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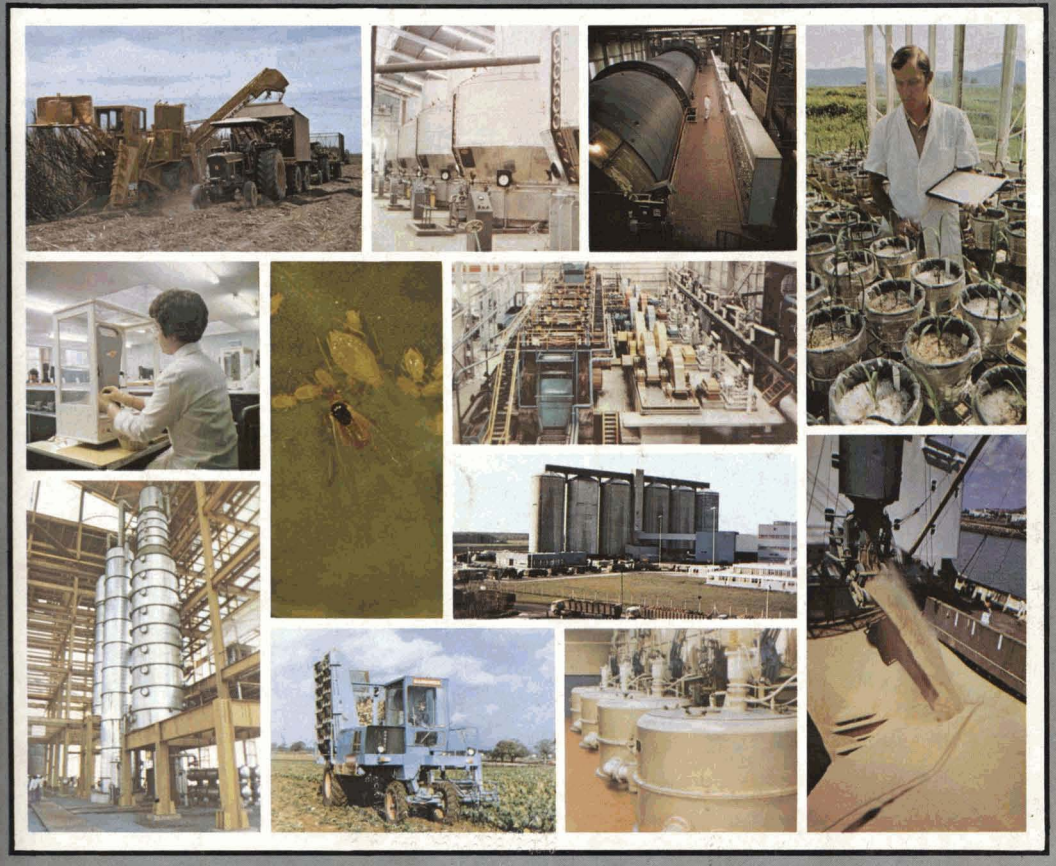

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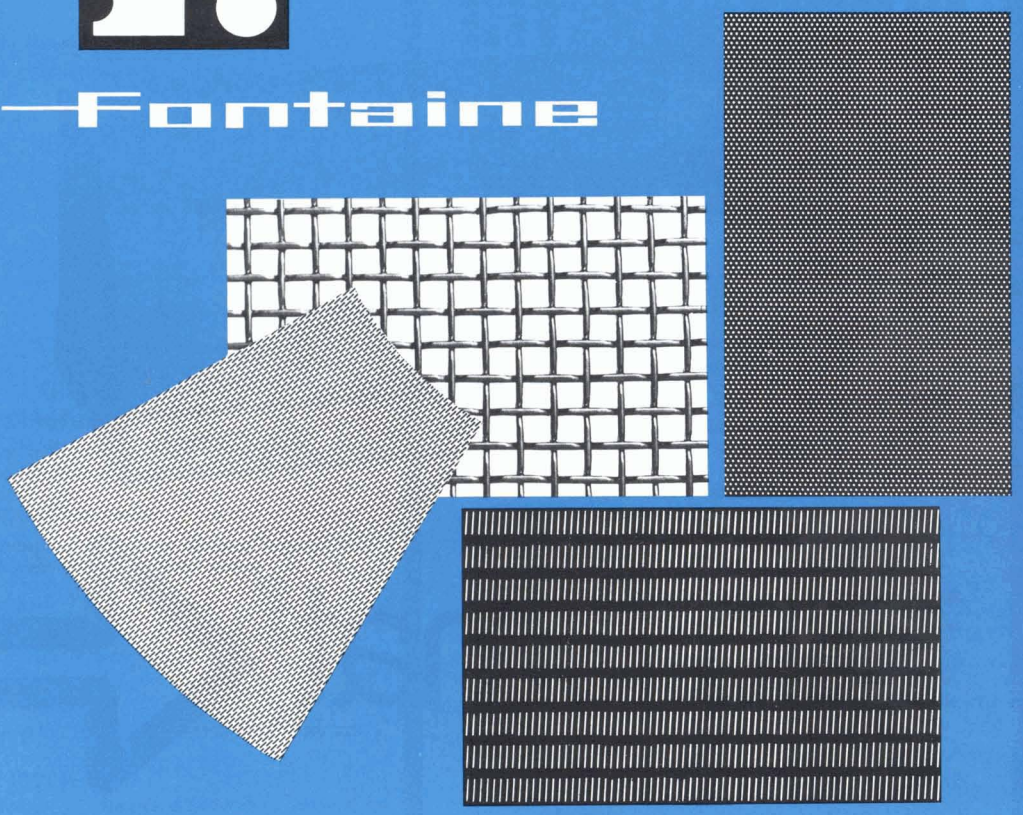

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NOTES AND COMMENTS

International Sugar Agreement

Under the terms of the Agreement, exporting members must notify the Council twice a year of the extent to which they will be able to make use of quotas granted to them. When quotas were restored recently it was agreed that the first date for such notifications would be June 15 and, somewhat surprisingly, the shortfalls notified totalled 1,285,878 of the total export quotas in effect of 15,149,519 tonnes, raw value. At their meeting on July 9 the Executive Committee of the I.S.O. decided to redistribute the shortfalls and has notified the nine exporting members eligible for such redistribution. It is expected, however, that a large part of the amounts offered will not be accepted and C. Czarnikow Ltd.[1] consider it possible that the current global quota of 14,646,292 tonnes will not be reached.

World sugar prices

From a level of £200 per tonne, the London Daily Price for raw sugar climbed during the first half of July, to reach a peak of £235 on July 14. This was attributed to emerging demand for physical sugar in the USA as well as the strike of Australian sugar workers, poor crop results in the West Indies, and new rumours of Soviet interest – all factors indicating a tighter raw sugar supply and demand position than previously expected, while a further factor was the weakening of sterling in which the LDP is expressed. Then initial assessments of a larger EEC beet sugar crop were published and some expected Iranian purchases failed to materialize, and the price eased to only £212 on July 20, subsequently strengthening on reports of frost in Brazil which had certainly affected the coffee crop and were thought likely to have damaged prospects for the sugar harvest. This, together with reports of high temperatures and dry conditions in the beet growing areas of the USSR and water shortages in Florida lifted the LDP to £228 on July 30, although on the following day it fell again to £221.

White sugar prices tended to follow the shifts in those for raw sugar during July, but within smaller ranges. The LDP(W) started the month at £225 – a premium of £25 – but at the raw sugar peak of £235 the premium had fallen to £15 and at the subsequent dip to an LDP of £212, the LDP(W) was £230, a premium of £18. At the end of the month the LDP(W) was £240 per tonne, £19 higher than the raw sugar price.

EEC sugar exports, 1980

F. O. Licht GmbH have recently published statistics of raw and white sugar exports from the member countries of the European Economic Community during 1980[2] and these, together with corresponding earlier figures, appear elsewhere in this issue. The EEC has become by far the world's largest white sugar exporter; white sugar exports have risen from 1.1 million tonnes in 1974 to 3.6 million tonnes in 1980. In addition, raw sugar exports reached approximately 389,000 tonnes in 1980 or some 9% of the total.

The steep increase of EEC sugar exports over the past years has provoked sharp criticism from other exporting nations. In the view of other sugar exporting countries, the EEC surplus is detrimental, particularly to third world producers. Subsidized EEC sugar exports are said to be depressing world prices and depriving other countries of export earnings. Australia and Brazil formally complained to the Council of the General Agreement on Tariffs and Trade (GATT) that the EEC was using export subsidies to obtain an unfair share of the world sugar market. During the period of high world prices EEC sources argued that Australia's complaints were irrelevant because export refunds were not being paid. However, with the recent fall in prices this argument was soon invalidated and export subsidies are being paid again.

On the other hand it cannot be overlooked that the Lomé Convention provides the ACP exporters a guaranteed market for a substantial proportion of their production at a price usually well in excess of that obtainable on the free market. Critics of the EEC sugar regime, however, argue that this income transfer does not outweigh the price depressing influence of EEC sugar exports.

