-March 1975 showed that, of the varieties tested, Co 1158 was the most susceptible to frost and CoJ 67, CoJ 46 and Co 1148 the most tolerant. Irrigation on frosty days saved the crop from bud damage.

Correlation study among sugar cane area, average cane yield and sugar recovery for Maharashtra. T. D. Patil. *Indian Sugar*, 1977, **26**, 763-766.—With new sugar factories being installed in Maharashtra, the area under cane is also increasing. Correlation studies showed a significant negative correlation between the area and sugar recovery ($r = -0.4375$), while no significant relationship was found between cane area and yield or between yield and recovery.

Weed control in Réunion. *C.E.R.F. Rpt.*, 1976, 36-38 (*French*).—Fifteen herbicides were tested and compared with standard chemicals. "Sencoral" at 2 kg.ha^{-1} a.i. was comparable to the standard "Diuron" at 3 kg.ha^{-1} for pre-emergence control of graminae and dicotyledons but was not very effective against *Cynodon dactylon* or *Cyperus rotundus*; it was toxic to maize and expensive. "Velpar" also gave good control in pre-emergence application, but had somewhat poorer effect on *C. dactylon* and *C. rotundus* although the last were reduced to 5% infestation of the area treated. Some toxicity symptoms were observed on certain varieties. "Caragarde 50" behaved similarly to "Diuron", while "Primextra", a formulation of "Atrazine" and acetanilide, was no more effective than "Atrazine" alone in powder form ("Gesaprim 80"). "Perflan T" was very similar to "Sencoral" but slightly more effective against *C. dactylon*. "Gepiron" at 6 kg.ha^{-1} a.i. controlled *Rottboellia exaltata* but even at 3 kg.ha^{-1} produced some toxicity symptoms in cane. "Basagran", a post-emergence herbicide, killed the aerial parts of *C. rotundus* but did not affect the roots and was therefore not as effective as an "Asulox 40"+"Actril DS" mixture. The mixture gave excellent control of *Paspalum paniculatum* and *P. dilatatum*: for dicotyledons a mixture of "Actril DS" with "Karmix" is recommended. "Roundup" has been tested to find the minimum dosage to control *Paspalidum geminatum*, *Artemisia vulgaris* and *R. exaltata*; further trials are continuing.

Sugar cane thrives with artificial drainage. R. P. Humbert. *World Farming*, 1977, **19**, (6), 20-21, 35.—Excess water in the root zone restricts oxygen availability and hinders growth, so that yields are low where a high water table persists. To avoid this, the land must be levelled, with earth added to fill in low-lying areas, and drained. Laying tile drains is time-consuming and costly, but a new method has been used to lay 50-cm corrugated plastic piping at a rate of 1 km per day at Mhlume Sugar Co. Ltd., Swaziland. The PVC pipes are laid at a spacing of 10-30 m along a controlled grade and perforations or slots allow water to enter, to run down the grade to an open or covered drain. The yield is expected to double in the drained fields. The use of a mechanical ditcher is also described and illustrated; it proved much more rapid than 100 men digging manually.

A case study of the effect of varying the length of the cropping season on the economics of cane and sugar production. T. Chinloy. *J.A.S.T.J.*, 1973, **34**, 28-34.—Productivity of sugar cane (in tons cane per acre per month) has been calculated from individual field records of Frome estate, and it is seen that December- and January-cut cane gives higher productivity than cane cut in subsequent months, there being marked drops from April to May and June. The capital cost of increased milling capacity so as to reduce the crop period by one month, i.e. December to May, would be $1,410,000 and the return on investment 3%. To reduce the crop by a further month, i.e. December-April, would cost $2,880,000 and the return on capital is calculated at 0·3%.

Method used for planning a typical sugar cane growing area—transformation and exploitation technology. R. Oviano. *J.A.S.T.J.*, 1973, **34**, 43-54. The development of sugar cane agriculture in Cuba since the 1959 revolution is described, with particular reference to the introduction of mechanization and the establishment of land planning in blocks suited to this and to irrigation and drainage systems. Intensification of cane cultivation requires a study of the existing conditions in land-holding, manpower availability and infrastructure, as well as soils, climate and water sources; analysis of the cane varietal pattern and harvesting cycle to be followed, etc.; and definition of difficulties which might prevent achievement of objectives, with means to overcome them. The techniques employed for land preparation, sowing, etc. for plant cane and treatment of ratoon cane are listed, and the administration of a cane region and a growing enterprise are described.

Alternate furrow irrigation on heavy clay soils. L. Ramdial and T. Chinloy. *J.A.S.T.J.*, 1973, **34**, 90-96. Comparisons were made of irrigation of cane in a field of 0·3% slope where burning was practised so that there was no obstructive trash blanket. Irrigations were in alternate furrows (i.e. 1, 3, 5, 7, etc.) each application, as

well as all furrows alternately (i.e. 1, 3, 5, 7, etc. for one application and 2, 4, 6, 8, etc. for the next). Cane yields by comparison with the standard twig-and-main practice varied between 90 and 104% and between 96 and 108%, respectively, over plant cane to 2nd ratoons and three estates, while water usage was reduced by a third. The better water utilization was partly due to cracking of the soil, which sometimes reached the subsoil and allowed better access to the cane roots. Where water is limited, use of the system using all furrows alternately would allow a greater proportion of the total cane area to be irrigated and would give a higher cane production than if the standard system were applied to a smaller proportion.

"Polaris" sugar cane ripener field performance in Hawaii. W. C. Zschoche. *Sugar y Azúcar,* 1977, **72,** (4), 21-22, 25-26.—The results are reported of industrial-scale application of "Polaris" (N,N-bisphosphonomethyl glycine) applied as a cane ripener in Hawaii, where the recommended application is of 4 lb active ingredient per acre, applied from the air in 7-10 US gallons, 6-10 weeks before harvest. Response differs with variety and with irrigation, and may be reduced if rain falls within 4 hours of application, but average gains were 0·53 tons.acre^{-1} of sugar in 1974, 0·40 in 1976 and 0·35 in 1976, compared with break-even responses of 0·08, 0·11 and 0·15 tons.acre^{-1} of sugar, respectively.

Results of industrial trials with "Polaris" ripener. R. Julien and M. Goolamhossen. *Rev. Agric. Sucr. Maurice,* 1977, **55,** 389-399.—Initial trials with "Polaris" had shown a positive response with four varieties (M 93/48, M 33/56, M 377/56 and S 17) and an optimum dosage of 4 kg.ha^{-1} a.i. applied about 9 weeks before harvest. A series of industrial trials were made in 1976 with the four varieties in ten estates, spraying by helicopter at different dosage rates and periods before harvest. The results of the trials are tabulated and discussed; all four varieties showed response to the ripener, the most sensistive being M 377/56. There was little difference between responses to 4 and 5 kg.ha^{-1}; because there was some difference in a number of areas between the responses to 3 and 4 kg.ha^{-1}, the latter rate is recommended. Although there was little or no further increase in recoverable sugar content between 6 and 11 weeks after application, application 6 weeks before harvest is not recommended because of poor re-growth observed at one site. This is to be the subject of further investigation, as is the application of "Polaris" to early ratoons.

Irrigation of sugar cane. II. G. D. Thompson. *S. African Sugar J.,* 1977, **61,** 161-174.—A review is presented with 74 references to the literature. Drip irrigation has not produced significantly better results than sprinkler irrigation in South Africa, and development work is needed to give a lateral system which is not harmed by cultivation practices or burning. Furrow irrigation is the form of surface irrigation which has been most successful in South Africa, and the Experiment Station has developed standards for inter-row furrow gradient, flow rate and length which are tabulated. Sprinkler irrigation is the method preferred in Natal because of steep topography, variable slopes, different soils and little available water. Dragline, solid-set and semi-solid set forms have been applied, but labour requirements now favour large travelling rainers moving over a 400 m distance in 7, 11 or 22 hours, depending on the gear selected. Other considerations include moisture retention by trash conservation instead of burning, the similar yields obtained when irrigation was applied only in summer instead of all year round, and yield improvement by use of smaller, more frequent applications of water. The yield increase is due to extra cane weight, and this through greater stalk length. Irrigation control has employed tensiometers and gypsum blocks; the Class A Pan of the US Weather Bureau has been adopted in more recent times, however. Effects of drying-off before harvesting in other countries as well as South Africa are discussed; recoverable sugar increases, although it decreases again if drying-off is too severe. The effect of drying-off on soil and tissue moisture contents is discussed, as are general considerations in respect of an irrigation application in South Africa.

Fertilizer requirement and age at harvest of Phil 64 varieties. F. L. Punzalan, F. E. Mercado, H. M. Miayo and D. L. Tupaz. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.,* 1975, 161-173.—Phil 6421, 6425 and 6429 were tested against Phil 56226 at two locations using different N fertilizer levels. None surpassed the control in rendement but produced optimum tonnage at 100 kg.ha^{-1} of N, whereas this was required at one location for the control but 150 kg.ha^{-1} at the other, probably owing to different soil organic matter. Rendement and sugar yield increased significantly between 10 and 14 months of age, and the data indicate that Phil 6421 and the control should be harvested at 12 months, and Phil 6425 and 6429 at 14 months after planting to maximize yield.

The design and installation of tile drain system in Victorias. A. A. Mactal. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.,* 1975, 233-243.— While open field drains are effective for removal of surplus water, they create a problem for mechanization, and sub-surface tile drainage was therefore installed at one part of the Victorias Milling Co. estate. The nature of the tiles, method of installing them and their performance and economics are described. The importance of maintaining an even gradient in the drains is emphasized as is the need to employ cross subsoiling. It is also necessary to maintain a permanent record of the location, sizes and depths of all drains.

Procedures in soil sampling: variations due to location and depth. W. G. Espada, I. S. Bombio, R. H. Palacios, L. L. Gargarita, R. R. Manopla and E. N. Momville. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.,* 1975, 244-252.—Soil samples were taken, using a zig-zag sampling scheme and at random, and the variations in N%, exchangeable K, available P and organic matter content % studied in relation to location, depth, size and sampling scheme. There was no significant difference between zig-zag and random sampling nor between 10, 15 and 20 borings per sample, but there were differences in the nutrients and organic matter as a function of sampling within and between rows and at different depths. For a visually uniform field, ten samples composited was adequate for organic matter and K, but more samples were required for P. Sampling should be in and between the rows.

SUGAR CANE MECHANIZATION

Evaluation of effects of dual-row planting of sugar cane. B. T. Roach. *Proc. 44th Conf. Queensland Soc. Sugar Cane Tech.*, 1977, 131-137.—Further details are given of the dual-row planting trials conducted in 1975[1], and information is given on data collected from them in 1976. While the number of stalks produced in the early stages of growth is much greater than could survive to maturity, there was still a substantial increase in stalk population at maturity and hence in cane yield by comparison with single-row planting. Other cane parameters were not generally affected by the system. In two trials, Massey Ferguson 515 harvesters experienced some difficulty because of the narrow throat and single base cutter, whereas in the other two trials a Toft 300 half-track harvester and a Toft 310 full-track machine found no difficulty since they have wider throats and dual base cutters. Observation of early growth in 1st ratoon crops has indicated that overall stool width in dual rows is only slightly greater than in plant crops and should not present any problems to harvesters, although later ratoon crops may do so unless stool width is reduced during ratooning. The effect of dual-row planting on ratoon crop yields has yet to be assessed, although preliminary indications are that there will be a greater yield than with single-row planting. No serious problems arose in planting or cultivating dual-row crops.

A study of field-to-tramline cane transport utilizing a simple model. J. R. Reghenzani. *Proc. 44th Conf. Queensland Soc. Sugar Cane Tech.*, 1977, 173-178.—Data on cane harvesting and transport from the Bundaberg area (where cane railway sidings differ from the pattern used in the far north of Queensland) were used to develop models; four haulage distances and two siding arrangements were used as inputs. Results indicated that adoption of the siding system used in the north of the state would be beneficial in terms of greater output where two double-bin trailers were used over a distance greater than 0·8 km, or where three double-bin units operated over a distance greater than 2 km.

Mechanical loading and cane transport at Trelawny Estates Ltd.—A time study. R. K. Spence and R. Arscott. *J.A.S.T.J.*, 1973, **34**, 111-115.—Time studies were made at three farms on mechanical loaders and haulage tractors. Actual loading time varied between 25·94% and 40·10%, and the study showed considerable scope for improved efficiency by elimination of waiting for carts to be available, and this requires better organization of infield hauling, reduction of the cart waiting time at the factory, and allowance for the breakdown of carts. Larger fields reduce the time spent in moving to new loading sites, and scrapping and piling of loose cane when empty carts are available is wasteful—it should be limited to times when carts are not available.

Methodology for Government tests on sugar cane harvesters in the Republic of Cuba. C. Iglesias. *J.A.S.T.J.*, 1973, **34**, 116-121.—Features of the programme for testing the design, construction and operation of cane harvesters are listed.

Description of the work of soil preparation and harvesting in the cultivation of sugar cane in the Pomalca, San Jacinto and Andahuasi Agrarian Production Cooperatives. M. Morales C. *Bol. Técn. Divn. Técn. Inst. Central Invest. Azuc.*, 1975, **4**, (3/4), 1-47 (*Spanish*).—A fairly detailed description is given of the preparation of soils, harvesting and (at San Jacinto) furrow reconditioning at the title cooperatives. The description given is of work done under normal conditions. Emphasis is placed on the sequence of operations to be followed in the work, machinery and equipment used as well as their hourly capacity, and various aspects which have to be taken into account for carrying out the work. Operations discussed include: soil preparation (root destruction, surface rotary cultivation, subsoiling, levelling, land surveying, furrowing and ditching) and harvesting (field preparation for harvesting, cutting and windrowing, loading and transport).

Mechanizing the sugar industry. E. A. Uichanco. *Sugar News* (Philippines), 1977, **53**, 48-50.—See *I.S.J.*, 1978, **80**, 48.

Cane transport by trailers and trucking system. E. de Asis. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 153-159.—The cane transport system for First Farmers Milling & Marketing Coop. Association is described. Planters from Bacolod-Murcia have an average 28-kg haul and use 16-ton trailers pulled by prime movers; those at Talisay-Silay have an average 7-kg haul and use a train of 5-ton trailers pulled by tractors. Where trailers cannot go, cane is loaded onto dump trucks while the factory has its own fleet of trucks for collecting cane from small growers (5 ha or less) whose area does not warrant trailers or trucks of their own (amounting to 60% of the total cane supply). The shift operation and payment system for hauling is described in detail.

Processing response of cut-chop combine harvested and conventionally harvested cane. M. A. Garcia. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 263-273.—Two chopper-type harvesters, one a single-row machine and the other a double-row harvester, were used to cut 2-3 ton lots of green cane while a 100-lb sample was cut by hand and burnt in the windrow. The chopped cane was crushed in a pilot-scale milling tandem preceded by a set of knives, while the manually-cut sample was passed four times through a laboratory mill with intermediate imbibition. Two series of experiments were conducted for each harvester, with different intervals between cutting and milling; cane, juice, water and bagasse were weighed and the bagasse and juice analysed. Temperatures and humidity were relatively low during the tests and consequently there was little difference in the rate of deterioration (measured as juice dextran and gum content) between manually- and machine-cut cane. The clarified juice from the manually-cut whole-stalk cane was significantly clearer than that from the chopped cane, but the clarifier mud volume was greater. There was no significant difference in boiling time or yield.

[1] Roach: *I.S.J.*, 1976, **78**, 335.

CANE PESTS AND DISEASES

Food habits of Norway and Polynesian rats in Hawaiian sugar cane fields. D. P. Fellows and R. T. Sugihara. *Hawaiian Planters' Record,* 1977, **59,** 67-86. The diet of *Rattus norvegicus* and *R. exulans,* which cause the greatest damage in cane fields, was studied by trapping and analysis of stomach contents to determine their food habits, to examine the effects of season and cane age, and to relate consumption of alternative foods to their availability. It was found that cane stalk and animal matter constituted most of the food volume of Norway rats throughout the crop cycle and of Polynesian rats in 7-24 months old cane. The latter pest in 0-6 months cane consumed large quantities of animal matter and fruits. Because of the wide variety of these, none appearing to be a limiting species, rat control by food manipulation appears unpractical, as does provision of "preferred" foods. However, heavy consumption of cane grubs suggests that suppression of these could deprive the rats of a major protein source, as might control of caterpillars of *Opogona apicalis,* not itself a cane pest. Control of volunteer cane, fruit and berries in wasteland near cane fields may aid control of the Polynesian rat, while the cane age/rat species composition change possesses control implications when better understood.

Smut now in Jamaica. R. A. Burgess. *Sugarcane Pathologists' Newsletter,* 1977, (18), 1.—Culmicolous smut, identified in Guyana in 1974, was subsequently found in Martinique and Trinidad and is reported from Jamaica[1]. Control measures are described, including modification of varietal planting policy; close to 50% of the Jamaican cane area is planted with the susceptible HJ 5741 variety.

Standardization of inoculation techniques for sugar cane smut disease. I. A. Nasr. *Sugarcane Pathologists' Newsletter,* 1977, (18), 2-5.—Three methods in use for varietal resistance testing include natural field infection and exposure trials, both of which require large areas. The third method—artificial inoculation—requires less area but may eliminate varieties with field resistance. However, it seemed most appropriate under Sudan conditions, and the techniques were studied with a view to standardization and improvement. Setts of ten varieties were inoculated by three methods (dipping in a spore suspension, applying a spore paste to the buds, and applying a spore paste to needle-prick wounds near the bud). The setts were planted and observed between 2 months and 6 months after germination. The first two techniques gave similar results and the dipping method is to be adopted because it is less time- and labour-consuming. The third method is very severe and will only be used for highly resistant varieties. To minimize variability in results with the dipping method, bud age and inoculum density are to be standardized.

Sugar cane diseases observed during the 1976 ISSCT sugar cane germplasm collection expedition in Indonesia. H. Koike and N. Berding. *Sugarcane Pathologists' Newsletter,* 1977, (18), 6-7.—A total of 570 samples of cane were collected during the expedition and several more observed for diseases. Several canes showing symptoms of ratoon stunting, mosaic and Fiji disease were not collected. On the others, 14 fungal diseases were identified, including red rot (the most common), yellow spot and rust (which were common), ring spot, a black leaf spot, brown spot and brown stripe; others found rarely were downy mildew, eye spot veneer blotch and leaf splitting. Only three bacterial diseases were observed and then rarely: ratoon stunting, red stripe and mottled stripe. Fiji disease, mosaic and chlorotic streak were the three virus diseases observed, while other diseases observed included several leaf spots, blotches and streaks.

Rhizosphere mycoflora of sugar cane infected with different strains of sugar cane mosaic virus. J. Prakash, L. N. Dubey and R. D. Joshi. *Sugarcane Pathologists' Newsletter,* 1977, (18), 12-13.—Plants of four varieties were infected with four strains of mosaic, and after a time the plants lifted, the roots separated using sterilized scissors, and the rhizosphere soil shaken into sterile distilled water. A 1-cm^3 aliquot of the suspension was inoculated onto a Petri dish and the micro-organisms grown on a nutrient medium and identified. Comparison between healthy and diseased plants showed differences between the fungal species present which are recorded in a detailed table.

A study of rhizosphere mycoflora of grassy shoot disease-infected sugar cane (*Saccharum officinarum* Linn.). J. Prakash and R. D. Joshi. *Sugarcane Pathologists' Newsletter,* 1977, (18), 14-16.—Healthy plants of five varieties were infected with grassy shoot disease and their rhizosphere fungi examined (see previous abstract). The details are tabulated, but it is also indicated that the number of fungi present was reduced by the incidence of the disease.

Long-term storage of sugar cane mosaic virus in infected plant material. K. Shukla. *Sugarcane Pathologists' Newsletter,* 1977, (18), 17-18.—Leaves of sorghum infected with mosaic were collected after 10 days when the virus concentration was maximum. The leaves were spread evenly over a nylon gauze covering a layer of anhydrous $CaCl_2$ in a large Petri dish. This was sealed with a waterproof tape and held in a refrigerator at —1°C for two weeks when the leaves were desiccated completely. The dry material was then transferred to rubber-stoppered tubes having some more $CaCl_2$ at the bottom, covered with an absorbent cotton wad. Half of the tubes were stored at —1°C and half at room temperature (29-31°C). The material from the tubes was used in transmission experiments, and it was found that the room temperature material infected 10 out of 20 plants after 2 months and 4 out of 20 after 3 months, whereas corresponding figures for the material stored at —1°C were 16 and 15 out of 20, respectively, and 5 out of 20 after 4 months. The method is therefore considered to be useful for storage of the virus for up to 4 months.

[1] See also *I.S.J.,* 1977, **79,** 59.

SUGAR BEET AGRONOMY

The irrigation coil. J. Demay. *Le Betteravier Franç.*, 1977, (315), 16-17 (*French*).—An account is given of this device, developed particularly in the past two years, which conducts water from a stationary main to a sprinkler in the field. The coil is unrolled so that the sprinkler reaches its limit position and is then recoiled so that the area covered by the sprinkler is in the form of a narrower strip than if water came from a stationary main direct to it and a more powerful jet were needed to cover the same area (in which case the larger water droplets would damage the soil to a greater extent while application would be less uniform). Motive power can be provided by a hydraulic motor operating a ratchet mechanism or a hydraulic turbine operating continuously through a reduction box. Water is supplied to the sprinkler through a flexible but resistant 60-90 mm dia. tube; the weight of the water it contains (approx. 8 kg.m^{-1}) absorbs 1 bar pressure per 100 m of unrolled tube as a function of resistance to its travel along the ground as the sprinkler is pulled back to the coil. Improvements to the basic design are described: guides, speed control, coil safety control, automatic stop and delay mechanisms. Factors to be considered in choice of unit are discussed, and the adaptation of the chosen type to the duty required is described.

The industrial value of beet. R. Vanstallen and N. Roussel. *Sucr. Belge*, 1977, **96**, 163-173 (*French*).—By the industrial value of beet is meant the overall combination of physical and chemical properties on which depends the amount of white sugar produced, sucrose content alone being insufficient to characterize this quality. The authors have considered juice purity, molasses sugar and extractible sugar using formulae from the literature, and analytical values of K, Na and α-amino N. The effects of a number of variables on these parameters are then examined, with copious references to the literature. These include organic fertilizers (excessive use of liquid manure being particularly harmful and an inverse relationship being established between beet value and N fertilizer usage). K fertilizer increases the K present in the beet and results in higher molasses loss over a range of 10-36 mg exchangeable K_2O per 100 g of soil; above 36 mg the effect is clearly harmful. The effect of P fertilizer is less clear but it shows a positively beneficial effect only when the $NaHCO_3$-soluble P is less than 10 ppm. Differences between varieties were generally smaller than for the same variety in different fields. Plant population affected the beet yield and sucrose content but not the juice purity or molasses sugar. There was little clear influence of insecticide or herbicide treatments on the beet value, although the use of effective insecticides against virus yellows vectors reduced incidence of this disease which diminishes the value of the beet. Removal of leaves gave a lower value in the residual root than when the beet were scalped and more non-sugars thus removed with the crown. Experiments on storage showed that topped beets kept for 3 weeks at 15°C lost only 3·3% of their initial sucrose content, 80% of this loss being through respiration, particularly in the first few days. At lower temperature (but above freezing point) the sugar loss was lower and in both cases there was no loss in beet value. There was a loss, however, when the stored beets became frozen and later thawed.

Sugar beet sowing with pneumatically-operated drills. H. Schafmayer. *Zucker*, 1977, **30**, 284-287 (*German*).—Comparative tests are reported involving three commercial pneumatic seed drills. Tabulated data include field emergence, placement accuracy, percentage of spaces occupied by more than one seed, and costs. It is concluded that while such drills are suitable for use in beet sowing, particularly with pelleted seed (which was more accurately placed than was unpelleted seed), their high costs dictate that they should be used for more than one type of crop, e.g. beet, maize and vegetables, over large areas. However, it is also pointed out that universal application in beet and maize can be difficult as a result of the overlapping of the sowing time for the two crops, so that there is need for easy and rapid conversion of the drill for the specific crop. (Conversion of a 6-row beet drill to a 4-row maize drill took 2 hours of skilled work.) Because of the greater complexity of the pneumatic machine, attention must be paid to the lifting power of the 3-point hydraulic system as well as the trim of the skid, which can affect the width of the drill path.

Some novelties in the area of beet mechanization. A. Vigoureux. *Le Betteravier*, 1977, **11**, (110), 9-12 (*French*). Photographs and descriptions are presented of equipment on show at the Wallonia Fair at Namur and at the SIMA Exhibition in Paris. They include harvesters, loaders, toppers, etc.

The effect of application of large doses of nitrogenous fertilizer to sugar beet on their storage properties. J. Malec. *Gaz. Cukr.*, 1977, **85**, 113-115 (*Polish*). N:P:K at 140:108:200 kg.ha^{-1} was applied (i) on its own, (ii) plus two top-dressings of 45 kg.ha^{-1} calcium nitrate, and (iii) plus two top-dressings of 45 kg.ha^{-1} urea, to beet of two varieties. The sugar, ash and dry solids contents were determined after harvesting and after 65 days' storage, as well as degree of infection by storage rot. Tabulated values are given of processing quality parameters, thin juice composition and daily sugar and weight losses. It was concluded that N has a considerable effect on beet quality, increase in the dosage causing increase in ash, invert sugar, amino-acids and lime salts, as well as storage losses and reduction in resistance to rotting.

Seasonal patterns of sugar beet growth. II. Simulating the effect of time of harvest initiation on productivity. D. Analogide. *Hellenic Sugar Ind. Quarterly Bull.*, 1977, (29), 283-308 (*Greek*).—The root and sugar yields during beet growth follow a sigmoid curve which can be expressed in the form $w = a/(1+be^{-ct})$. The process extends to September each year; however, harvesting starts usually in mid-July when the yield is only 70% of the potential. Assuming that the tonnage harvested daily = the tonnage processed by the factory = constant, an expression is derived for the total sugar harvested during the campaign, and the date for harvest initiation determined by means of a computer so as to give maximum sugar productivity.

A new drilling technique. R. Munday. *British Sugar Beet Rev.*, 1977, **45**, (2), 11.—A UK farmer has added a Stanhay 6-row drill on the back of a tractor-mounted Lely "Roterra" harrow, so turning the soil preparation and beet sowing into a single-pass operation. Details are given of the equipment and operation, and it is noted that a band sprayer is to be fitted to the front of the tractor for the next campaign.

How the Boydells beat the mud and harvested their beet. D. Charlesworth. *British Sugar Beet Rev.*, 1977, **45**, (2), 17.—Very wet and muddy conditions made harvesting very difficult, so a UK farmer and his son fitted the 18·4×15·26 wheels from a grain combine harvester to their Standen "Cyclone" beet harvester which normally uses 6·00×16 tyres. A special hub adaptor plate was needed. The bigger wheels and tyres permitted harvesting in fields previously impassable.

Another record-breaker. D. Charlesworth. *British Sugar Beet Rev.*, 1977, **45**, (2), 24-25.—An account is given of the UK Spring Demonstration of 1977[1].