The EEC has also come under criticism because of its attitude towards the International Sugar Agreement (ISA). The EEC is being blamed for the ISA's failure to achieve its price objectives throughout most of its life. It is argued that the ineffectiveness of the ISA during prolonged periods of oversupply is not surprising considering more than 20% of available supply – coming from the EEC, Czechoslovakia and Taiwan – is not covered by the Agreement. The Executive Director of the International Sugar Organization recently stated that the very large Community exports were the most important single factor in the weakness of the world market in 1978 and 1979 and that the EEC's absence is the most important ISA weakness.

However, if the EEC had drastically reduced its export surplus over the past two years, as has been demanded by its critics, the world would have faced a severe supply crisis. Despite the high level of EEC sugar production world sugar stocks are likely to be reduced by 2.5 million tonnes in 1980/81 after a fall of more than 5 million tonnes the previous year. Hence, the high level of EEC exports provided a welcome breathing-space for many consumers, not forgetting the net importing developing coontries. What is regrettable is that the EEC export policy is so inflexible during periods of surplus and this is not likely to change much under the new EEC sugar regime, as the agreed quotas show that the EEC has given up trying to cut directly and substantially the level of quota production. Only the fact that EEC sugar producers will have to finance wholly the disposal of surpluses and the new stock holding provisions may result in a somewhat greater flexibility.

In view of the ever increasing demand for white sugar and the freight advantage the EEC enjoys in Western Europe, Africa and the Near and Middle East, the outlook is not too grim for EEC sugar exporters. In 1980 the EEC was able to increase its exports by no less than 20% against the previous year and no substantial reduction is forecast for 1981.

The satisfactory export performance in 1980 was partly a result of increased deliveries to Eastern Europe. Sugar exports to the East European countries jumped from 53,000 tonnes in 1978 to over 900,000 tonnes in 1980. The reasons behind the sharp increase are the pro-

[1] *Sugar Review*, 1981, (1554), 119.
[2] *International Sugar Rpt.*, 1981, **113**, 389 – 397.

duction shortfalls in USSR and Cuba in 1979/80 and 1980/81. With better weather in the USSR and Eastern Europe in general, import requirements should shrink in the years ahead.

The largest market for EEC sugar is the Near and Middle East. Both in 1979 and 1980 exports exceeded 1.3 million tonnes. With the ever increasing sugar demand in that area sugar imports are likely to remain strong. Only exports to Iran are likely to suffer a temporary setback. How soon the situation will be back to normal is impossible to predict.

With the likely recovery of sugar production in Eastern Europe, the possibility of a substantially higher Cuban crop and the limited growth potential in other existing markets the EEC must develop new foreign outlets to dispose of its sugar surplus unless the Community cuts back on production. Whether the development of new markets is a real possibility remains to be seen.

World sugar balance, 1980/81[1]

In their third assessment of the world sugar balance for September/August 1980/81, F. O. Licht GmbH set production very slightly lower than in the second assessment of February 1981, at 86,965,000 tonnes, raw value, while consumption is now considered to be 450,000 tonnes lower, at 89,191,000 tonnes. Thus, while a reduced deficit of 2,226,000 tonnes is in prospect against a previous estimate of 2,663,000 tonnes, this still represents a fall in final stocks to 26.41% of annual consumption. Factors which have contributed to sluggish demand are identified as: further inroads by substitute sweeteners, particularly HFCS, internal shortages in specific countries such as India, Iran and Poland, slowing world economic growth, and escalating world prices, particularly during the period September 1980 – March 1981.

Licht point out the large number of variables which will affect production and consumption in 1981/82 but believe that the net effect could be a rise in production to about 92 million tonnes and consumption of about 91 million tonnes. The net surplus of 1 million tonnes could be substantially higher if good weather is experienced in key areas – in which case a more efficient ISA would be needed – while, if poor weather induced another shortfall, a major price boom could be triggered because of the low level of stocks.

Licht's figures are reproduced below:

	1980/81	1979/80	1978/79
	tonnes, raw value		
Initial stocks	26,038,000	31,313,000	30,542,000
Production	86,965,000	84,905,000	91,005,000
Imports	27,748,000	29,737,000	27,103,000
	140,751,000	145,955,000	148,650,000
Exports	28,009,000	30,042,000	27,669,000
Consumption	89,191,000	89,875,000	89,668,000
Final stocks	23,551,000	26,038,000	31,313,000
,, ,, % consumption	26.41	28.97	34.92

Sugar in the Middle East[2]

The Middle East remains an important market for sugar exporters throughout the world. The rapid rise in per caput incomes which came with the oil boom has resulted in dramatically higher imports of sugar in the Gulf and Iran and Iraq. But North Africa, as well, remains a big importer of sugar, with per caput consumption in the area amongst the highest in the world, largely because of dietary habits –notably the drinking of sweet tea.

While the more arid areas of the Middle East will never be able to support an indigenous sugar industry, several nations have been paying increasing attention to the problem of curbing sugar imports. The move to boost domestic production has gathered momentum since sugar prices started to rise in 1980. But, despite valiant efforts in such countries, the Middle East and North Africa are likely to continue to represent an important and growing market for sugar in the forseeable future. The table below shows the pattern of production and consumption over the past three seasons in eight major countries of the region.

	1980/81	1979/80	1978/79
	tonnes, raw value		
Production			
Algeria	10,000	12,000	12,000
Egypt	675,000	661,000	668,000
Iran	320,000	650,000	653,000
Iraq	25,000	38,000	34,000
Morocco	359,000	359,000	398,000
Sudan	212,000	141,000	146,000
Tunisia	9,000	7,000	8,000
Turkey	935,000	1,068,000	1,096,000
	2,545,000	2,936,000	3,015,000
Consumption			
Algeria	500,000	490,000	480,000
Egypt	1,160,000	1,100,000	1,050,000
Iran	1,000,000	1,050,000	1,278,000
Iraq	440,000	490,000	561,000
Morocco	680,000	660,000	640,000
Sudan	400,000	380,000	348,000
Tunisia	195,000	185,000	170,000
Turkey	1,279,000	1,260,000	1,100,000
	5,654,000	5,915,000	5,627,000
Deficit	3,109,000	2,979,000	2,612,000

EEC sugar outlook in 1981/82

Although it is too early to predict the EEC sugar balance with any degree of accuracy, it seems as if another large surplus will weigh heavily on the world market next year. At the beginning of July the Commission estimated that the export surplus could be around 4,180,000 tonnes but, in the view of F. O. Licht GmbH[3], this is too low a figure.

The Commission estimate of consumption for 1981/82 is 9,565,000 tonnes (including Greece), practically the same as in 1980/81; in view of the continuing economic problems, this seems to be a realistic assumption. However, while it is early in the season, all signs at this stage point to average or even slightly above average crop results. On top of this there has been a substantial rise in EEC beet plantings this year[4]. Taking the average of the crop yields for the past three years in each country, the larger areas would produce a Community total of 13,652,000 tonnes of sugar, white value. This is approximately 1,000,000 tonnes higher than the 12,534,000 tonnes estimated by the Commission which has calculated on a basis of smaller beet areas than Licht and on a 10-year average yield which does not take account of the recent upward trend in sugar yields. The higher production figure would give a total export surplus of 5.3 million tonnes, white value, of which 2 million tonnes would be C-quota sugar which will have to be disposed of without any restitution (export subsidy).

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1 F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 371 – 375.
2 *Public Ledger's Commodity Week*, July 25, 1981.
3 *International Sugar Rpt.*, 1981, **113**, 461 – 463.
4 *I.S.J.*, 1981, **83**, 225.

By MAGNUS NILSSON
(Alfa-Laval AB, Tumba, Sweden)

As oil becomes more expensive, the fermentation and distillation of cane molasses to produce alcohol (for use as fuel or chemical feedstock) is an increasingly attractive proposition. A problem that must be overcome, however, is the serious pollution caused by such processes. An average-sized molasses distillery producing 60,000 litres/day of alcohol creates the same pollution load as domestic sewage from a city of *one million inhabitants*. The volume of liquid waste is typically ten to fourteen times the alcohol production: around 600,000 to 840,000 litres/day. Its polluting strength, assessed as a five-day biological oxygen demand (BOD_5), is usually about 25,000 ppm but in exceptional circumstances can be as high as 50,000 ppm.

Public authorities will no longer tolerate discharge of such damaging effluents untreated into the environment, and strict regulations have been introduced or are planned in most cane-growing countries. At the same time, financial considerations demand that the distiller should find an economical, and if possible a profitable, method of disposing of the effluent.

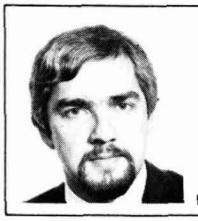
Traditional aerobic methods of effluent treatment are most unattractive for the distiller because of the high energy costs required for aeration with no compensating revenue from the end-products.

A more promising biological approach is anaerobic digestion of molasses stillage which yields a methane-rich fuel gas. However, the process is not very efficient in energy terms; less than 35% by weight of the degradable organic matter in the stillage is converted to methane while the rest is converted to carbon dioxide and water or consumed in sludge growth.

Nor does anaerobic digestion completely solve the pollution problem. A 95% breakdown of the organic pollutants is generally the best that can be expected. For a stillage with an original BOD_5 of 25,000 ppm, 95% reduction leaves an effluent at around 1,250 ppm — still about three times the pollution load of domestic sewage. To meet normal statutory requirements for discharge, the effluent must undergo a costly "finishing" treatment using aerobic techniques or simple lagooning, and even then the colour problem is not removed.

Breakdown efficiencies greater than 95%, to reduce the degree of final effluent treatment to acceptable limits, are technically possible, but involve considerable increases in retention time and sludge recycle ratios. The law of diminishing returns applies, adversely influencing the overall economics of treatment.

A further consideration is that the micro-organisms responsible for anaerobic digestion can be extremely temperamental, readily inhibited by other chemical matter present in the stillage or by temperatures outside a narrow band.



Magnus Nilsson

The approach of the chemical engineer is quite different. He starts by considering what is potentially valuable in a molasses stillage, as well as what is unwanted. Unwanted are the pollutive organic materials that create the biological oxygen demand. Potentially valuable are (1) the total energy contained in these same organic materials considered as fuels and (2) inorganic substances, principally potassium, which could be re-used as fertilizers.

The obvious method of destroying the unwanted materials while recovering the two valuable components is combustion. Combustion can completely destroy all organic materials, so reducing the biological pollution problem to zero. At the same time it liberates all the available energy as hot gases while leaving all inorganic materials in the solid residue.

Because raw stillage is actually incombustible owing to its water content, a necessary precursor to combustion is some method of concentrating the liquid, normally by evaporation.

The complete energy approach

Even though evaporation consumes energy rather than generating it, evaporation on its own, without subsequent combustion, is already used by some distillers to bring stillage down to a manageable volume. The resulting concentrate is saleable as an animal feedstuff, although recently its price has fallen behind the rising cost of energy for evaporation. Other sugar producers currently spread the concentrate on cane fields as a fertilizer. However, this too creates problems, which include polluting run-off into rivers, "scorching" of foliage, unpleasant odour in hot weather, and attraction of insects that carry cattle diseases.

As explained above, it is in evaporation *followed by combustion* that the greatest potential lies, by making the total de-pollution process actually profitable. The concept is not new, of course; the practical difficulty has been to recover the heat energy efficiently without leaving behind an intractable and valueless fused ash of glassy or slagged consistency.

A new process is believed to be the first that is both energy-efficient and able to realise the fertilizer value of the solid residue, which is recovered as dry, powdered ash. It results from international collaboration between two companies: Alfa-Laval AB of Sweden on the evaporation side and A. Ahlström Oy. of Finland on the combustion side.

Compared with biological processes the plant occupies very little space. The first section is the Alfa-Laval evaporation plant, which concentrates the stillage to a syrup with a dry solids content of about 60%. Based on many years of experience in the concentration of liquids liable to deposit scale on process surfaces, the multiple-effect evaporation unit is highly efficient in both steam and mechanical energy usage. There is also sufficient flexibility to allow cleaning of the stages during normal operation without loss of efficiency.

After evaporation, the concentrated syrup is heated to near boiling-point and injected into the combustion zone of the Ahlström Stillage-Fired Boiler. Here, air introduced tangentially produces a swirling flow which rapidly dries and then combusts the droplets, finally throwing the resulting ash particles against the water-cooled walls of

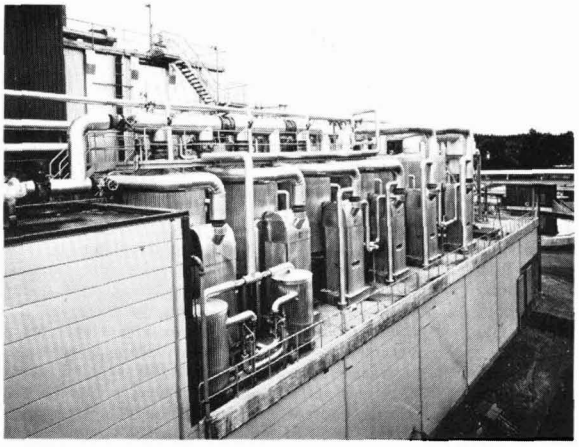


Fig. 1. A typical Alfa-Laval evaporation plant

the combustion chamber, where they drop down. The hot gases pass on to the boiler's main heating section, where fine ash particles deposited on heating surfaces are dislodged by rapping devices. Cyclones, wet scrubbers or electrostatic precipitators remove more ash from the flue gases before discharge, to give an overall solids recovery ranging from 90% to over 99%.

High boiler efficiencies can be achieved, and steam may be produced either at a high pressure for auxiliary power generation (with pass-out steam going to processing) or at a lower pressure for direct use in distillation. Additional fuel is required only during start-up and this may be derived locally, from within the plant economy, in the form either of raw molasses or of distilled alcohol. No imported oil is needed.

Profitable energy recovery

A typical stillage from a 60,000 litres/day molasses distillery of conventional design consists of 31.2 tonnes.hr^{-1} of liquid with 8% dry solids content. To concentrate this to 60% DS, 27.0 tonnes.hr^{-1} of water must be evaporated, which requires 6.2 tonnes.hr^{-1} of steam. Subsequent combustion will generate 9.6 tonnes.hr^{-1} of steam, giving a surplus of 3.4 tonnes.hr^{-1}. At a value of US$23/tonne, and assuming 300 days plant operation a year, this represents an annual steam value of US$560,000. Additionally, 0.9 tonnnes.hr^{-1} of ash containing 0.33 tonnes.hr^{-1} of K_2O (potash) will be recovered. At US$225/tonne K_2O, this will bring in revenue of over US$500,000 a year.

This example, which represents the process at its *least* profitable, shows how it will always generate useful revenue whilst eliminating the pollution problem. Clearly, revenue would be significantly greater if the raw stillage were more concentrated to start with. Less steam would be required for evaporation and the evaporation plant could be smaller.

Consider, for example, a stillage with a bulk of 17.2 tonnes.hr^{-1} and at a concentration of 14.5% dry solids from a 60,000 litres/day distillery. This would require only 2.9 tonnes.hr^{-1} of steam for evaporation to 60% dry solids. Combustion would then generate a surplus of 6.7 tonnes.hr^{-1} of steam, worth US$1,100,000 a year. Potash revenue would again be about US$500,000 a year.

To obtain so concentrated a stillage, some fraction of it must be recycled during processing. In the example above, 40% of the stillage is recycled to dilute the raw molasses. This in turn requires a good quality molasses, which can be obtained by the use of modern techniques of molasses pretreatment (to kill bacteria and remove suspended solids, dissolved calcium salts and volatile impurities), and by separating and recycling the yeast after fermentation. If all these techniques were introduced simultaneously with the new de-pollution process, the payback period on the investment has been calculated (on 1980 prices) at 3.9 years for a 60,000 litres/day distillery or just 2.4 years for a 180,000 litres/day distillery. These figures make no allowance for the value of pollution abatement.

Not all distillers would wish to invest on this scale. Nonetheless, depending on the composition of the individual molasses, between 10% and 20% of stillage can usually be recycled *without* introducing pretreatment. This would place the steam revenue from combustion somewhere between the two examples above while, as always, completely eliminating the pollution problem.

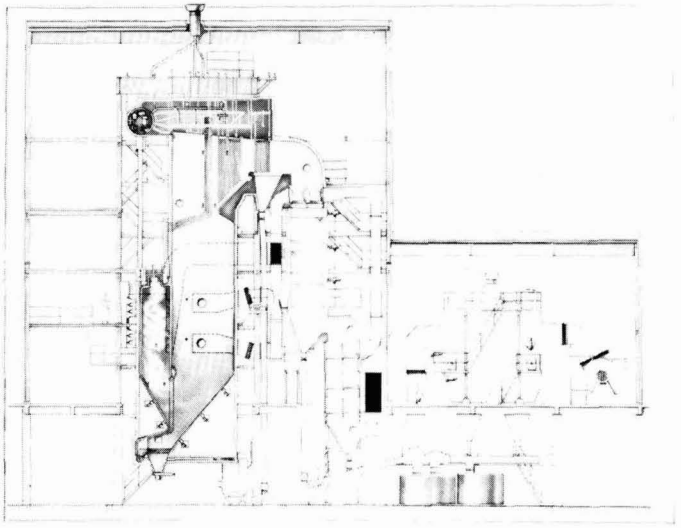


Fig. 2. Cross-section of the Ahlström boiler with ash recovery

Future developments

Alfa-Laval AB is presently developing a new fermentation technique known as "Biostil" which will yield a highly concentrated molasses stillage with a DS content of about 35%. The Biostil process is expected to be available commercially soon and will introduce a new concept in fermentation coupled with stillage treatment.

At 35% dry solids content, the stillage is autothermal (capable of sustaining combustion) without the need for further evaporation, although the boiler efficiency would naturally be reduced. Even with some form of simple primary evaporation to bring the solids up to 60% dry solids, the steam balance is such as to make a typical molasses distillery completely self-sufficient in thermal energy without any external fuel-source. The Ahlström boiler itself becomes the steam-raising facility serving the distillery. And with the elimination of pollution and recovery of a potash-rich ash as before, the economics of production are raised to a high level of attractiveness.