Assessment of drill performance. Anon. *British Sugar Beet Rev.*, 1977, **45**, (2), 26-27.—Results are given in the form of histograms which demonstrate the performance of seven seed drills operated at 3·2 and 4·8 km.hr^{-1}. The slower speeds produced diagrams closer to the ideal (narrow peaks about the 15 cm chosen seed spacing interval).

Four techniques to beat wind erosion. Anon. *British Sugar Beet Rev.*, 1977, **45**, (2), 38-39.—Wind erosion of sandy and high organic soils is prevalent in parts of the UK, and four measures to counteract it are described, including autumn sowing of rye at right angles to the proposed beet rows (to be sprayed with "Gramoxone" or similar herbicide before sowing of the beet), use of "Vinamul 3270"[2] as a soil crusting agent, application of sugar factory waste lime (filter cake), and planting of straw. The first appears to be the most effective method.

Agriculture and sugar beet in England. W. C. von Kessel. *Die Zuckerrübe*, 1977, **26**, (4), 8-10 (*German*). A survey is presented of beet agriculture in the UK, with particular attention devoted to fertilization, plant protection, and typical equipment used. Mention is also made of the role played by the British Sugar Corporation in beet processing and in its advisory capacity with regard to beet farming.

Wild beet—the problem is increasing. Anon. *Die Zuckerrübe*, 1977, **26**, (4), 14 (*German*).—It is pointed out that the attentive farmer cannot have failed to come across pockets of wild beets in his fields. These have their origin in bolters which may have stood in the same place for up to 6 years; while they remain, further bolters will occur. Conditions in 1977 in West Germany favoured vernalization of beet sown some five weeks later than normally. Bolters should be removed for three reasons: (1) to avoid seeding of early bolters and subsequent spread of wild beets, (2) because early bolters become woody and create difficulties in processing, while late bolters use some of their accumulated sugar to promote flowering, and (3) because all bolters hinder harvesting. It is pointed out that in countries to the west of West Germany there are already some areas in which the problem is so great that no normal beet agriculture is possible. Data obtained in Belgium are reproduced, since they equally apply under the climatic conditions of West Germany; they show the quantities of seed produced by bolters (expressed as kg.ha^{-1}) and numbers of viable beet fruit per ha obtained from cut bolter heads and side shoots.

Intercropping—why? where? when? Soil fertility must be maintained. Anon. *Die Zuckerrübe*, 1977, **26**, (4), 15 (*German*).—The question of soil fertility, where beet is grown in a 3-year rotation, is discussed. It is stressed that organic fertilization is absolutely essential for maintenance of soil fertility, and that breakdown of humus is greater where beet growing is interspersed between growing of other root crops. Three possible means of high-dosage organic fertilization exist: removal of beet leaves and straw for cattle feeding and replacement with farmyard or liquid manure and green manure culture; ploughing-in of beet leaves and straw with partial growing of green manure; and burning of the straw and selling of the beet leaves, with dependence on green manure for maintenance of soil fertility (although in this case there is no complete compensation for organic matter which is broken down in the soil). (There are also partial solutions which are intermediate between these three systems.) The question of suitable intercrops is discussed, as is the growing of green manure and suitable fertilization of green manure crops and beet. A table is given of stubble crops suitable for intercropping. Another major advantage of green manure is the benefits imparted to soil structure as a result of root penetration, although good seedbed preparation is also important for good root penetration.

Beet injury by herbicides used in the previous year. Anon. *Die Zuckerrübe*, 1977, **26**, (4), 16 (*German*).—Mention is made of injury to wheat, maize and beet where herbicides applied in one crop have affected the subsequent crop. It is stressed that such damage can be avoided if attention is paid to the advice given on use of certain herbicides.

Effect of various organic fertilization measures on sugar beet emergence. B. Stahlecker. *Die Zuckerrübe*, 1977, **26**, (4), 18-19 (*German*).—Tests were conducted over an 8-year period in a 4-year rotation at four sites in Lower Saxony in which straw and green manure were applied to the soil as well as calcium nitrate (also applied without organic fertilizer) and "Lindane" as soil insecticide. Tabulated results indicate the effect of green manure, spring liming and insecticide application on beet emergence. In general, all treatments individually had beneficial effect, although the advantages of green manure were not so obvious in absolute values, since satisfactory stands were achieved despite a drop in emergence without treatment and without thinning. The effects of green manure were much more marked where emergence fell by more than 40% without treatment, and increased with number of applications.

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[1] *I.S.J.*, 1977, **79**, 217-219.
[2] *ibid.*, 1978, **80**, 63.

BEET BREEDING AND VARIETIES

Performance of some sugar beet varieties in the Punjab. D. S. Deol, R. S. Kanwar and B. S. Bains. *Sugar News* (India), 1977, **8**, (9), 14-15.—Results of beet varietal trials carried out at Jullundur in 1971-72, 1973-74 and 1974-75 are discussed. The figures for the latest of the three seasons showed that Ramonskaya 06, which is being grown commercially and seed of which is available in India, had a lower yield than the other varieties tested. Maribo "Magnapoly" had the second highest yield and the highest sugar content of all eight varieties, while Maribo "Resistapoly" had the second highest sugar content although the second lowest yield. Both Maribo varieties are considered suitable for Punjab conditions, and seed is being produced.

Stability analysis of certain sugar beet varieties. H. K. Goula and G. N. Skarake. *Hellenic Sugar Ind. Quarterly Bull.*, 1977, (28), 295-317 (*Greek*).—Yield data obtained under varying conditions of growth period and previous crop at five locations represented by four soil types in 1975 and 1976 (hence, twelve different environments) were applied to stability analysis of twelve beet varieties. A significant variety × environment effect was observed in the case of beet yield and sugar content but not in the case of sugar yield. Generally, all varieties tended towards stable performance as expected from their broad genetic base, but some exhibited adaptative trends as well.

Achievements of the Potato and Sugar Beet Research Institute "ICCS" at Brasov in sugar beet during ten years. I. Popovici and Z. Stanescu. *Prod. Veget., Cereale si Plante Tehn.*, 1977, **29**, (2), 3-8 (*Rumanian*).—Work carried out by the institute during the period 1965-75 is summarized. Mention is made of the significant contribution to beet yields made by Rumanian polyploid varieties R Poli 1, R Poli 7 and Polirom and the recently introduced Monorom monogerm polyploid variety, and information is given on beet seed growing and breeding work generally. Studies on fertilization and beet sowing are reported, as well as trials on control of beet pests (particularly the beet weevil *Bothynoderes punctiventris*), diseases and weeds.

Results of comparative trials of sugar beet in Belgium from 1974 to 1976. N. Roussel, R. Vanstallen, W. Roelants and T. Vreven. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1977, 45-95 (*French*).—Trials were sown in six localities at each of which 46 varieties were included (13 multigerm and 33 monogerm), using a randomized block design, sowing with a precision drill and harvesting with a 6-row machine. Details of the tests are given and the results recorded in tables. Average data from the 1974, 1975 and 1976 campaigns showed the higher dependence of beet quality on locality and conditions than on variety, with juice purity especially affected by the fertilizers applied.

Trials of commercial varieties of sugar beet. D. S. Kimber and A. F. H. McCullagh. *British Sugar Beet Rev.*, 1977, **45**, (2), 18-19, 28.—Tabulated data are given of results of the eleven 1976 trials (one was abandoned and results from six more rejected through lack of uniformity) of ten commercial beet varieties in the UK. Root yields were above those of 1974 and 1975, ranging from 29·6 to 63·6, averaging 45·9 tonnes.ha^{-1}. The sugar content was lower, averaging 14·5%, but the yield of sugar per acre, at 6·69 tonnes, was higher than the 6·34 tonnes of 1974 and 6·16 tonnes of 1975. The variety Cora has been added to the list of recommended varieties, while Sharpe's Klein Megapoly has been removed. Nomo and Vytomo have the highest sugar yields and lowest number of bolters, while Vytomo contained least impurities in clarified juice. Cora and Amber had the highest seedling emergence (62·1% and 61·1%, respectively), but even the lowest figure, that for Amono, was 53·1%. Vytomo has tolerance to virus yellows but is unfortunately very susceptible to downy mildew, so that a large area devoted to this variety would be unwise.

Conclusions from results of national sugar beet varietal trials in 1972-1975. L. Karaman. *Listy Cukr.*, 1977, **93**, 121-127 (*Czech*).—Beet varietal trials held in Czechoslovakia in 1972-75 are reported and the results tabulated. Of commercial varieties of Czechoslovakian origin, Dobrovická A was the best in terms of beet yield and sugar content, althouth Monofort (an imported variety) was better in terms of white sugar yield. Two new imported varieties were also roughly comparable to Dobrovická A: Kawegigamono had a sugar content very slightly lower than the Czechoslovakian variety, while Maribo Unica 11737 had a slightly higher sugar content, but in other terms both were equal with Dobrovická A. A new Czechoslovakian variety, Monohybrid I, lagged far behind Dobrovická A as regards the most important properties and had a tendency to bolt, so that it was officially restricted to cultivation on only 10,000 ha.

The quality of sugar beet seed in 1977. R. Vanstallen. *Le Betteravier*, 1977, **11**, (111), 10-12 (*French*).—The quality of beet seed has been under study by the IBAB (Institut Belge pour l'Amélioration de la Betterave) since 1963, and observations of the improvement during this period are reported. The demand for genetic momogerm seed has grown since 1963, and the germination power has improved also from 73% to 94% on average (89-96%), that of precision seed being 87% on average (83-93%). Coated seed has given as good results as uncoated, except in the case of a single variety "Monohil". By 1976 monogermity of the seed had reached about 88% on average (73-86% for precision seed, 95-99% for genetic monogerm seed). Little difference was found between the relatively high vigour of all varieties. No complaint was received about the variation in seed density expressed as weight of 100,000 glomerules. In the case of uncoated precision seed, there was an excessive proportion of large seed (3·5-5·4 mm) in three varieties (Polyx spécial, Tribal spécial and Zwaanpoly), while with the polyploid variety Desprez there was too high a proportion of small seed. Since these fractions unfavourably affect distribution by a precision drill, the situation must be remedied for the future.

CANE SUGAR MANUFACTURE

Boiler ash separation by ponding. R. N. Jones and R. A. Dyne. *Proc. 44th Conf. Queensland Soc. Sugar Cane Tech.*, 1977, 335-340.—The systems introduced at Millaquin and Fairymead for the 1976 season are described. The Millaquin scheme handles fly ash only, while that at Fairymead is used for both fly ash and undergrate ash. Ash separation from water in the ponds generally exceeds 99%, and the quality of recycled water is excellent. Ash recovery from the ponds and its disposal have presented no difficulties. Maintenance requirements are low (the only mechanical components being the slurry centrifugal pumps) and no undue abrasive wear of the piping has been found.

Mossman mill ash separation system. B. J. Milford. *Proc. 44th Conf. Queensland Soc. Sugar Cane Tech.*, 1977, 341-344.—At Mossman, ash is sluiced from the boilers into a sump, whence the slurry is pumped via a mud hopper and stilling box to a coarse screen; the screened water passes to an ash circulation tank, while the solid material falls onto a screw which mixes it with mud from two "DorrClones" and a fine screen (the "DorrClones" operating in parallel and treating the material from the ash circulation tank). The water from the circulation tank passes to a dirty water sump, which also collects from the drains of the filter and clarifier stations and from which the clean water is pumped to the ash separation system. The clean water from the "DorrClones" flows via a fine screen to a baffled section of the ash circulation tank and is returned to the boilers. The final ash is still too wet for disposal on its own, but is mixed with filter cake from a centrifuge which is of inadequate water content for easy spreading on soil. Operation of the scheme in 1976 showed that wear of the fine screen was so great that it had to be taken out of service within 1 week; the coarse screen wore less rapidly, although it had to be replaced within 12 weeks. The rubber-lined apex valves on the "DorrClones" wore out, while the vortex finders were practically unmarked after the season. The boiler pump also wore out more quickly than the return pump, creating flow imbalances, whereas the mixing screw did not wear appreciably. The system performed highly satisfactorily, however.

Development of a bagasse feeder. R. W. Luxford, W. H. Magnussen and M. J. Wilson. *Proc. 44th Conf. Queensland Soc. Sugar Cane Tech.*, 1977, 369-372.—Because of occasional choking of drum-type bagasse feeders installed at Victoria factory as part of a boiler installation, investigations were carried out with the aim of developing an improved feeder. Details are given of a modified feeder design which resulted from the studies and which proved satisfactory in trials, requiring little power in the handling of bagasse in the moisture range 43-45% and ash contents probably in the range 3-9%. A linear relationship was established between bagasse velocity down the supply chute and the feeder speed, so that use of the feeder as a feed rate indicator is also suggested.

The use of metallic expansion bellows in a sugar mill environment. R. C. Corrie. *Proc. 44th Conf. Queensland Soc. Sugar Cane Tech.*, 1977, 373-381.—Metallic expansion bellows are generally accepted as the best solution to thermal expansion problems, it is stated, and basic types of restrained and unrestrained bellows are described, as are types used in sugar factories on turbine inlet and exhaust connexions, high- and low-pressure steam piping, pump connexions and boiler flue ducting. Stress corrosion cracking of the stainless steel used as basic material by most bellows manufacturers is discussed, as are means of preventing it.