At 35% dry solids content, moreover, where the BOD_5 would be well in excess of 200,000 ppm, other forms of effluent treatment, involving microbiological processes, become ineffective, mainly owing to inhibition from inorganic salts. Evaporation and combustion becomes the only economically feasible solution for stillage treatment.

Summary

In sugar-producing countries where molasses is fermented and distilled, the effluent can be a valuable energy-producing by-product. By evaporation of the stillage followed by combustion in a boiler, enough energy can be recovered to pay back the capital investment in a reasonable time. At the same time, the serious pollution problem associated with molasses distilleries is eliminated. Combustion of the pollutant organic materials can generate more steam than is needed for the preceding evaporation. The surplus steam can be used profitably in the sugar processing plant or distillery, or to generate electricity. Valuable inorganic substances, notably potassium, can be recovered in the form of a dry ash suitable for fertilizers. It is estimated that some two-thirds of the potassium that has been assimilated by sugar cane during its growth can be recycled in this way. Since all cane-growing countries currently import potassium for fertilizer-compounding, there is a direct benefit to the balance of payments as well as to the individual distiller.

Récupération d'énergie des résidus de distillerie

Dans les pays producteurs de sucre où les mélasses sont fermentées et distillées, l'effluent peut être un sous-produit producteur d'énergie. Par l'évaporation de la vinasse, suivie de sa combustion dans un générateur de vapeur on peut récupérer suffisamment d'énergie pour amortir le capital investi en un temps raisonnable. Simultanément, le problème sérieux de pollution, associé aux distilleries de mélasse, est eliminé. La combustion du matériau organique polluant peut produire une quantité de vapeur supérieure à celle qui est requise pour l'évaporation qui précède. La vapeur excédentaire peut être utilisée avec profit en sucrerie ou en distillerie, ou pour la production d'électricité. Des matières inorganiques de valeur, surtout le potassium, peuvent être récupérées sous forme de cendres sèches utilisables comme fertilisants. On estime que quelque deux tiers du potassium assimilé par la canne à sucre au cours de sa croissance peuvent être recyclés de cette façon. Comme tous les pays producteurs de canne importent couramment de la potasse pour la fabrication de fertilisants, il y a là un bénéfice direct pour la balance des payements aussi bien que pour le distillateur individuel.

Energiegewinnung aus Brennereiabwässern

In Zucker herstellenden Ländern, die Melasse vergären und destillieren, kann die Melasseschlempe ein wertvolles energieproduzierendes Nebenprodukt sein. Durch Eindampfung der Schlempe und anschließende Verbrennung in einem Heizkessel kann ausreichend Energie gewonnen werden, um die Investitionskosten in angemessener Zeit zu amortisieren. Gleichzeitig wird ein schwerwiegendes Umweltschutz-Problem der Melassebrennereien gelöst. Die Verbrennung umweltverschmutzender organischer Stoffe kann mehr Dampf erzeugen, als für die vorhergehende Eindampfung benötigt wird. Der Überschußdampf kann wirtschaftlich in der Zuckerfabrik oder Melassebrennerei oder zur Elektrizitätserzeugung verwendet werden. Wertvolle anorganische Substanzen, besonders Kalium, können in Form von für Düngemittel geeigneter trockener Asche gewonnen werden. Man schätzt, daß etwa zwei Drittel des vom Zuckerrohr während des Wachstums gespeicherten Kaliums auf diesem Weg zurückgewonnen werden können. Da alle Rohr anbauenden Länder laufend Kalium für Mehrnährstoffdünger importieren, entsteht ein direkter Nutzen für die Zahlungsbilanzen sowie für die einzelne Brennerei.

Recuperación de energía de efluentes de la distilería

En paises productores de azúcar donde se fermenta melaza, el efluente de la distilería puede estar un sub-producto de valor, capaz de servir como un fuente de energía. Por evaporación de la vinaza, y entonces su combustión en una caldera, bastante de energía puede recuperarse para amortizar la inversión en un periodo justo. A la vez, la problema importante de contaminación asociado con distilerías de melaza se elimina. Combustión de las materias orgánicas contaminantes puede generar más vapor que lo requerido en la evaporación precedente. El exceso de vapor pueden usarse con provecho en la fabricación de azúcar o en la distilería, o para generar electricidad. Valiosas sustancias inorgánicas, notablemente potasio, puede recuperarse en la forma de una ceniza seca, conveniente para uso como abono. Es estimado que unos 65% del potasio que se ha asimilado en la caña de azúcar durante su crecimiento puede recircularse en este manera. Actualmente, todos paises cañeros importan potasio como abono y el proceso ofrece un beneficio directo al balance de pagos así como para el distilador individual.

Ending of Peru drought[1]. — The return of rains in the north after three years of drought has facilitated a sugar cane replanting scheme under which 25,000 hectares are to be sown by the end of this year. Production in 1981 is expected to be 19% above the original estimate of 482,000 tonnes, compared with 568,000 tonnes in 1980, rising to traditional levels of 930,000 tonnes by 1983 if the drought does not recur. Peru imported 46,000 tonnes of sugar for the first time in 1980 and expects to have to import about 170,000 tonnes in 1981.

New Nigerian sugar factory[2]. — Nigeria is to establish a third sugar factory, expected to produce 100,000 tonnes of refined sugar annually, in Niger State, according to official sources. A technical agreement is to be signed with Polish, Soviet and Cuban firms for the project, 90% of which is owned by the federal government and 10% by the Niger state government.

[1] *Bank of London & S. America Review*, 1980, **15**, 103.

[2] F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 340.

Tate & Lyle success in corn syrup processing

Tate & Lyle Process Technology Ltd. (Protech), part of the Chemicals Division of Tate & Lyle Ltd. has won US Food and Drug Administration approval for the use of Taloflote in the processing of corn syrups. An official announcement of the Amendment to 21CFR Part 173.5(C) was published in the U.S. Federal Register on June 9, 1981. This was Protech's third successful US F & DA Petition. US F & DA approval opens the door for Protech to enter the rapidly growing US corn sweetener market. Protech is already building Taloflote corn syrup clarification plants at two US locations and one of these, in Illinois, will process a larger volume than Thames Refinery's melt liquor flow.

A mobile Taloflote pilot plant is being leased by Protech to another US corn giant. The plant has been built in London and has been

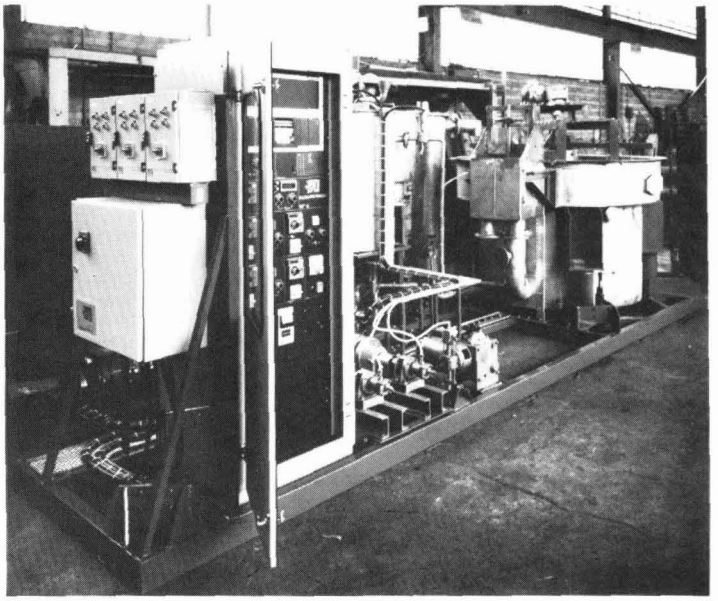


Fig. 1

airfreighted to the USA by Jumbo Jet (Figs. 1. and 2.) The Taloflote process was first developed by Protech about 4 years ago in response to a request from a large US corn syrup company. The President of the Company was attending the official opening of a Talofloc sugar refining plant in Louisiana and recognised the potential in corn syrup processing. A Protech representative was with him two days later to discuss the development program which included the filing of the FDA Petition.

The Taloflote corn syrup clarification process is cheaper to install and cheaper to operate than a conventional filtration station which uses a large number of rotary vacuum filters. The process is fully automatic and Protech manufactures the electronic control equipment which is the heart of the system.

Protech has also supplied the clarification and electronic control equipment for a second pilot plant which was shipped by sea-freight to the USA at the end of June. This pilot plant has been built to test the latest T & L technology in immobilized enzymes. The plant has been built at Group R & D's premises at Deacon Way, Reading, and the immobilized enzyme is being manufactured by British Charcoals & Macdonalds in Greenock. This is an excellent example of the way in which several parts of the Tate & Lyle Group have collaborated in bringing new technology to the market place.

The Taloflote clarification process can be applied in all corn syrup manufacturing processes but is particularly appropriate in the manufacture of high fructose corn syrup and alcohol for use as a gasoline extender.

Fig. 2

Effect of bagasse treatment on microbial growth

By D. S. DAHIYA and H. VEERAMANI*
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Introduction

Among agricultural residues, cane bagasse is the most significant, about 200 million tonnes being produced annually[1]. At present this is mostly burnt as fuel in the sugar factories, but its availability in vast amounts could make it a most important raw material for the fermentation industry, especially for the production of single-cell protein. During the last few years production of single-cell protein from cellulosic wastes[2-4] has been studied with increased interest. Bagasse as such is resistant[5] to microbial attack and needs prior treatment by physical[6] and chemical[7] agents to improve its assimilation characteristics. The present investigation deals with the study of treatment of bagasse with different chemical agents to make it suitable for growth of the fungus *Trichoderma viride* and *Cellulomonas* sp. bacteria.

Materials and methods

Preparation of bagasse and treatment: Whole bagasse was dried in the sun after removing soluble residual carbohydrates along with other contaminants by washing with warm water. A portion of the dried sample was ground to 60-65 mesh size powder in an electric grinder. It was freed of fat content by extraction with hot alcohol:ether mixture (3:1) and the material dried and stored. The fat-free bagasse was treated in different ways: powdered bagasse samples (composition, Table I) were treated with sodium hydroxide[7], sodium chlorite[8], and sulphite as in the treatment of cellulosic wastes. For comparison eucalyptus wood pulp (treated and untreated) and cellulose powder (Whatman) were also taken with the above samples.

Table I. Composition of bagasse sample oven-dried at 80°C

	%
Ash	1.6
Lignin	14.2
Pentosans	19.8
Cellulose	37.8

Microorganisms and growth: The cellulose-digesting microorganisms used in this study were *T. viride*[9] and *Cellulomonas* sp.[10]. The cultures were grown in standard basal salt medium with the above substrates at 1% level, using L-shaped culture tubes for cultivation on a rotary shaker at 35°C. The cell growth of cultures was observed by noting the changes in turbidity and optical density (OD) values in a Beckman model B spectrophotometer. When growth was complete (six days), the *T. viride* cultures were filtered, washed, dried at 105°C and weighed. For protein estimation, aliquot portions of filtered and washed biomass were extracted with 1N NaOH and the protein content in the extract was determined by the biuret method. The substrate loss and cell yield were calculated.

Results and conclusion: Whole bagasse and wood became suitable for microbial growth after chemical treatment. The chemical treatment of the crude cellulosic wastes removes pentosans and lignin material which are resistant to microbial attack[5]. Sulphuric acid and sulphite treatments produce some toxic materials during treatment, since the growth observed is less (Table III). Alkali treatment and chlorite treatments result in good growth of *Cellulomonas* and *T. viride* cultures (Table II). Chlorite treatment of bagasse and eucalyptus wood produced best growth giving highest conversions of substrate to microbial biomass and protein (Table III). Alkali treatment is preferable to acid treatment possibly owing to the smaller residual lignin content. Similar views have been expressed by Han & Callihan[7]. Alkali- and chlorite-treated bagasse and wood were better than cellulose powder, while CMC and cotton also showed less growth than bagasse. The chlorite treatment process turned the bagasse into a soft bleached pulp and the latter was completely assimilated by microorganisms. This chlorite process of pre-treatment of bagasse for microbial fermentation has not been reported previously.

Table II. Effect of chemical treatment of bagasse on the growth of *Trichoderma viride* and *Cellulomonas* cultures

Treatments	Cell Growth (Turbidity, O.D. Unit)	
	T. viride	*Cellulomonas* sp.
Control (Untreated bagasse)	0.59	0.62
CMC (Carboxymethyl cellulose)	0.48	0.52
Cotton	0.20	0.18
Bagasse (Chlorite-treated)	1.69	1.75
Eucalyptus wood pulp (Chlorite-treated)	1.21	1.23
Bagasse (Alkali-treated)	1.17	1.20

Table III. Effect of chemical treatment of bagasse on the growth of *Trichoderma viride* for biomass and protein production

Treatments	Substrate less % Initial	Cell yield	
		mg/ml Biomass	mg/ml Protein
Control (Untreated bagasse)	47.6	2.0	760
Bagasse (Acid-treated)	21.6	0.8	360
Bagasse (Sulphite-treated)	38.2	1.42	580
Bagasse (Alkali-treated)	78.0	4.0	1660
Bagasse (Chlorite-treated)	82.4	4.5	1710
Eucalyptus wood pulp (Untreated)	55.0	1.48	600
Eucalyptus wood pulp (Chlorite-treated)	82.0	4.4	1700
Cellulose powder (Whatman)	42.4	1.20	560

Acknowledgement

The authors wish to express their gratitude to Dr. Mary Mandels, Pollution Abatement Division, Food Science Laboratory, U.S. Army Natick Development Centre, Natick, MA 01760, U.S.A., for kindly providing the cultures of *T. viride* and *Cellulomonas* sp. We are also thankful to Dr. K. A. Prabhu, N.S.I., Kanpur, India, for valuable discussions.

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Effect of bagasse treatment on microbial growth

Summary

Of the various processes tried for chemical treatment of bagasse, the chlorite process has been found the most effective for the production of microbial biomass and protein.

Effet du traitement de bagasse sur le développement de microbes

On a trouvé que le procédé à chlorite était le plus effectif, entre un nombre de procédés essayés pour le traitement chimique de bagasse, pour la production de biomasse bactérielle et de protéine.

Einfluss der Bagasse-Bearbeitung auf das Wachstum von Mikroben

Unter verschiedenen versuchten chemischen Bagasse-Bearbeitungsverfahren zeigte sich das Chlorit-Verfahren als das günstigste zur Erzeugung von bakteriellem Biomass und Protein.

Efecto del tratamiento de bagazo sobre desarrollo microbiano

De los varios procesos examinado para el tratamiento químico de bagazo, el método con clorito se ha demostrado el más efectivo para producción de biomasa microbiana y de proteína.

Chromosome number distribution of *Saccharum spontaneum* in the southwest region of China

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(Sugarcane Industry Research Institute, Ministry of Light Industry, Beijing, People's Republic of China)

Introduction

Saccharum spontaneum is highly valuable in the breeding of new varieties of commercial sugar cane with respect to increasing vigour and adaptability and improving disease and pest resistance. Without the contribution of *S. spontaneum* in sugar cane breeding history, the incessant rise of sugar content and yield in hybrids through succeeding crossings would be inconceivable. All prominent commercial varieties now cultivated throughout the world possess germplasm of the species. 'Nobilization', a term applied to the increase of chromosome number through crossing and back-crossing between and among the noble cane and *S. spontaneum*, thus leading to the increase in sugar content and higher yield of the hybrids, is well known to sugar cane breeders[1]. New *S. spontaneum* sources will provide genetic material with considerable potential for contributing to increased yields when hybridized with commercial sugar cane varieties.

Rao & Babu[2] found chromosome numbers of *S. spontaneum* in India of 2n=40 and 2n=48, in addition to those previously found with 2n=54[3] and 2n=128[4]. The wild glagah of Java *S. spontaneum* has 2n=112 chromosomes[5]. In 1961, Bremer[6] reported the chromosome numbers of *S. spontaneum* examined to that time to be 2n=48, 56, 64, 72, 80, 96, 112, and 128.

In the mountainous southwest region of China, including Yunnan Province, the southern part of Sichuan, and the western parts of both Guizhou and Guangxi, which are all situated in the subtropical belt, solar radiation is plentiful and evenly distributed throughout the year. The sky is cloudy, rainfall adequate, and temperatures not too high in the summer. Low atmospheric humidity and relatively high air temperature are characteristic of the winter days. Because of its geographical vastness, its range in elevation and climate, and the evolutionary period in which *S. spontaneum* has existed in this area, this region of China has become a tremendous reservoir of *Saccharum* genes.

Before 1965, preliminary collections of wild cane materials from some subtropical provinces of China were conducted by the Sugarcane Industry Research Institute and chromosome numbers of some of them were investigated[7]. However, studies were more or less discontinued during the following ten years. In 1974, the annual conference of the Inter-Provincial Cooperation Session of Sugarcane Scientific Research Works determined that a systematic survey on the distribution of *S. spontaneum* in the subtropical belt of China and a collection of samples should be made. Detachments were sent each year from 1975 to 1979 to survey various parts of the region. Samples were brought to the Sugarcane Breeding Station, situated by the southern coast of the Hainan Island, and were cultivated and preserved in the nursery plots[8,9,10].

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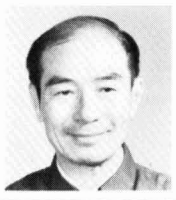
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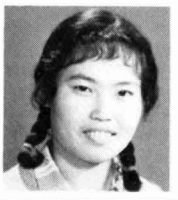
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During the last several years, we have made chromosome counts on a portion of these materials, some of which were published in 1976[11]. This paper reports our preliminary studies on chromosome number distribution of *S. spontaneum* in the southwest region of China.

Procedures

Inflorescences of plants of *S. spontaneum* raised in the nursery plots were sampled, fixed in Farmer's solution, and, after being rinsed with and preserved in 70% ethanol, were brought back to the Sugarcane Industry Research Institute in Guangzhou for chromosome counts[7]. Microsporocytes were stained with acetic orcein, squashed, made permanent, mapped, and photomicrographed. The slides were preserved in the cytological laboratory of the Sugarcane Industry Research Institute and made ready for inspection at any time.