Reduced clarification factor and clarification factor × clarification efficiency. S. Srinivasan, K. T. Pillar and V. K. Chelladorai. *Indian Sugar*, 1977, **26**, 747-751. The clarification factor used in the Indian sugar industry is calculated by the Institute formula and suggestions have been made by Joshi *et al.*[1], Mittal[2] and Chandresekaran[3] for improvements to this, including reduction to a raw juice purity of 85 (the "reduced clarification factor"). A new formula is proposed and values worked out using the various formulae for a number of cases. In simple terms, clarification efficiency is the % removal of non-sugars from mixed juice and this should be the value obtained for the clarification factor.

A study on low-grade massecuite boiling for better exhaustibility of final molasses. S. Srinivasan, C. N. Jayaraman, V. K. Chelladurai and N. Santhanam. *Proc. 40th Ann. Conv. Sugar Tech. Assoc. India*, 1974, (II), M.1-M.6.—A comparison was made of boiling *C*-massecuites, using a seed slurry prepared by alcohol precipitation according to the method of Oomen & Gurumurthy[4], and using icing sugar. The slurry gave massecuite of lower viscosity, lower molasses purity, reduced purging time and better sugar colour.

Non-condensable gases—the importance of their removal in an evaporator unit. S. Srinivasan. *Proc. 40th Ann. Conv. Sugar Tech. Assoc. India*, 1974, (II), M.7-M.15.—Evaporator performance at Dharmapuri sugar factory was poor and found to be due to irregular and inadequate withdrawal of incondensable gases from the second effect. This was found to be the result of a common withdrawal pipe for all vessels of only $2\frac{1}{2}$ in diameter, which was too small. Providing an additional pipe, as well as a means of venting the 2nd effect to atmosphere instead of only to the vacuum line, permitted crushing at the rated capacity with acceptable syrup Brix.

A review on the suggestion for improving the exhaustibility of final molasses—clarification of penultimate or *B*-heavy molasses. D. L. N. Rao. *Proc. 40th Ann. Conv. Sugar Tech. Assoc. India*, 1974, (II), M.17-M.23.—The author has patented a process whereby *B*-molasses is diluted, carbonatated and the clarified solution concentrated and sulphited, impurities being

[1] *I.S.J.*, 1967, **69**, 346.
[2] *ibid.*, 1966, **68**, 314.
[3] *ibid.*, 1968, **70**, 372.
[4] *ibid.*, 1974, **76**, 54.

removed and *C*-massecuite boiling being improved with an additional recovery of 0·20% sugar % cane. Details are given of experiments on which the process is based and a cost analysis is presented for a 2400 t.c.d. plant.

An economical installation of multiple-effect evaporators for a modern sugar factory. I. Influence of number, design, relative capacities of effects, condensate extraction and flash heat utilization on performance efficiencies. S. P. Misra. *Proc. 40th Ann. Conv. Sugar Tech. Assoc. India,* 1974, (II), M.25-M.39. See *I.S.J.*, 1974, **76**, 277.

Economics of installation of a De Smet diffuser. B. N. Rao, A. V. N. Rao and K. S. R. Rao. *Proc. 40th Ann. Conv. Sugar Tech. Assoc. India,* 1974, (II), E.1-E.8.—At Andhra Sugars Ltd., Tanuku, the 5-year average extraction is 94·19% with a De Smet bagasse diffuser against 90·41% for the last five years of milling alone. Average boiling house recovery has fallen slightly from 87·40 to 87·33%, but the overall extraction is 82·26% against 79·02%, a gain of 3·24% on cane. At the same time, the diffuser requires less power and less maintanance and costs less to operate. The capital cost is higher, but the interest charge and depreciation are negligible compared with the additional profit, while the diffuser also provides great flexibility of capacity.

Milling ratios and their influence on milling performance. M. N. Krishnamurthy. *Proc. 40th Ann. Conv. Sugar Tech. Assoc. India,* 1974, (II), E.11-E.17.—The importance of the milling ratio (the ratio between feed and discharge openings of a three-roller mill) for obtaining maximum extraction at each squeeze is discussed with reference to comments and reports in the literature. The influence of a number of factors on the proper ratio (moisture in bagasse, roller pressure, maceration, cane preparation, roller surface, reabsorption and squirting) are discussed, and it is concluded that settings must be based on individual circumstances but should be as low as possible.

Electricity generation and distribution in a sugar factory. R. C. Campbell. *J.A.S.T.J.*, 1973, **34**, 64-71. Factors which should be borne in mind in regard to ordering and operating power generating and distributing equipment in the tropics are discussed, e.g. turbine blades should be of stainless steel where there is little or no superheat; an idle turbine should have hot air blown through it to keep it dry internally, for continuous operation through the crop, duplicate oil coolers and filters should be provided, etc. These recommendations are given under the headings: generation, switchboards and low voltage fuses.

Magnesium oxide substitution and the purity of final molasses at New Yarmouth factory. J. J. Zwaardemaker. *J.A.S.T.J.*, 1973, **34**, 75-79.—Substitution of 73% of the lime requirement for clarification by magnesium oxide markedly reduced scale formation in the evaporator but gave supersaturations higher than usual, so that fine grain occurred in *C*-boiling and resulted in higher molasses losses. By diluting the *A*- and B-molasses feed to the *C*-pans, this fine grain was dissolved and did not pass through the centrifugal screens to raise final molasses purity, which reached an average of 31·73 against 34-35 without dilution.

Energy inventory for Hawaiian sugar factories, 1975. D. Murata and W. Gibson. *Hawaiian Planters' Record,* 1977, **59**, 51-65.—Industry-wide figures have been assembled in order to provide an inventory for the year 1975 of fuels used in Hawaiian sugar factories (2,733,000 tons of bagasse burnt as fuel out of a total of 2,909,000 tons, 44,000 tons of leafy trash from the cane cleaners, 606,120 barrels of fuel oil, and other materials including 4700 tons of wood chips and 2100 cubic yards of macadamia nut shells), steam energy produced from these fuels (18,200,000 million B.Th.U.) and electricity produced and consumed (697 million kWh *vs.* 493 million kWh, the balance being sold to public utilities). At present efficiencies, only a little surplus bagasse exists, but leafy trash, equivalent to 515,000 barrels of oil, could be recovered from the cane cleaners for burning. A 5% increase in thermal efficiency could result in an additional annual excess of bagasse of 175,000 tons, equivalent to some 170,000 barrels of oil; it is considered that such an increase in efficiency is attainable with minimal capital investment.

Improved two-and-a-half boiling system. G. Aleman. *Sugar J.*, 1977, **39**, (11), 22-23.—The original 2½-boiling system was devised to give a high-purity raw sugar without affecting recovery or increasing steam consumption by the pans. In the improved version described, *C*-sugar is made into a magma with clarified juice (which dissolves fines) and built up in a pan to *A*-footing for the A_1 and A_2 pans. These two are built up on syrup and a syrup/A_1-molasses/A_2-wash mixture, respectively. The A_1-strike gives product sugar and A_1-molasses sent to the feed tank for the A_2 pan, while the A_2 centrifugals are arranged so that the A_2-molasses and A_2-wash are collected separately. The A_2-wash is also sent to the A_2-feed tank (this being the improvement since it gives a higher quality A_2-sugar without increasing the purity of the A_2-molasses and hence the *C*-massecuite). The *C*-massecuite is seeded on a charge of syrup and molasses of 68-70 purity and then boiled on A_1-molasses up to a certain point and then with A_2-molasses.

Waste impoundment efficiency at the sugar mill. K. M. St.-Pé. *Sugar J.*, 1977, **39**, (11), 25-26.—Where direct sunlight is restricted by plant growth such as water hyacinth, duckweed, trees, etc., impounded waste water may be of low BOD yet have little dissolved oxygen. This is illustrated by an account of two ponds to which were supplied condenser cooling water and cane wash water from Caldwell Sugar Cooperative. One had adequate phytoplankton in it which converted CO_2 to oxygen which was dissolved at a concentration of 8·3 ppm near the surface (where the phytoplankton was accumulated) and 4·9 ppm near the pond bottom; the other pond had a thick cover of duckweed (*Lemna* spp.) over its surface and no measurable oxygen content, although anaerobic bacteria present had eliminated the BOD content. To oxygenate the water to make it fit for discharge into Louisiana waterways, it would be necessary to use a herbicide to kill off the duckweed (which would initially raise the BOD) and permit sunlight to stimulate the activity of aerobic bacteria.

BEET SUGAR MANUFACTURE

The 1976 campaign (in West Germany). E. Reinefeld. *Zucker*, 1977, **30**, 263–273 (*German*).—After a short summary of the weather and beet growth as well as crop results and remarks on beet and juice quality in West Germany 1976/77, the author discusses more specific aspects of the campaign, including

Corrected Sugar Content (in beet): Tests were carried out to see if the Corrected Sugar Content in beet, calculated as pol—[0·343 (K+Na) + 0·094 N_{Bl} + 0·29] where N_{Bl} is the "blue number", was a sufficiently accurate measure of the crystal sugar recoverable from low-quality beet. The calculation was applied to beet brei analysis, and molasses sugar predicted. Molasses sugar was also predicted from thick juice non-sugars determination. Close agreement was found between the two sets of predictions. Equally close was the agreement between sugar yield predictions obtained by both methods.

Molasses composition: Comparison was made of molasses non-sugars contents in 1976/77 and previous campaigns or periods of several years' duration. In the latest campaign, the purity was somewhat higher, although this corresponded to a somewhat lower organic non-sugars:ash ratio. Maximum values of the ratio occurred in dry areas. Analytical results are tabulated.

Factory slicing capacities: It is pointed out that of 52 factories, only 22 operated for longer than 80 days, 9 for longer than 90 days, and only 3 for more than 100 days. The tendency for factory expansion is discussed, and it is mentioned that Plattling, expanded to a daily beet slice of 12,000 tonnes, worked for 102 days; however, 48% of the thick juice was stored for further processing during the post-campaign period.

Beet slicing and diffusion: Because of better mechanical properties, particularly reduced brittleness, the beet sliced better than in the previous campaign, and temperatures of 72–73°C were possible in the middle section of tower diffusers. Diffusion losses were lower than in the 1975/76 campaign.

Pulp pressing: Problems were encountered at some factories because of the greater beet throughput. The average beet marc content was also higher (at 4·5%) than in the previous campaign, which would be expected to increase the pulp quantity. However, for reasons which cannot be explained, there was a 10–12% fall in dry solids throughput and considerable slip occurred. The resultant increased pressing time at reduced throughput led to a marked rise in pressed pulp dry solids, while power consumption rose appreciably. In some factories, however, the pressed pulp dry solids was inadequate and seemed to result from the good microbiological conditions in diffusion and hence high pH values. The question of diffusion water acidification and acid addition in the diffuser is examined in relation to pulp pressing quality. It is stressed that acid formation by micro-organisms in tower diffusers is much greater when the pH in the middle section is 6 or below. Apart from sugar losses and the reduction in natural juice alkalinity, infection also has a marked effect on thick juice colour.

Juice purification: Although there were no real difficulties in juice treatment, alkalinity reserves were sufficiently low to warrant addition of soda (a maximum of only 0·06% on beet, however). The low and fluctuating alkalinities led to considerable thick juice colour in some factories. In North Germany there was a clear relationship between thick juice colour on the one hand and beet quality and growing conditions on the other. Whereas good-quality beet taken from heavy soils gave thick juice having a colour content of less than 300 ICUMSA units, beets of lower quality taken from light soils gave thick juice colour of more than 2000 ICUMSA units. In some factories there was a considerable increase in colour from thin juice 1 to thin juice 2, but investigations have failed to reveal the causes, and no correlation was found with beet quality, the phenomenon occurring with high- and low-quality beet. Adjustment of thin juice pH in accordance with thick juice pH has proved of value, while photometric determination of thick juice invert sugar has permitted the content to be kept below 0·1% on dry solids, although at some factories it is still too high at 0·2–3%.

Making thin juice alkaline with magnesium oxide: In relation to the increased molasses yield which results from addition of soda (and hence Na^+ ions) to juice, reference is made to the use of magnesium oxide as proposed by Schoenrock *et al.*[1]

Boiling: Tests have been conducted with massecuite stirrers at some factories. While the supplier of a propeller-type stirrer stipulated a propeller diameter 90% of the downtake diameter, it is pointed out that a downtake diameter is itself rather large. However, on the basis of a peripheral speed of 6 $m.sec^{-1}$, calculation of the corresponding shaft horsepower N in terms of Newton's number, massecuite Brix, propeller diameter and rotary speed shows how reduction in the last two components will greatly decrease the value of N. Tests were carried out with the aim of confirming this, so as to avoid installing an over-powered propeller on the one hand but not to jeopardize the stirrer efficiency in terms of boiling and massecuite quality on the other. Results are discussed, particularly in terms of heat transfer and evaporation rate; in one case, a French 3-bladed propeller installed in a 40-tonne white sugar pan of 250 m^2 heating surface almost doubled the values of these two factors and reduced by 80% the conglomerate content of the resultant white sugar. This was achieved at a speed of 58 rpm, the rated power of the drive being 22 kW.

Crystallization: Problems have been encountered with low-grade massecuite cooling, whereby the increased throughput at some factories has led to the need to reduce the cooling time, often to only about 20 hr. The question of balance between temperature and water addition is discussed, and a diagram is presented showing a typical crystallization run as obtained at certain factories, in which the crystal growth rate obtained after 20 hours was in agreement with the value obtained by Grut. To avoid inadequate crystallization rates at the start of the process, the first units in a battery should be equipped with cooling elements which have a tumb-

[1] *I.S.J.*, 1975, 77, 214.

ling action and thus ensure thorough mixing. The use of vertical crystallizers is briefly discussed.