Results

The chromosome number of the wild *S. spontaneum* clones with respect to locality and natural conditions are summarized in Table I. Clones from various locations in the same district are grouped. The sketch map (Fig. 1) shows the locations where clones were collected. Some photomicrographs of the microsporocytes at metaphase are presented in Fig. 2 and Fig. 3, showing their chromosome number.

Chromosome numbers of *S. spontaneum* clones taken in this region are primarily 2n=80; some are 2n=64. Of interest is the observation of one clone with 2n=68 and another with 2n=116 chromosomes which are exclusive lines to the province of Yunnan.

[11] Sugarcane Industry Science and Technique Information Station: *Sugarcane Industry*, 1976, **5**, 45-46 (in Chinese).

Table I. Lines of *S. spontaneum* indicating the chromosome numbers

Denomination or number of the lines	Chromosome number	Place the line collected	Natural conditions† of the place
"Sichuan Miyi"	2n=80	Sichuan Miyi	a.a.t. 20°C; a.r. 1000mm; Red loam
76-I-24	2n=80	Sichuan Miyi	
75-I-15	2n=80	Sichuan Dukoushi	e. ca 900m; Red loam
78-I-8	2n=80	Quizhou Rongjiang	a.a.t. 18.2°C; a.r. 1080mm; Red loam and yellow soil
78-II-12	2n=80	Quizhou Rongjiang	
78-III-12	2n=80	Quizhou Wangmo	a.mi.t. -4.8°C; e. 550m; Red loam and yellow soil
78-III-14	2n=80	Quizhou Wangmo	
78-III-15	2n=80	Quizhou Wangmo	
78-III-18	2n=80	Quizhou Wangmo	
78-III-1	2n=80	Quizhou Xingyi	a.a.t. 19.2°C; a.r. 1111mm; e. 830m; Mountain yellow earth
78-III-2	2n=80	Quizhou Xingyi	
"Guangxi Tianlin"	2n=80	Guangxi Tianlin	a.a.t. ca 20°C; a.r. 1000mm; e. 1100-1300m; Mountain yellow earth
"Guangxi *spontaneum*"	2n=80	Guangxi ?	
76-I-6	2n=80	Yunnan Heqing	e. 1525m; Mountain red earth
76-II-2	2n=80	Yunnan Yongsheng	a.a.t. 18.5-21.6°C; a.r. 500-700mm; e. 1300-1400m; Mountain red earth
76-I-21	2n=80	Yunnan Yuanmou	a.r. 600mm; e. 1100m; Red loam
75-II-2	2n=80	Yunnan Eshan	a.a.t. 18.1°C; a.r. 1905mm; e. 1700m; Red loam
"Yunnan Panqi No. 2"	2n=80	Yunnan Panqi	a.a.t. 19.5°C; a.r. ca 800mm; e. ca 1000m; Red loam
"Yunnan Zhuyan *spontaneum*"	2n=80	Yunnan Zhuyan	a.a.t. 19.5°C; a.r. 800mm; e. 1200m; Red loam
"Yunnan Kaiyuan"	2n=116	Yunnan Kaiyuan	a.a.t. 19.8°C; a.r. 796mm; e. 1050m; Red loam
"Yunnan Kaiyuan *spontaneum*"	2n=80	Yunnan Kaiyuan	
75-II-14	2n=80	Yunnan Kaiyuan	
75-II-15	2n=80	Yunnan Kaiyuan	
75-II-18	2n=80	Yunnan Kaiyuan	
"Yunnan Yuanjiang No. 1"	2n=80	Yunnan Yuanjiang	a.a.t. 24.5°C; a.r. 800mm; e. 410m; Red loam
"Yunnan Yuanjiang No. 2"	2n=80	Yunnan Yuanjiang	
75-II-3	2n=80	Yunnan Yuanjiang	
75-II-4	2n=64	Yunnan Yuanjiang	
75-II-6	2n=80	Yunnan Yuanjiang	
75-II-7	2n=80	Yunnan Yuanjiang	
75-II-9	2n=80	Yunnan Yuanjiang	
75-II-10	2n=64	Yunnan Yuanjiang	
75-II-11	2n=64	Yunnan Yuanjiang	
75-II-26	2n=80	Yunnan Mengzi	a.a.t. 18.7°C; a.r. 780mm; e. 1300m; Mountain red earth
75-II-32	2n=64	Yunnan Funing	a.a.t. ca 17-18°C; e. ca 1200m; Red loam and yellow soil
75-II-28	2n=80	Yunnan Maguan	a.a.t. 16.8°C; e. 1332.9m; Red loam
"Yunnan Hekou No. 1"	2n=80	Yunnan Hekou	a.ma.t. 36.2°C; e. 136.7m; Mountain yellow earth
75-II-35	2n=80	Yunnan Hekou	
75-II-36	2n=64	Yunnan Hekou	
75-II-22	2n=80	Yunnan Jingping	a.a.t. ca 23°C; e. ca 130m; Mountain yellow earth
76-III-18	2n=80	Yunnan Simao	a.ma.t. 34.9°C; a.mi.t. -3.4°C; a.a.t. 18.1°C; a.r. 1000mm; Red loam
76-III-17	2n=80	Yunnan Jinghong	a.a.t. 21.4°C; a.r. 1100mm; e. 530m; Red loam
"Yunnan Yunxian"	2n=80	Yunnan Yunxian	a.a.t. ca 18°C; e. ca 1300-1400m; Red earth
75-I-3	2n=64	Yunnan Baoshan	a.a.t. 16°C; e. 1600m; Red earth
75-I-7	2n=80	Yunnan Baoshan	
75-I-8	2n=64	Yunnan Boashan	
75-I-10	2n=64	Yunnan Manshi	a.ma.t. 36°C; a.mi.t. -0.6°C; a.r. 1636mm; e. 913.6m; Red earth
"Yunnan Nujiang"	2n=68	Yunnan ?	

† a.a.t. average annual temperature
a.ma.t. absolute maximum temperature
a.mi.t. absolute minimum temperature
a.r. annual rainfall
e. elevation

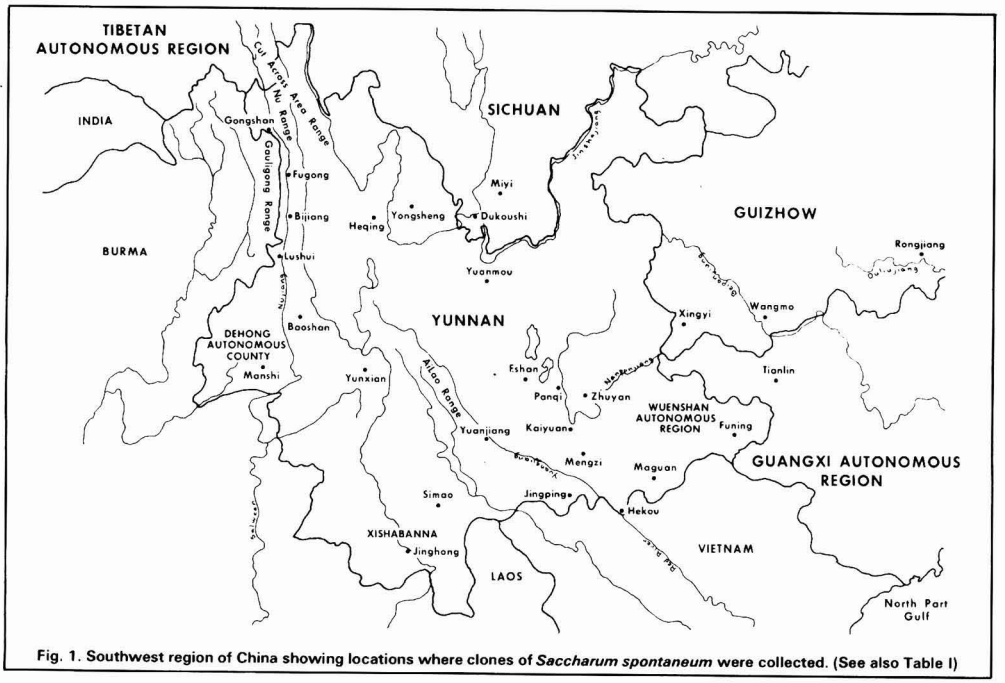

Fig. 1. Southwest region of China showing locations where clones of *Saccharum spontaneum* were collected. (See also Table I)

Discussion

The sample of clones from Sichuan, Guizhou, and Guangxi provinces was rather limited and was collected from only a few portions of the area within these provinces. The possibility that *S. spontaneum* clones possessing a chromosome number other than 2n=80 exist in these provinces needs further investigation.

In Yunnan, the wild cane clones with 2n=80 are distributed over the whole province, from Heqing and Yuanmou near the northern border to Maguan, Hekou, Jingping, and Simao near the Vietnam and Laos boundaries, and from the east border district Funing to Jinghon and Mangshi situated in either Xishabanna or the Dehong Autonomous County, both adjacent to Burma. In this province the wild clones with 2n=64 chromosomes are basically distributed along the river valley of Nujiang between the Gauligong Range and the Nu Range and are also found along the river valley of Yuanjiang east of the Ailao Range. In the district Funing near the Guangxi Province, a wild clone with 2n=64 chromosomes has also been found.

In 1965, one clone, "Yunnan Kaiyuan", which was collected from the Kaiyang district in the early 1950's and preserved in the wild cane nursery plots in the Sugarcane Industry Research Institute in Guangzhou, was found by our group to have 2n=116 chromosomes[12]. In the same year from the same nursery plots, another clone "Yunnan Nujiang", which had been collected from along the Nujiang River, was found to have 2n=68. But during the succeeding 10 years, the wild cane plots were ruined and the plants which had been collected before 1965 disappeared. Up to now, among those clones which were collected from Yunnan in the years 1975 to 1977, we have failed to find any which have 2n=116 or 2n=68 chromosomes.

The survey and collection made by the detachments were carried on within the territory of China. However, the natural distribution of plants is not restricted by national boundary, but rather follows the climatic condition, topography, and latitude of the locality. Because the river valleys of Nujiang and Yuanjiang stretch down to Burma and Vietnam, respectively, where their names become the Salween and the Red Rivers, and because the climates of the areas along these two river valleys down to their estuaries are still subtropical, it would be logical to assume that in these two countries similar clones of *S. spontaneum* are distributed.

It seems that along the river valley of the Nujiang, a greater percentage of the clones with 2n=64 chromosomes was found. But the lines collected were only from the river valley of the middle stream of this river, i.e. from Mangshi, Baoshan, etc. The river valley of the upper stream of Jujiang has not been explored. Whether there are any important clones of wild cane worth collecting in that area is uncertain. However, it is our judgement that a survey in this area of higher elevation, including Lushui, Bijiang, Fugong, Gongshan, and even up to the Cut Across Area Range, would be significant and should be attempted.

Furthermore, clones of *S. spontaneum* with chromosome numbers of n=20, n=24, etc., have been found in India[2]. The n=20 variants were of the bushy, clump-forming, wiry-leaved type; the variants with n=24 were also of the close clump-forming type with slender stalks and wiry or narrow leaves[2]. Our detachments sent in 1975 to 1978 did not find these variants in the southwest region of China. It is unlikely that such bushy

[12] *Ann. Rpt. Sug. Res., Sugarcane Ind. Res. Inst.*, 1965, 1-198 to 1-199 (in Chinese).

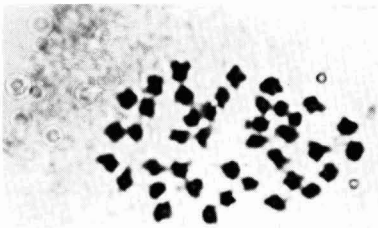

Fig. 2. Clone 78-II-8 from Guizhou Rongjiang. 2n=80 (x 1500)

and conspicuous variants were overlooked, as members of the detachment had all received special training before their mission began. But in the river valley of the upper stream of Nujiang, the question whether these variants actually exist needs clarification.

In the immense area of the central south and southeast regions of China, including the provinces of Guangdong, Jiangxi, Fujing, Guangxi, and a portion of Zhejiang, various wild clones are distributed[9,10,13,14]. To survey, collect, and investigate the clones in these regions would lead to a more complete understanding of this significant resource in China.

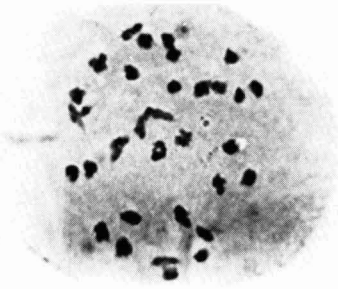

Fig. 3. Clone 75-I-10 from Yunnan Manshi. 2n=64 (x 1200)

Acknowledgement

We are pleased and obliged to make acknowledgement to Dr. R.L. Cushing, Dr. D.J Heinz, and Mrs. Grace Mee of the Experiment station of the Hawaiian Sugar Planters' Association. Drs. Cushing and Heinz kindly arranged the revision and the publication and Mrs. Mee reviewed and made editorial corrections and suggestions for the paper. Here we express our enthusiastic thanks.

Summary

Following the determination made by the annual conference of the Chinese Inter-Provincial Cooperation Session of the Sugarcane Scientific Research Works that the distribution of *Saccharum spontaneum* in the subtropical belt of China should be systematically surveyed, clones were collected from various localities in the southwest region of China by the detachments sent. Chromosome counts were made on a portion of these materials. Clones which have 2n=80 chromosomes are scattered throughout the whole of southwest China. Those possessing 2n=64 chromosomes are chiefly found along the river valleys of Nujiang and Yuanjiang. Plants with chromosome numbers lower than 2n=64, i.e. 2n=48, 54, etc., or higher than 2n=80, i.e. 2n=112, 128, etc., have very rarely been found. A more thorough and intensive survey in this region as well as other regions in the subtropical belt of China is suggested.

La distribution du nombre de chromosomes de *Saccharum spontaneum* dans la région sud-ouest de la Chine

Suite à la décision, prise à la conférence annuelle de la section de cooperation interprovinciale chinoise de la Recherche Scientifique en Canne à Sucre, de relever systématiquement la distribution de *Saccharum spontaneum* dans la zone subtropicale de la Chine, des clones furent recueillis dans diverses localités de la région sud-ouest du pays par les équipes y envoyées. On compta les chromosomes sur une partie de ces matériaux. Des clones possédant 2n = 80 chromosomes sont dispersés sur tout le sud-ouest de la Chine. Ceux possédant 2n = 64 chromosomes sont trouvés principalement lelong des vallées des rivières Nujiang et Yuanjiang. Des plantes avec un nombre de chromosomes inférieur à 2n = 64, c.à.d. 2n = 48, 54, etc., ou supérieur à 2n = 80, c.à.d. 112, 128, etc. ont été trouvés très rarement. On suggère un relevé plus approfondi et plus intensif dans cette région ainsi que dans d'autres régions dans la zone subtropicale du pays.

Verteilung der Chromosomenzahl von *Saccharum spontaneum* im Südwesten Chinas

Im Rahmen des Beschlusses der jährlichen Konferenz der "Chinese Inter-Povincial Cooperation Session" der "Sugarcane Scientific Research Works" die Verbreitung von *Saccharum spontaneum* im subtropischen Gürtrel Chinas systematisch zu untersuchen, wurden Klone an verschiedenen Orten im Südwesten Chinas von entsandten Beauftragten gesammelt. Bei einem Teil dieses Materials wurden die Chromosomen gezählt. Klone mit 2n = 80 Chromosomen kommen über den gesamten Südwesten Chinas verstreut vor. Solche mit 2n = 64 Chromosomen wurden hauptsächlich längs der Flußtäler von Nujiang und Yuanjiang gefunden. Pflanzen mit einer niedrigeren Chromosomenzahl als 2n = 64, d.h. 2n = 48, 54 usw., oder mit einer höheren Chromosomenzahl als 2n = 80, d.h. 2n = 112, 128 usw., wurden sehr selten gefunden. Eine ernsthaftere und intensivere Untersuchung in dieser Region und auch in andereren Regionen im Südwesten Chinas wird vorgeschlagen.

Distribución de cuentas de cromasomas de *Saccharum spontaneum* en la región del sud-oeste de China

Como parte de una inspección sistemática de la distribución de *Saccharum spontaneum* en la zona sub-tropical de China, se han coleccionado clonas de varias localidades en la región del sud-oeste y se han contado las cromasomas en una porción de estas materias. Clonas con 2n = 80 cromasomas se distribuyen en la entera región. Estas con 2n = 64 cromasomas ocurren principalmente a lo largo de los valles de los ríos Nujian y Yuanjiang. Plantas con cuentas de cromasomas menos de 2n = 64, es decir 2n = 48, 54, etc., o más de 2n = 80, es decir 2n = 112, 128, etc., se han encontrado muy raramente. Se sugiere un examen más minucioso y más intensivo de esta región y de otras regiones de la zona sub-tropical de China.

[13] Fujiang Survey and Collection Detachment: *Report on survey and collection in sugar cane parental resources in South China*, 1979, 1-8 (in Chinese).

[14] Central China Survey and Collection Detachment: *Report on survey work of wild cane resources*, 1979, 1-8 (in Chinese).

SUGAR CANE AGRONOMY

The effect of bagasse furnace ash on the growth of plant cane. Y. C. Pan, K. L. Eow and S. H. Ling. *Sugar J.*, 1979, **42**, (7), 14-16. – See *I.S.J.*, 1979, **81**, 109.

Nutrient indices at different growth phases in relation to the final yield of cane and its quality. K. R. Perumal. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, Ag.25-Ag.36. – Field trials with three varieties showed that maintenance of a high leaf sheath moisture and K content and high leaf N in the early growth stages contributed to a high cane and sugar yield at harvest, while reduction in all three parameters was necessary for increased sugar yield.

Effect of soil temperature and glucose content of the planting material on the germination of periodically planted sugar cane. N. Mukerji. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, Ag.37-Ag.43. – Studies with two varieties showed a highly significant positive correlation between germination and temperature and a non-significant positive correlation between germination and glucose content.