Continuous centrifugal performance: Earlier it had been reported that fine crystals smaller than the centrifugal screen perforations caused a rise in molasses purity. Noticeably higher proportions of fine grain occurred in factories where there was a tendency, because of application of the Quentin process, to use a considerably higher non-sugar:water ratio than recommended by Grut. It had been argued that this would compensate for the losses in continuous centrifugal output. However, microscopic studies have shown that there is 80–100% probability of penetration of fine crystals through the screen perforations, depending on massecuite throughput. It has been calculated that at a 2% proportion of fine crystals in the massecuite and 80% chance of screen penetration, the molasses purity would rise by about 0·7 units. Daily analysis of individual molasses samples is suggested as a means of checking continuous centrifugal screens. Since, for maximum low-grade massecuite exhaustion, the massecuite should have a large crystal surface area and so a relatively small size distribution (0·25–0·30 mm), it is obvious (as demonstrated by photomicropraphs of crystals from two factories) that massecuite containing crystals of smaller average size will contain fewer fine crystals (because of the higher distribution uniformity) than will a massecuite having coarser grain.

A new Pfeifer & Langen ion exchange process: Reference is made to a new patented ion exchange process for production of invert syrup or liquid sugar from beet juice. The author particularly discusses the need for preliminary colloid removal from the juice in order that the resin does not become blinded. Preparative carbonatation can be used for this; high alkalinity is not necessary, since the invert sugar does not need to be degraded, and coloration associated with invert sugar degradation therefore does not occur. No Maillard reaction takes place in later stages, since the ion exchange removes amino-acids. The residual invert sugar increases the liquid sugar yield, instead of passing to molasses. However, the solution leaving the exchanger columns is more viscous (although ash-free and almost colourless) than conventional commercial liquid sugars, so that subsequent treatment with $Ca(OH)_2$ is still necessary. A major advantage of the ion exchange process, it is thought, is the possibility of using an intermediate product which can be stored, as can thick juice, for post-campaign processing.

Experience with Westfalia separators for thick juice and remelt. W. K. Nielsen. *Paper presented to Int. Sugar Tech. Staff Conf. Irish Sugar Co. Ltd.*, 1977.—After pilot-plant and part-industrial trials, a total of six Westfalia SAMS 15037 centrifugal separators were installed at Nakskov factory and four at Stege, in each case to handle all the thick juice. The insoluble material is separated on discs which revolve at high speed and is removed by a desludging valve which empties the separator over a 10-second period once an hour, the sludge being returned to the main liming tank. During the first campaign the separators were cleaned with nitric acid but were found to be coated with almost pure silicic acid; in the 1976 campaign, therefore, cleaning was by 30 minutes' treatment with 2% NaOH followed by a similar treatment with 1·5% nitric acid. Experience in 1975 showed a 32% reduction of filterable impurities from 13·4 ppm to 9·2 ppm by use of the separator, while turbidity was reduced by 18%. Most of the sludge consists of Ca salts (mostly sulphate but also carbonate, citrate, oxalate, sulphate and phosphate) and there is a little iron oxide and silica. The solids in the sludge discharged corresponded to between 3 and 12 ppm on thick juice and would have been incorporated in the sugar produced, reducing its quality; analysis of white sugar showed that Nakskov and Stege factories had the lowest filterable impurities of the group and were lower after installation of the separators than before, when thick juice filters had been used. White sugar turbidity was not affected. The separators cost 20% more than kieselguhr filters but running costs are only 10% and they are to be preferred economically.

Automatic formalin doser for the DC diffuser. L.Vig and G. Vladár. *Cukoripar*, 1977, **30**, 77-78 (*Hungarian*). Details are given of the design and operation of an automatic formalin doser, three of which have been installed at Szolnok sugar factory (two for the diffuser and one for the raw juice tank).

Experience from introduction of FiLS-60 and FiLS-100 filters in (sugar) manufacture. V. T. Rud', Yu. F. Tsyukalo, N. B. Il'chenko and Yu. V. Anikeev. *Sakhar. Prom.*, 1977, (6), 20-24 (*Russian*).—Soviet FiLS-60 and FiLS-100 filters have been proving generally satisfactory as automatic filter-thickeners for 1st carbonatation juice treatment at a number of sugar factories, but in some cases problems have arisen. The design and operation of an improved version are described. The basic filter, very similar in design to the Grand-Pont and DDS filter-thickeners, contains a number of vertical tubes (4 in the FiLS-60 and 6 in the FiLS-100 model) up which the juice flows under pressure from a feed pipe located across the lower section of the filter. Filter elements alternate with the tubes across the filter. The juice strikes the top cover of the chamber and cascades over the elements, thus helping to remove mud from the top of the elements. When mud is discharged through the bottom port, a certain amount of untreated juice is also discharged (the filtrate leaving the chamber through a manifold linked to the elements) and is recycled to the filter together with fresh carbonatation juice. The height of the untreated juice discharge pipe above the mud discharge port is critical for the mud density. When poor-quality beet is being processed, experience has shown that filter throughput and mud density fall; to overcome this, it is recommended to shorten the filtration cycle and have 3-4 purges of untreated juice between mud purges. Advice is given on assembly of the filter, and mention is also made of tests with various filter cloth fabrics.

Means of improving the water economy of sugar factories. A. P. Parkhomets, V. I. Sergienko and A. I. Sorokin. *Sakhar. Prom.*, 1977, (6), 25-29 (*Russian*).—A survey is presented of work carried out in the period 1939-76 by the group concerned with efficient sugar factory water utilization at VNIISP (All-Soviet Research Institute of the Sugar Industry), and a list is given of recommended measures for improving water utilization and effluent treatment and disposal.

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LABORATORY STUDIES

Molasses sugar prediction. Ö. Krieger. *Cukoripar*, 1977, **30**, 54-60 (*Hungarian*).—The Vukov-Bárány formula for molasses sugar prediction[1] has been found to give inaccurate results. However, while good agreement was found between true and calculated values of molasses sugar as based on the residual non-sugars and alkali cations in thin juice, the calculation and analytical method used were labour-consuming. From analysis of 45 beet samples for K and Na, regression equations were derived for molasses sugar based on (1) K, (2) Na, (3) (K+Na), (4) K:Na ratio and (5) K+Na determined separately [as distinct from (3) in which the K and Na were determined together]. The best correlation was found for (5), although the others, except (1), also gave good correlation to within $\pm$0·15-0·16%. Application of the formulae to flame photometric measurements carried out on aqueous digestions of raw juice gave good results, and demonstrated the applicability of the method for rapid analysis of a large number of samples.

Metals in crystal sugar. L. G. de Souza, L. A. de Lima and M. M. Mischan. *Brasil Açuc.*, 1977, **89**, 65-70 (*Portuguese*).—Samples of white sugar from five sugar factories from each of three regions in Brazil were analysed for K, Ca, Mg, Fe, Al, Cu, Zn and Mn, and the results (average of four determinations) are tabulated and discussed. Cu contents varied between 0·00 and 0·43 ppm, well below the toxicity level of the Codex Alimentarius.

Automatic purity analysis. W. K. Nielsen. *Paper presented to Int. Sugar Tech. Staff Conf. Irish Sugar Co. Ltd.*, 1977.—Automatic purity measurement has been known for some time where the impurities in a solution are measured in terms of conductivity and a chosen dilution. More recently the measurements have included analysis for sugar content as well, and a new device has now been designed by the Danish Sugar Corporation. In this, the concentration is brought to within the range 12-27% total solids and measured accurately by means of a float in the liquid within a polycarbonate chamber; the float is connected by a leaf-spring to the soft iron core of a differential transformer which provides a voltage corresponding to the float position and hence to the density. The polarization of the solution is measured using a Thorn Automation Ltd. automatic polarimeter utilizing the Faraday effect which gives a current in the compensator cell directly proportional to the optical activity. The polarization signal and density voltage are conducted via an interface system to a minicomputer with printer which prints the apparent purity of the sample, as well as the density and pol. The meter operated with good results during the 1976 campaign at two factories and is more accurate than the standard method. Because lead acetate affects the optical activity of levulose and amino-acids, the meter gives true results only if this is not used. Raffinose and invert sugar had a considerable effect on molasses purity.

Some aspects of nitrogen in beet. M. O'Sullivan. *Paper presented to Int. Sugar Tech. Staff Conf. Irish Sugar Co. Ltd.*, 1977.—Comparisons were made between beet analyses at Carlow in various years up to 1976 and between Carlow and Mallow. The poor quality and results obtained in 1976 were shown to be due to the high amino-nitrogen content of the beet coupled with low natural alkalinity. The changes undergone by nitrogen compounds in beet processing are reported from the literature and confirmed by analytical data from the 1976 campaign, together with the harmful effects observed.

Analytical investigation of the topography of the chemical composition of the sugar beet root. I. J. Zahradníček, M. Ondráček, M. Bezouška and J. Jary. *Listy Cukr.*, 1977, **93**, 49-56 (*Czech*).—Beet root samples were divided longitudinally and laterally into 15 sections (in the case of wider roots) and 16 sections (in the case of elongated roots), and the sucrose, conductimetric ash, α-amino N and invert sugar contents determined in each. The results are compared with values given in the literature. The highest sucrose and lowest non-sucrose contents (except for invert sugar) were found in the upper sections of the root just below the hypocotyl. The maximum α-amino N was found in the epicotyl and root tip, a finding in good agreement with that of Lüdecke[2], as was the negative correlation found between sucrose and α-amino N contents.

The growth rate of sucrose crystals in pure solutions. R. Bretschneider, J. Čopíková and P. Kadlec. *Listy Cukr.*, 1977, **93**, 59-64 (*Czech*).—Sucrose crystal growth rate was determined by means of a special arrangement incorporating a 4-litre vessel filled with solution in which was suspended the growing crystal on a pan attached by metal wire to the beam of a laboratory balance. The initial crystal weighed about 4 g and measured 1·6 mm. The growth time was about 2·5 hr for highly supersaturated solutions and about 6 hr for less supersaturated solutions. The growth rate was calculated by the method of least squares. The experiments were conducted at 1·05-1·3 supersaturation and 30-85°C. Results are tabulated and given in graph form. Two equations were derived, one for the temperature range 30-40°C and the other for 50-85°C, each equation then being modified at the 10% significance level to give sufficiently accurate values.

Enzymatic determination of sucrose. *C.E.R.F. Rpt.*, 1976, 39 (*French*).—Examination of methods for determining sugar in molasses showed that the Clerget method was sensitive to the nature and level of impurities, while the enzymatic method was rapid and, being specific to sucrose, gave a measure of the true sucrose content of the molasses; the average was calculated for 4 or 5 measurements. Comparison of the variants of the Clerget method with the enzymatic method showed that the Jackson & Gillis No. 4 method appeared the best; this is to be tested industry-wide in Réunion.

[1] *I.S.J.*, 1964, **66**, 128, 237.
[2] "Zuckerrübenbau" (Verlag Paul Parey, Hamburg) 1953, pp. 13-14.

BY-PRODUCTS

Possible methods of utilizing beet tails and fragments and collecting trash and weeds. A visit to Attin factory, France. D. Hatzeantoniou. *Hellenic Sugar Ind. Quarterly Bull.*, 1977, (28), 343-349 (*Greek*). Treatment of beet waste is briefly discussed and details are given of the system used at Attin sugar factory, where pressed pulp is mixed with pressed tails, trash and weeds (initially removed from the beet washer and passed over a vibratory sieve to a slicer and thence to a small press) and subsequently dried and pelleted. A typical composition of the pellets is given.

The birth of the world's largest 100% bagasse market pulp mill—Pingtung pulp factory, Taiwan Sugar Corp. J. S. I. Wang. *Taiwan Sugar*, 1977, **24**, 313-316.—An illustrated description of the Pingtung pulp mill is given with a flow diagram of the Kraft process used. The mill produces 300 tonnes of bleached pulp per day and cost approximately $36·5 million for equipment, erection, buildings, roads, etc.

Symposium on cattle feed from sugar by-products. "Pimola". I. Duphorn. *J.A.S.T.J.*, 1973, **34**, 6-7.—The ability of ruminants to convert cellulose plus simple nitrogen compounds into protein is described and reference made to the use of sugar cane by-products for animal fodder. "Pimola"[1] is the name given to bagasse pith (separated during board manufacture) mixed with molasses; this can be incorporated optimally up to 60% in cattle diet.

Some considerations and preliminary observations on the use of "Pimola" in cattle fattening rations. G. B. Thomas. *J.A.S.T.J.*, 1973, **34**, 7-10.—Literature on feeding of urea, molasses and bagasse pith to cattle is discussed, and observations are recorded on the feeding of "Pimola" (see previous abstract); the feed is palatable to animals and keeps adequately. Unfortunately, varying availability of different feed components meant that the diet was not consistent and results were difficult to interpret.

Experience with the feeding of molasses and bagasse pith. K. B. Davidson. *J. A. S. T. J.*, 1973, **34**, 10-15. Trials carried out over a three-year period are reported. No firm conclusions may be drawn from the results, however; given favourable conditions (which cannot yet all be defined), the rations developed (a combination of 18·5% corn, 46% molasses, 22·5% pith, 11% soya bean meal and 2% urea) may give acceptable rates of gain, although conversion overall was disappointing. Care needs to be taken, in spite of the high roughage level, to prevent molasses toxicity. Constant pith quality is a critical factor, and work needs to be done on development of locally-produced ingredients, including steam or NaOH treatment to improve bagasse digestibility.

The Comfith process. I. Sangster. *J.A.S.T.J.*, 1973, **34**, 15-19.—A description is given of the principles and economics of the Comfith process[2] whereby the cane in billets is split, the inner pith separated for sugar recovery and eventual use as animal feed, while the epidermis is removed from the rind for wax recovery and the bulk of the rind used for board manufacture.

Economic evaluation of sugar industry derivatives. H. Noa S. *J.A.S.T.J.*, 1973, **34**, 20-28.—An account is given of the considerations applying in Cuba's planned economy conditions to the utilization of sugar industry by-products and of the organization of the Cuban institute ICIDCA as well as the projects under study as short-, medium- and long-range feasibilities.

Sugar beet top silage. C. Astill. *British Sugar Beet Rev.*, 1977, **45**, (2), 15.—A description is given of the use of a tractor-drawn Moreau 6-row topper/chopper/blower which tops the beet and feeds the tops to a 4-bladed mill which pulverizes them and then blows them through a side-discharging overhead duct into a trailer which runs beside the topper. The tops are taken to a clamp where they are unloaded onto a concrete base and ensiled for feeding to the farm animals.

Drying beet tops. D. Moore. *British Sugar Beet Rev.*, 1977, **45**, (2), 20.—Tops and crowns have different characteristics and, if they are to be dried, the tops should be harvested less crowns. They can be dried and pelleted at no growing cost, whereas a grass fodder crop would cost £20 per tonne of dry material to grow. A problem is silica contamination which also tends to wear the dies used for pelleting, and the tops removal and collection system needs to be improved to reduce soil in the tops. The dried tops in pelleted form are an acceptable fodder in spite of the soil content, and they keep well in storage over five months.

Fermentative conversion of sugar cane juice into fungal protein. I. Screening of various fungi and effect of different concentrations of cane juice. K. Singh and D. S. Chahal. *Indian J. Mycology and Plant Pathology*, 1974, **4**, (1), 49-55; through *S.I.A.*, 1977, **39**, Abs. 77-796.—Twenty-two fungi were tested for their growth and protein production on a basal medium containing 2% cane juice; 13 of them were selected for further tests on media containing 2, 3, 4 or 5% cane juice Results are tabulated.

Fermentative conversion of sugar cane juice into fungal protein. II. Effect of different nitrogen sources, levels of ammonium nitrate and incubation period. K. Singh and D. S. Chahal. *Indian J. Mycology and Plant Pathology*, 1974, **4**, (2), 177-181; through *S.I.A.*, 1977, **39**, Abs. 77-797.—Of 5 fungi which had given good results in previous tests, *Aspergillus terreus, Cladosporium herbarum, Curvularia palescens* and *Fusarium equiseti* gave maximum % protein and total protein with NH_4NO_3 as N source, while *Colletotrichum falcatum* gave best results with KNO_3. Optimum N levels and incubation periods were also tested.

[1] *I.S.J.*, 1973, **75**, 327.
[2] *ibid.*, 1972, **74**, 123-124.

PATENTS

UNITED STATES

Cane topper. J. C. Hudson, of St. Thomas, Barbados, *assr.* F. W. McConnel Ltd. **3,841,072.** 29th August 1972; 15th October 1974.

Beet diffuser. J. Giersing, of Stege, Denmark, *assr.* A/S De Danske Sukkerfabrikker. **3,841,908.** 25th October 1972; 15th October 1974.—See UK Patent 1,376,181[1].

Sugar centrifugal. A. Mercier, of La Madeleine, France, *assr.* Fives-Lille Cail. **3,844,949.** 21st May 1973; 29th October 1974.—Surrounding the conical basket of a continuous sugar centrifugal is a co-axial rubber sleeve, one end of which is rigidly attached to the casing. A weight is carried by the other end of the sleeve and a reciprocating movement is imparted to this weight so that the sleeve is alternately stretched and contracted, minimizing damage to the crystals striking it after discharge from the basket.

Alcohol fermentation. D. R. Mussell, of Clare, MI, USA, *assr.* Dow Chemical Co. **3,845,218.** 20th April 1973; 29th October 1974. Yeast fermentation of (30%) aqueous sucrose-containing solutions to ethyl alcohol is accelerated by adding 25-200 (50-200) ppm of O,O-dipropyl phthalimidophosphonothioate or O,O-dipropyl-(4-methylphthalimido) phosphonothioate.

Conversion of aldose sugars to kestose sugars. L. Tumerman and J. H. Guth, *assrs.* Kraftco Corp., of Glenview, IL, USA. **3,850,905.** 30th October 1972; 26th November 1974.—To a (5-60% w/w) solution of an aldose sugar, e.g. dextrose, lactose, is added (0·5-4 moles per mole of sugar of) an alkali or alkaline earth (Na or Ca) aluminate catalyst and the mixture maintained at a temperature sufficient to convert the aldose to the corresponding kestose sugar, e.g. levulose, lactulose (25-130°C), the pH adjusted to 6-8 so as to precipitate the aluminate moiety of the catalyst, giving a suspension of $Al_2(OH)_3$ in a sugar solution. The concentration of $Al_2(OH)_3$ in the mixture is controlled at less than 8% w/w and the mixture moved in a stream at a flow rate of at least 1 ft.sec^{-1} (2-20 ft.sec^{-1}) in a direction substantially parallel to a membrane [of pore size 10-100 Å (15-100 Å)] while maintaining a pressure of 2-2000 psig (5-500 psig) across the membrane so that the sugar solution is transferred through it. The filtrate is then further treated by dialysis or ion exchange to remove salts to give a solution of specific conductivity less than 100 mmho.cm^{-1}.

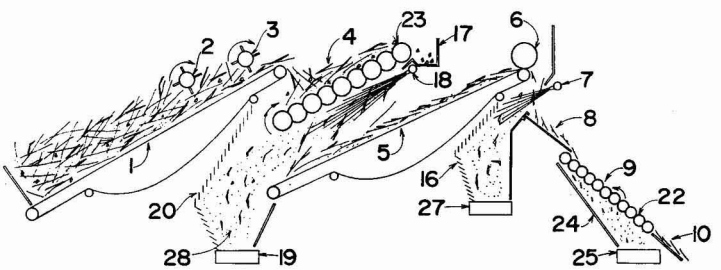
Cane or beet diffuser. H. D. Backofen and D. Dittmann, *assrs.* Braunschweigische Maschinenbauanstalt, of Braunschweig, Germany. **3,853,615.** 21st December 1972; 10th December 1974.—See UK Patent 1,375,280[2].

Clarification of sugar liquor. J. T. Rundell and P. R. Pottage, *assrs.* Tate & Lyle Ltd., of London, England. **3,853,616.** 19th June 1972; 10th December 1974.—The process is the same as that described in UK Patent. 1,397,927[3].

Cleaner for mechanically harvested cane. J. W Herkes, of Wailuku, HI, USA. **3,854,585.** 28th February 1973; 17th December 1974.

Dirty cane is received on the first conveyor 1 and carried upwards at an angle of 30-35° (or up to 40°) and at 35-40 ft.min^{-1} (or as low as 20 ft.min^{-1}) to two sets of levelling knives to give a blanket thickness of about 18 inches. The knives have larger diameter cylinders than usual, both for strength and to eliminate a tendency for cane to wrap itself around the knives. The blanket falls onto a screen 4 in the form of a series of shafts 23 carrying parallel toothed rings. This allows cane to fall through but carries larger rocks to collector 17. A blower 18 provides an air blast which carries light material so that it does not fall on conveyor 5 but is collected in chamber 28.

The cane and dirt, sand, etc., is spread evenly on conveyor 5 and carried up to a shaft carrying circular



saws 6 which cut at least part of the cane into shorter lengths. The discharged cane falls vertically through another air blast from blower 7 which separates more leaves and trash which falls into chamber 27 while the cane falls onto the inclined plate 8 and cascades over the dirt separator 9. This consists of a series of pocketed rolls 22 with guard rings to allow passage of the cane to conveyor 10 while allowing dirt to fall into chamber 24 whence it is removed by conveyor 25.

Increasing cane yield. S. J. Buckman and M. L. Pulido, of Memphis, TN, USA. **3,854,928.** 14th November 1973; 17th December 1974.—The sucrose content of cane is increased by application (as a spray of an aqueous solution) (2-12 weeks before harvest) to the foliage, of an effective amount [1-10 (2·5-4) lb.acre^{-1}] of poly[oxyethylene-(dimethyliminio)ethylene-(dimethyliminio)ethylene dichloride].

Cane cart. D. B. Davis, of New Iberia, LA, USA. **3,856,354.** 15th March 1972; 24th December 1974.

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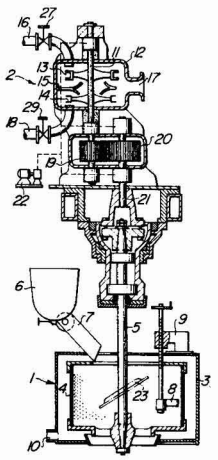
[1] *I.S.J.*, 1978, **80**, 59.
[2] *ibid.*, 58.
[3] *ibid.*, 89.

Polysaccharide production. F. K. E. Imrie, of Wallington, England, *assr.* Tate & Lyle Ltd. **3,856,625.** 29th May 1973; 24th December 1974.—See UK Patent 1,394,413[1].

(Drive for a) Suspended-type centrifugal separator. S. Nishimura and K. Ishihama, *assrs.* Shin Nippon Machinery Co. Ltd. **3,857,783.** 30th March 1973; 31st December 1974.

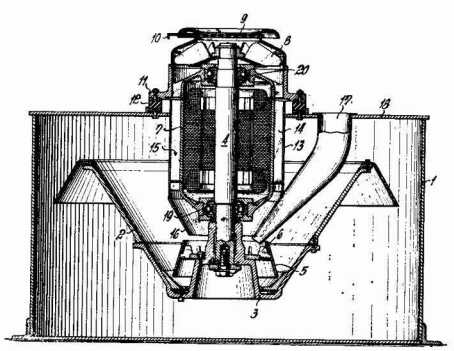
The drive of the sugar centrifugal 1 is a two-rotor steam turbine 2 which transfers motion through gearing 19, 20, shaft 21 and a coupling to shaft 5 of the centrifugal basket. The turbine is provided with a pipe 16 for admission of pressurized steam to act on the normal rotor



13 and another 18 to supply steam to the reversing rotor 14. A common exhaust port 17 is fitted. Valves 27, 29 in pipes 16, 18 govern the flow of steam through each and hence the direction, speed and acceleration of the basket for the various parts of the centrifugalling cycle.

Continuous centrifugal. B. Fiedler, of Grevenbroich, Germany, *assr.* Maschinenfabrik Buckau R. Wolf AG. **3,860,165.** 13th September 1974; 14th January 1975.

The centrifugal has a normal accelerator cone 5 and basket 2 but its drive is an air-cooled motor mounted on the top closed cover 18 by way of resilient buffers 12.



The motor has journals 19, 20 and its shaft 4 is connected to the basket 2. On the outside of the motor are radial ribs 14 within housing 13 which extends downwards to a frustro-conical section 16 which is smaller at the bottom than the entrance of the cone 5. At the top of the shaft are mounted blades which draw in air through opening 9, the size of the latter being governed by slide 10.

The air passes downwards and is heated by the ribs 14 which conduct heat away from the motor. The temperature and quantity of hot air produced are thus governed by slide 10. Massecuite is admitted through inlet 17 and is mixed with hot air within cone 5 so giving a product with viscosity suitable for separation of the components.

Increasing beet and cane sugar content. M. L. Weakley, of Pryor, OK, USA, *assr.* Nipak Inc. **3,860,411.** 27th July 1972; 14th January 1975.—The recoverable sugar content of beet and cane is increased (and the total weight of the crop also increased) by application to the (soil or the foliage of the) growing plant of an effective amount (0·001-0·03 lb per lb of sucrose normally produced) of biuret (as a solid or in an aqueous solution or suspension) to cause an increase in the sucrose content.

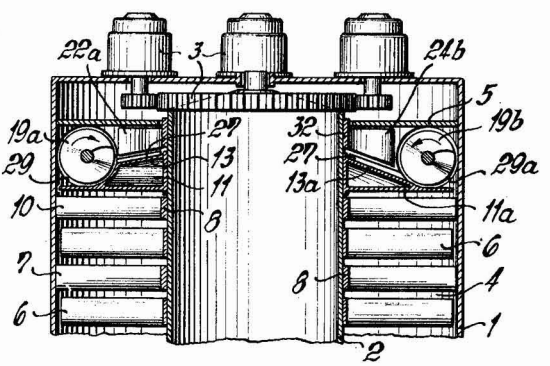
Method of dissolving granulated material (sugar). G. W. Paugh, of St. Louis, MO, USA, *assr.* Ralston Purina Co. **3,860,452.** 1st August 1973; 14th January 1975.—Sugar and sufficient water (heated to 150-190°F) to give the required Brix (up to 83°Bx) (65-75°Bx) are mixed and the mixture (agitated for 20-40 sec and) fed to a grinder where the granulated solid is ground sufficiently so that it (will pass through a 0·012-inch screen and) is substantially dissolved instantly.

Cleaner/harvester for windrowed cane. L. G. Fowler, of Belle Glade, FL, USA. **3,863,431.** 9th May 1973; 4th February 1975.

Cane planter rake plate. R. Usie, of Houma, LA, USA. **3,865,261.** 20th April 1973; 11th February 1975.

Beet or cane diffuser. E. Straube, of Bedburg, Germany, *assr.* Maschinenfabrik Buckau R. Wolf AG. **3,867,194.** 10th May 1973; 18th February 1975.

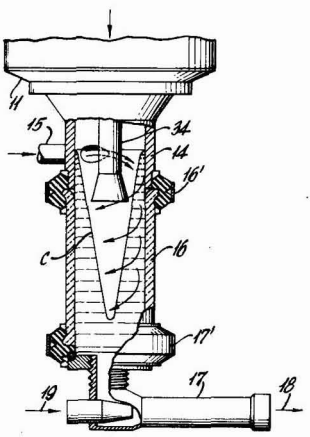
The beet or cane diffusion tower includes an outer conduit 1 and a co-axial inner conduit 2 forming an annular diffusion chamber in which the material treated



[1] *I.S.J.*, 1978, **80**, 89.

is raised by agitator arms 6 carried by conduit 2 against a counter flow of water provided through a top inlet not shown. Angled retarding arms 7 on the outer conduit 1 prevent rotation of the materials with arms 6. At the top of the diffuser, expelling arms 11, 11a have conical surfaces 13, 13a which cooperate with baffles 22a, 24b to direct the exhausted material so that it can be removed by screw conveyors 19a, 19b.

Continuous production of syrup. A. Pfeuffer, of New York, NY, USA. **3,867,195.** 25th August 1972; 18th February 1975.—Sugar from hopper 11 falls through a slide into a vortex chamber 14 into which water enters tangentially through inlet 15. Below chamber 14 is a hydraulic mixing chamber 16 formed by a glass tube, held to chamber 14 by clamp 16′. The chamber discharges to the suction side of ejector 17 and flows by pipe 18 to a container from which a part of the liquid is recycled to be pumped through port 19 of the ejector. Inert gas may be supplied through duct 34. The crystals are entrained in the tangential flow of water in chambers 14, 16 and so do not come into contact with solid walls or structures to cause abrasion.

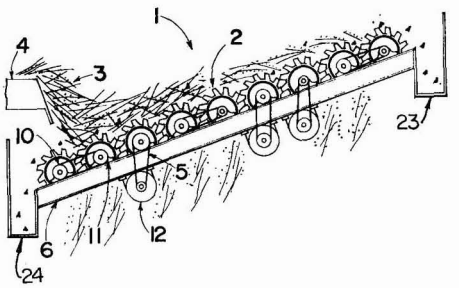


Making levulose with immobilized dextrose isomerase. R. A. Messing, of Horseheads, NY, USA, *assr.* Corning Glass Works. **3,868,304.** 16th February 1973; 25th February 1975.—A solution of (>45%) dextrose [buffered to pH 7·2-8·2 (7·4-7·8)] is incubated with an immobilized dextrose isomerase (derived from a *Streptomyces* organism) composite with the enzyme adsorbed on the inner surfaces and within the pores of a porous alumina body [of particle size 4-200 (25-60) mesh USSS] having an average pore diameter of 140-220 Å [and contained in a column (maintained at 55-70°C) through which the dextrose solution is passed continuously].

Ripening of sugar cane. L. G. Nickell, of Honolulu, HI, USA, *assr.* Hawaiian Sugar Planters Association. **3,870,503.** 3rd October 1973; 11th March 1975.—The sugar yield of cane is increased by applying an effective amount [1-80 (1-40) lb.acre^{-1}] 2-10 (3-8) weeks before harvest, of *n*-valeric acid or the sodium salt or ethyl ester of an aliphatic acid of 1-5 C atoms (*n*-valeric acid or its Na salt or ethyl ester).

Mechanical screen for mechanically harvested sugar cane. J. W. Herkes, of Santurce, Puerto Rico. **3,870,627.** 27th November 1972; 11th March 1975.

The screen 1 is located after the discharge of a conveyor on which a blanket of cane has passed and has been levelled to a uniform layer. It is in the form of six or more (9-15) rolls 2, of 30 inches diameter, fitted with toothed wheels. The teeth on each wheel are slightly offset alternately with respect to the longitudinal direction of the screen and the wheels are 12 inches apart and staggered on adjacent rolls so that their arcs overlap but one wheel revolves in the space midway between two wheels on the next roll. The speed of the first roll is about 30 rpm such that the tips of the teeth travel at about 377 ft.min^{-1} or about 10-20 times the speed of the cane blanket.



The adjacent and succeeding rolls are driven so that there is about 15% higher speed between each and the 9th roll has a tooth tip speed of about 1155 ft.min^{-1}. This may be effected by use of suitable sprockets on the roll ends which are linked by chains 5, 10 and driven by motors 12. The leading edge of each tooth is straight with a sweep-back angle of aprox. 52° and has a straight end about 2 inches long, while the trailing edge is radial and straight; the distance between teeth is 2 inches at their base and 10 inches at the tip. The space between the rolls allows cane and dirt to fall through, but rocks and large objects in the cane blanket are kicked upwards by the movement of the toothed wheels (clockwise as in the illustration) and carried to the receiver 23. Others may fall down from the end of the screen into the receiver 24. (See also US Patent 3,854,585[1]).

Sugar cane conveyor and cutter for windrowed cane. H. A. Willett, of Thibodaux, LA, USA, *assr.* Cane Machinery & Engineering Co. Inc. **3,871,256.** 30th May 1972; 18th March 1975.

Animal feed. J. F. Higgins, D. R. McDonald, M. A. Hanson and W. P. Moore, *assrs.* Allied Chemical Corp., of New York, NY, USA. **3,873,734.** 28th January 1974; 25th March 1975.—The liquid feed of the above patent is used to impregnate a solid ruminant feed (alfalfa or corn) to provide 2-10% N on dry weight, and the mixture dried at 180-240°F for 5-60 min, and the product pelleted and agglomerated at 500-20,000 psig pressure and 140-300°F (200-300°F), after which the pellets are cooled to ambient temperature within 1-60 min.

[1] *I.S.J.*, 1978, **80**, 123.

TRADE NOTICES

Sugar factory emission control systems. American Centrifugal Industries Inc., 251 Welton St., Hamden, CT, USA 06511.

The "CentriField" scrubber is a wet contact scrubber using the centripetal vortex principle for use in the control of emission from bagasse furnaces. The liquid-gas contact is better than with a venturi system. The concentric cage unit has been designed for efficient scrubbing of gases containing large volumes of particulate material; there are no moving parts or small orifices. Most of the particulate matter is handled in the outside wet section of the contactor, while final scrubbing of the gases is carried out in the secondary vane cage with clean water which is introduced through an open pipe to the cage assembly. The "CentriField" can be operated over a pressure difference range of 2-100 in H_2O. For use with bagasse it is usually made of stainless steel.

Also obtainable from American Centrifugal Industries is the "CentriForce" bagasse dryer, which fiberizes and dries bagasse with the aid of waste heat from the boiler flue gases without the use of supplementary natural gas. Field tests have shown that it can reduce moisture levels to below 35%, thus increasing the heat value of the bagasse by about 55% (assuming an initial moisture content of 52%). The dryer may be installed with or without scrubber, and will replace the induced draft fan.

"Eloptron" instruments. Schmidt & Haensch Optisch-elektronische Messtechnik, Naumannstr. 33, Berlin 62, Germany D-1000.

The "Polartronic Universal" is the first automatic polarimeter that can be programmed for any required special scale without conversion. It has a built-in calculator module and adjustable ratio factor, so that simply by operating a selector switch and suitably adjusting the calculator coefficients, the operator can quickly convert the polarimeter into (i) one for indicating the optical activity in angular degrees, (ii) a percentage polarimeter directly indicating the quantity of a certain optically active substance such as dextrose and levulose, or (iii) a saccharimeter indicating in °S. The instrument has a rotatable analyser coupled to an optical decoder which feeds its measuring pulses into a counter and thence to the calculator module where the algebraic sum of the stored pulses is processed to produce a value in angular degrees. The measuring range is —70° to +70°S or —170 to +170°S. Accuracy and reproducibility are ±0·01°S.

The "Reductomat" is a fully-electronic polarograph for rapid determination of reducing sugars on the basis of differences in oxidation rates in a buffered periodate solution. The instrument comprises a magnetic stirrer with reaction cell, measuring electrodes, storage tank with metering device for the phosphate-buffered reagent, electronic display and control section and a timer adjustable from 1 to 5 minutes (the optimum reaction time being 3 minutes). Measuring accuracy corresponds to that of conventional methods for invert sugar determination, and is in many cases better.

Electronic bag weigher. Howe Richardson Scale Co. Ltd., Bestwood Estate, Nottingham, England NG5 5HD.

The ECB 51 nett bagging weigher automatically checks the weighing of every weighment to within adjustable tolerance bands, automatically tares the weigh hopper at every weighment and has an optional automatic compensation adjustment to match the actual weight to the desired set weight. Push-button weight selection of up to 6 or 12 bag weights is available, while the compensation control adjustment is also manually controllable for rapid change according to the material to be weighed. Use of an electronic load cell/lever system permits high-speed bagging and suffers less wear because of the virtual absence of movement. Complete calibration can be carried out in less than 2 minutes. A wide range of feeders is also available.

PUBLICATIONS RECEIVED

Distillation plant. Codistil Construtora de Distilarias Dedini S.A., C.P.1249, Piracicaba, São Paulo, Brazil 13400.

A colour brochure gives details of distillation plant available from Codistil which can supply distilleries having a daily output of up to 220,000 litres of alcohol.

Sugar factory equipment from Brazil. Zanini S.A. Equipamentos Pesados, C.P.139, Sertãozinho, São Paulo, Brazil 14160.

An illustrated brochure in English and Portuguese gives details of sugar factory machinery available from Zanini, who design and build complete turn-key factories as well as alcohol distilleries.

Irrigation system for Ivory Coast.—A £2 million contract to supply sprinkler systems and overground pipeline in the Ivory Coast has been won by Dunlop Irrigation Services, of Thame Park Rd., Thame, Oxon., England, as sub-contractors to HVA-International B.V., of Amsterdam, Holland. The equipment will be made of aluminium, and sprinkler output will be 2·9 $m^3.hr^{-1}$ at a pressure of 3·2 $kg.cm^{-2}$, and the total area to be irrigated will be about 4200 ha. Dunlop Irrigation Services will assist with the manufacture, design and installation of the equipment, and offer a complete irrigation technical consultancy service. The contract concerns one of six sugar cane developments being set up by the Ivory Coast Government.

Beet harvester order from Japan.—The Mitsubishi Corporation have placed an oder worth £80,000 for 16 self-propelled "Cyclone" beet harvesters with F. A. Standen & Sons (Engineering) Ltd., of Ely, Cambs., England.

Lime kiln contracts from BSC.—Fives Lille-Cail (U.K.) Co. Ltd. have received an order from the British Sugar Corporation for a second lime kiln together with associated skip hoist and conveyors to be erected next to two existing kilns at Bury St. Edmunds sugar factory. It will have a capacity of 220 m^3, will be 40 m high and have a diameter of 4·3 m. It will utilize the patented double valve charging system developed by Fives-Cail Babcock which is designed to provide an air-lock during the loading cycle. A triple air inlet system is also incorporated so as to provide optimum burning efficiency.

Statements published under this heading are based on information supplied by the firm or individual concerned. Literature can generally be obtained on request from the address given.

Mauritius sugar statistics[1]

	1977		1976	
	(tonnes, tel quel)			
Opening stock ...		237,083		133,647
Production		665,435		689,932
		902,518		823,579
Consumption		37,500		36,358
Surplus in storage		23		976
Exports—				
Comoro Islands	1,290		0	
Canada	44,186		14,408	
Ireland	4,877		0	
Italy	2,433		5,000	
Niger	10		0	
Seychelles	1,196		1,347	
UK	528,782		493,671	
USA.....	53,651		36,679	
Yemen	0		9	
		636,425		551,114
Closing stock		228,616		237,083

Sucrose ester surfactant licence agreement for Japan. Talres Development B.V., of Amsterdam, a subsidiary of Tate & Lyle Ltd., and Mitsui Toatso Chemical Co. Inc., of Tokyo, have announced that a licence agreement has been signed between them to enable the Japanese company to manufacture sucrose surfactants using the Tate & Lyle patented process. The licence agreement will be supported by technology developed by Talres Development Ltd., of Reading, England. The latter are currently building a plant to manufacture both sucrose surfactants and a range of sucrose ester products. The Mitsui company is building a plant to produce sucrose surfactants for the Japanese domestic market.

New Indian sugar factory[2].—A new sugar factory is to be built during the current financial year on the Zira-Talwandibhai road in Ferozepore district of Punjab State. The mill will have a capacity of 1250 t.c.d.

Papua-New Guinea sugar industry study[3].—Papua-New Guinea has commissioned the UK company Booker Agriculture International Ltd. to make a feasibility study for a projected sugar industry. If it is decided to go ahead with the project, Papua-New Guinea could be producing 30,000 tonnes of sugar a year and could meet the country's domestic demands by 1985. Papua-New Guinea imported 19,934 tonnes of sugar in 1975/76. The Booker team is to report back by June on their study.

Albania sugar expansion[4].—Albania's Sixth Five-Year Plan (1976–1980) provides for a substantial increase in the production capacity of the sugar industry. During the plan period the production capacity is to be increased by 80%; as the industry comprises only one factory it seems certain that another will be built during the period.

Mauritius sugar crop, 1977[5].—The 1977 sugar cane harvest began on 8th June and ended on the 23rd December 1977. The 21 sugar factories crushed 6,022,285 tonnes of cane, 379,992 tonnes less than the record figure of 1976. Total sugar output amounted to 665,435 tonnes, tel quel, equivalent to 704,762 tonnes, raw value. Average cane yield was 74·6 tonnes.ha^{-1} as compared with the record figure of 79·1 tonnes.ha^{-1} in 1976. The average sugar extraction was 11·05%. The crop was very disappointing and was the lowest since 1971. The causes of the drop in production were mainly a drought which prevailed during the growing season and an infestation of cane fields by the scale insect *Pulvinaria iceryi*.

Guyana sugar production 1977[6].—A four-month strike, ended at the beginning of January, cut Guyana sugar production in 1977 to 241,527 long tons, compared with about 330,000 tons in 1976, according to the state-owned Guyana Sugar Corporation. This is 77·4% of the 312,153-ton target set by the Corporation before the Guyana Agricultural and General Workers' Union strike last August over a $215 million profit-sharing dispute. Production for the autumn crop, which closed on 31st December 1977, totalled 137,183 tons.

Argentina sugar exports[7]

	1977	1976	1975
	(tonnes, raw value)		
Afghanistan ...	10,869	0	0
Angola	14,242	54	0
Chile	185,630	39,089	0
China	21,114	0	0
Colombia	17,237	0	0
Denmark	12,600	0	0
Egypt	8,804	33,737	5,863
Finland	11,278	0	0
France	11,500	12,193	7,767
Germany, East	0	5,900	0
Ghana	6,521	4,308	0
Iran	13,695	0	0
Italy	1,087	0	0
Japan	0	0	6,020
Jordan.....	5,435	0	0
Libya	6,195	10,326	54,345
Malaysia	12,199	0	0
Mauretania ...	0	6,600	0
Morocco	76,983	0	3,756
Pakistan	10,869	0	0
Portugal	44,644	10,817	0
Rumania	32,206	0	0
Senegal	26,600	0	3,883
Spain	0	3,536	3,560
Sri Lanka	11,956	0	0
Sudan	0	11,129	0
Syria	29,422	0	0
Tunisia	0	38,334	5,266
UK	0	0	830
Uruguay	4,376	0	0
USA.....	325,212	99,336	97,374
Venezuela ...	35,132	17,232	0
Yemen	4,565	0	0
Yugoslavia ...	0	0	8,192
Total	940,371	292,591	196,856

Malta refinery proposal dropped[8].—The proposal to erect a sugar refinery in Malta[9] has been dropped in view of the low prices of sugar, and excess world production.

Colombia sugar prospects[10].—The 1978 sugar crop is expected to be sufficient to satisfy local demand. In 1977 imports of 5000 tonnes were necessary.

Vietnam sugar plans[11].—According to official sources, sugar output in 1978 is expected to reach 160,000 tonnes, tel quel, of which 74,000 tonnes will be produced by state-run sugar factories. Estimated production in 1977 was 31,300 tonnes. The Government of Vietnam plans to erect more sugar factories in cane-growing areas. The Chief Economic Planner, Le Thanh Nghi, said in a radio broadcast that the factories will be capable of processing several dozen to 100 tons of sugar cane daily, supplied by large cane-growing areas of less than 1000 hectares each where big factories have not yet been built. The current Five-Year Plan (1976–1980) provides for an increase in sugar production to 250,000 tonnes, 56% above the target figure for 1978.

Australian record sugar crop[12].—Final figures issued by the Australian Sugar Producers Association Ltd. reveal that the recently-completed 1977 Australian sugar harvest yielded a record 3·34 million tonnes of 94 net titre raw sugar against 3·29 million tonnes in 1976. The Queensland cane crop of 22·33 million tonnes (22·27 million tonnes in 1976) yielded 3·21 million tonnes of raws (3·16 million) with a ccs ratio averaging 14·33 (14·23 in 1976).

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[1] *Mauritius Sugar News Bull.*, 1977, (12).
[2] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (1), 14.
[3] *Reuters Sugar Rpt.*, 23rd January 1978.
[4] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (1), 7.
[5] *Mauritius Sugar News Bull.*, 1977, (12).
[6] *Public Ledger*, 7th January 1978.
[7] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (4), xvi.
[8] *Zeitsch. Zuckerind.*, 1977, **102**, 830.
[9] *I.S.J.*, 1977, **79**, 300.
[10] *Bank of London & S. America Review*, 1978, **12**, 29.
[11] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (1), 12.
[12] *Queensland Newsletter*, 22nd February 1978.

Taiwan sugar exports[1]

	1977	1976	1975
		(*tonnes, raw value*)	
Guam	327	411	435
Hong Kong	6,407	7,569	1,927
Indonesia	11,957	0	0
Japan	296,746	225,242	96,657
Jordan	0	0	1,304
Korea, South	160,478	107,871	147,862
Malaysia	31,464	0	272
Morocco	0	14,705	0
North Borneo	0	0	1,087
Portugal	0	12,969	0
Saudi Arabia	65,981	52,176	36,741
Sri Lanka	9,264	9,264	0
United States	78,227	78,882	127,691
	660,851	509,089	413,976

Paraguay sugar production 1977[2].—The 1977 sugar crop in Paraguay is reported at 75,000 tonnes, compared with 70,000 tonnes in 1976 and 80,000 tonnes in 1975.

Switzerland sugar production, 1977[3].—The two Swiss sugar factories sliced a total of 544,940 tonnes of beets in their 1977 campaign to produce a total of 78,524 tonnes of white sugar.

New Turkish sugar factory[4].—On 28th October the Turkish Deputy Prime Minister opened the new Afyon sugar factory which is to produce 42,000 tons of cube sugar and 68,000 tons of granulated sugar annually.

Greece sugar production, 1977[5].—The factories of Hellenic Sugar Industry S.A. sliced a total of 2,450,000 tonnes of beet, grown on 44,000 hectares, and having an average sugar content of 14·32%. Sugar production was 270,000 tonnes, white value.

Polish sugar machinery manufacturing capacity increase[6].—The SFUP factory in Swidnica, Poland, which produces technological equipment for sugar factories, is to be expanded and modernized at a cost of more than 1,000,000,000 zloty. More than half of the factory's production—the largest of its kind in the Comecon area—is exported.

China sugar purchases[7].—Unofficial trade estimates have put China's 1977 free market sugar purchases at 1·5 million tonnes, making it the world's third largest buyer.

High fructose corn syrup plant closure in Hollands[8]. Koninklijke Scholten-Honig N.V. has announced that it is to stop production of maize-based high fructose corn syrup at its Dutch plant in Koog aan de Zaan. The same company had already stopped construction of its planned factory at Tilbury in England and had shelved plans to expand production in Holland, believed to be 20,000 tonnes per annum. The measures are the result of failure to reverse the EEC decision to put a production levy on HFCS; the Company is continuing its legal action to reverse the levy decision.

Molasses alcohol plant in the Philippines[9].—The Energy Development Board is putting up a 15-million pesos plan in the Negros-Panay area of the Philippines to produce pure alcohol from molasses for incorporation (15:85) with petrol as motor fuel, as part of the Government's energy conservation programme. The plant will produce 30 million litres of pure alcohol per year, and plans to establish more such plants will depend on the performance of the first.

Cuban-Spanish sugar trade problems[10].—Talks on a new Cuba-Spain trade agreement were interrupted in Madrid after the Spanish side asked for a letter of respite for its contractual obligation to import 75,000 tons of sugar from Cuba agreed in 1974. The Spanish negotiators emphasized that sales of investment goods to Cuba did not come up to expectations and that there are no signs that this will change in future.

Norway sugar imports[11]

	1977	1976
	(*tonnes, white value*)	
Belgium	5,887	10,804
Czechoslovakia	2,844	9,679
Denmark	76,574	51,164
Finland	14,892	18,661
France	216	455
Germany, East	50	7
Germany, West	26,507	8,403
Holland	33	403
Italy	0	18
Poland	4,821	7,099
Sweden	85	72
UK	33,055	48,136
	164,964	154,901

New Tunisia sugar factory possibility[12].—According to Tunisian press reports, a second sugar factory may be built at Beja; the 1977 sugar beet harvest in Tunisia was a record 118,600 tonnes and the 80,000 tonnes.year^{-1} factory at Beja is now too small to cope.

New Guatemala sugar factory[13].—Agropecuaria San Francisco S.A. is building a 3000 t.c.d. sugar factory near Chiquimullilla in the Department of Santa Rosa, Guatemala. The project is based on the utilization of new equipment combined with second-hand equipment from factories in Louisiana and Puerto Rico. The San Francisco factory is scheduled for start-up this year and will produce raws as well as plantation white sugar by the sulphitation process. International Planning Services Inc. of Baton Rouge, Louisiana, is in charge of project management, purchasing and detailed design and engineering. The San Francisco plant is one of three factories being built in Central America under IPS technical direction and supervision.

PERSONAL NOTES

Alfonso L. Fors has been appointed Technical Director of International Sugarcane Consultants Inc., of Miami, Florida, a company formed to assist cane growers to produce sugar cane more efficiently and economically. Inter-American Transport & Equipment Co., the Florida-based cane transportation specialists, are a subsidiary of ISC.

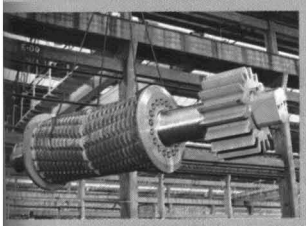
The Tate & Lyle Engineering Board has been re-organized as follows:

Dr. Michael C. Bennett and **William M. Higgins** have been appointed Deputy Managing Directors. **Dr. Bennett,** in addition to his responsibilities for the Talo Products and Processes Division, Farrow Irrigation and British Charcoals & Macdonalds Ltd., assumes reponsibilitiy for sales policy and organization, and for personnel policy.

Mr. Higgins will be responsible for the technical performance of the Company, with particular reference to the organization and execution of contracts and projects, and in addition, will be responsible for office administration.

Frank Davison, while remaining Deputy Managing Director of Tate & Lyle Technical Services Ltd., is appointed Marketing Director, Agriculture. **Ian Carmichael** is appointed Marketing Director, Factory Engineering, **Leonard A. Carter** is appointed Purchasing Director, and **Denis Dickinson** is appointed Personnel Director in addition to responsibility for Public Relations.

[1] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (4), xix.
[2] *Bank of London & S. America Review*, 1978, **12**, 35.
[3] *Zuckerind.*, 1978, **103**, 87.
[4] F. O. Licht, *International Sugar Rpt.*, 1977, **109**, (34), 6.
[5] *Zuckerind.*, 1978, **103**, 89.
[6] F. O. Licht, *International Sugar Rpt.*, 1977, **109**, (34), 7.
[7] *Public Ledger*, 21st January 1978.
[8] F. O. Licht, *International Sugar Rpt.*, 1977, **109**, (35), 12.
[9] *Sugar News*, 1977, **53**, 294.
[10] F. O. Licht, *International Sugar Rpt.*, 1977, **109**, (35), 12.
[11] C. Czarnikow Ltd., *Sugar Review*, 1978, (1375), 31.
[12] F. O. Licht, *International Sugar Rpt.*, 1977, **109**, (34), 12.
[13] *Sugar J.*, 1977, **40**, (7), 31.



El azúcar representa una importante fuente de energía en el mundo entero. El extraerlo de la caña de azúcar con eficiencia es siempre una tarea difícil que depende sobre todo de las características y de la calidad del equipo utilizado.

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Zanini, a través de su asociación con Farrel, adquirió la tecnología necesaria para llegar a lo que es lo más importante: fabricar los mejores trapiches del mundo: TRAPICHES ZANINI - FARREL.

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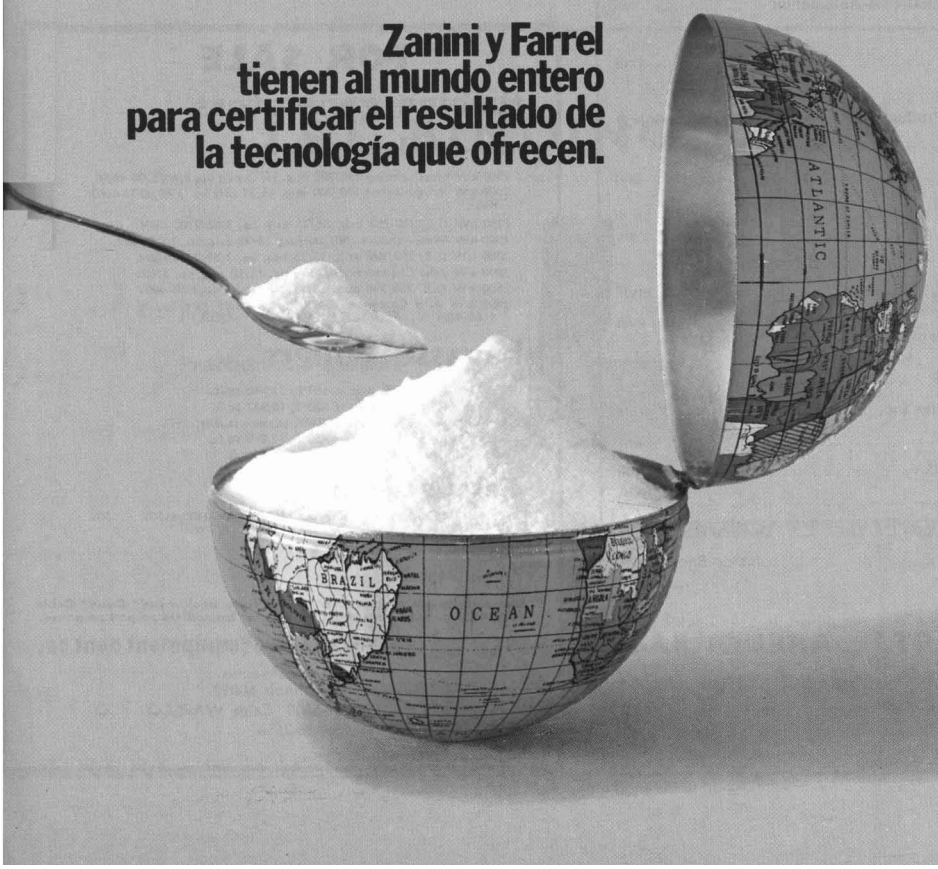
Zanini y Farrel tienen al mundo entero para certificar el resultado de la tecnología que ofrecen.



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