Arrowing phenomenon in Co 1148 variety of sugar cane in Mawana area. A. K. Garg, R. K. Sahgal, J. S. Pandey and S. K. Taneja. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, Ag.57-Ag.68. – Arrowing in Co 1148 cane, induced by favourable climatic conditions, was followed by a fall in juice quality with rise in temperature two months later and an increase in fibre content by comparison with non-flowering cane.

Factors affecting sugar cane quality – a review. M. L. Agarwal, S. P. Dua and A. Ali. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, Ag.69-Ag.78. A survey is presented of the literature, with 52 references, on those factors having positive and negative effects on cane quality.

The control of Johnson grass and other weeds in Louisiana sugar cane, spring 1980. Anon. *Sugar Bull.*, 1980, **58**, (11), 6, 8-10, 12-14. – Recommendations are given on pre- and post-emergence treatments (including aerial application of chemicals) for the control of Johnson grass, Raoul grass, Bermuda grass, browntop panicum and annual weeds in plant and ratoon cane.

Predicting tons of sugar cane per acre using solar radiation, temperature and percent plant cane, 1971 through 1976. R. J. Allen, G. Kidder and G. J. Gascho. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 18-22. – Radiation data expressed as average daily Langleys (standard units of solar energy equivalent to 1 gram-calorie per cm^2 surface area) for the major growth period, combined with the annual growing season temperature expressed as degree-days, can be used to derive relatively accurate equations for predicting cane yield per acre for the Florida industry; besides equations for industry-wide predictions, individual equations have been derived for four factories. Adjustment of the solar energy values improved the equations, whereas (with one exception) adjustment of the annual temperature did not. Including the area under plant cane gave some improvement, despite the relatively wide variation in this factor between years. Use of the equations to predict yields is indicated.

Influence of planting date on yield and quality of sugar cane for syrup. D. M. Broadhead. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 24-25. – Experiments conducted in 1969-75 to determine the optimum planting date for syrup production are reported. Stalk yield in four plant crops was significantly higher when planting was carried out on September 1 and October 1 than on November 1, while there was little difference between the yields from the two earlier plantings. Variety x date of planting interaction was not significant for stalk yield. Planting date did not affect stalk yield from 1st and 2nd ratoon crops. Brix was unaffected by planting date. The possibility of reducing the planting rate by early planting on September 1 is thus indicated, but further tests with different planting rates are considered necessary.

Effects of water management and row height on sugar cane yield. C. R. Camp. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 26. – In an experiment initiated in 1973 involving CP 65-357 cane grown in 0.01-acre plots containing silty clay loam soil, water management treatments included maintenance of a constant water table (1 ft below the soil surface), drainage to a depth of at least 5 ft, or allowing the water table to fluctuate naturally with rainfall in undrained soil. The cane was planted in furrows opened on the conventional ridge or on a flat surface (as used in Louisiana to increase plant population because of narrower inter-row spacing). Yield from the plant crop was significantly higher in the case of a constant water table than with drainage; plant population and cane and sugar yield for the 1st ratoon crop were significantly higher with drainage than with the other two treatments, while the yield parameters of the 2nd ratoon crop were significantly higher in the flat-planted than in the ridge-planted rows. Rainfall was above normal in the year of the 1st ratoon crop (and hence the water table high, particularly during the growing season) but below normal in the other two crops. It is pointed out that, with flat planting, setts and ratoons are at a greater depth, relative to the furrow, than with ridge planting, and damage resulting from poor internal soil drainage will probably occur more frequently in the flat system.

Effect of water management on yield and longevity of sugar cane. C. E. Carter. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 27. – Experiments conducted in the same type of plot and soil as described in the preceding abstract included the following treatments: (1) maintenance of a constant water table during the growing season; (2) as (1) but during both growing and dormant seasons; (3) irrigation, followed by sub-surface drainage; and (4) saturation of the soil profile for various periods. Varietal response to constant water tables was also determined. Cane yields from plots with constant water table heights (24, 32, 40 and 48 in below the soil surface) were 56% greater than where the water table fluctuated, while yield differences for the four water tables were not significant. When the water table was maintained 12, 30 or 48 in below the surface during the growing season only, yields were not significantly different between treatments; however, when these same levels were maintained during both growing and dormant seasons, yields were significantly lower for the high water tables (15, 26 and 33

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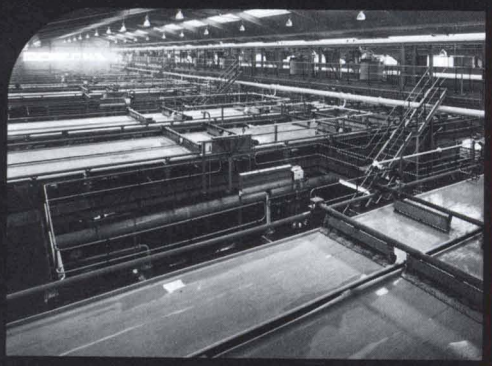

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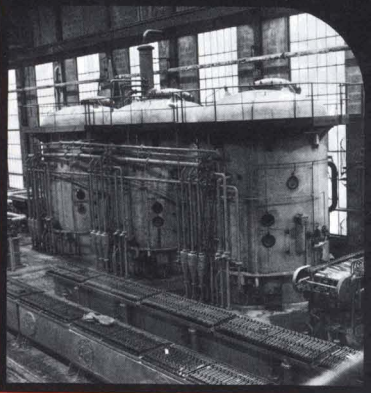

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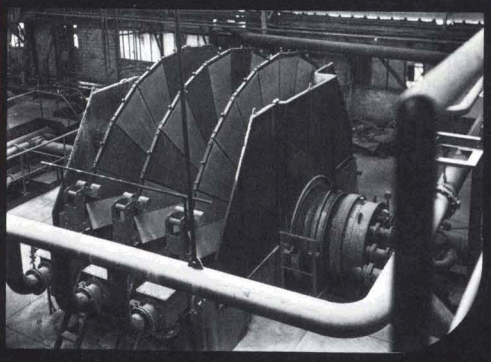

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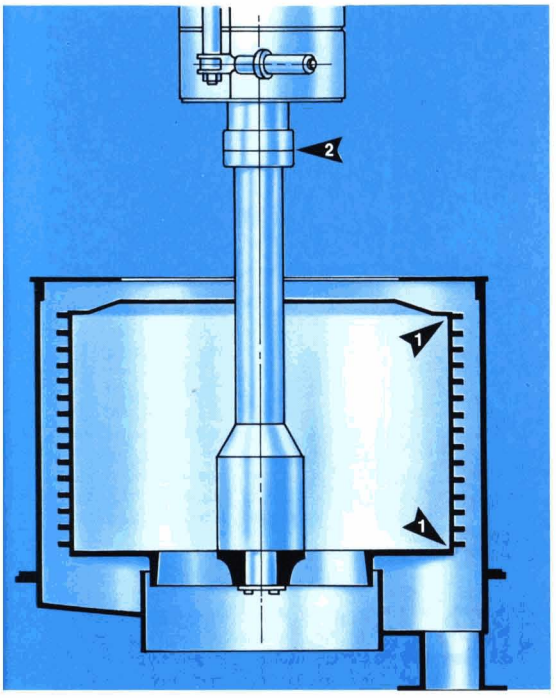

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tons.acre $^{-1}$ with 12, 30 and 48 in, respectively). Irrigation when two-thirds of the available water had become depleted gave yields that were not significantly different from those in the unirrigated plots. Saturation of the soil profile for 1, 2 or 4 weeks followed by sub-surface drainage to a depth of 5 ft for 7, 6 and 4 weeks, respectively, gave a reduction of 0.21 and 0.40 tons.acre $^{-1}$ (in 1972 and 1973) per day increase in flood duration by comparison with the yield in continuously drained, non-flooded plots. Yields of cane for three varieties with a 2-ft constant water table were similar to those with a 4-ft constant water table.

The effect of N,N-bis (phosphonomethyl) glycine on some physiological components of sugar cane yield. G. Dill and F. A. Martin. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 37-42. — The effect of the title ripener (Glyphosine) on photosynthesis, dark respiration, specific leaf weight and % dry weight was examined during the latter stages of cane crop development. It was applied at 3.36 kg.ha $^{-1}$ to L 62-96 cane on September 17, after which sampling was initiated on September 21 and continued at two-weekly intervals up to and including November 16. Treatment suppressed average photosynthetic and dark respiration rates and increased % dry weight, but did not affect average specific leaf weights.

Comparing sugar cane yield data from two geographic areas on light and heavy soils. H. P. Fanguy and C. A. Richard. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 56. Correlation coefficients were calculated from outfield results to determine the varietal response association between the two major cane-growing areas of Louisiana. Positive correlations were found between varietal yields from the two areas, whereas non-significant correlation was found for varietal yields between light and heavy soils, suggesting that general variety recommendations may be made for the two areas, but that different recommendations are required for light and heavy soils.

Comparative post-freeze deterioration of six sugar cane varieties. G. J. Gascho and J. D. Miller. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 57. — The deterioration rates of six varieties were compared during a 9-week period after severe frosts at Belle Glade, Florida, during January 18-20, samples being harvested each week. Brix, raw juice pH, acidity, stalk weight and juice per stalk were determined, and the theoretical yield of sugar per ton of cane, % juice sucrose, % purity and % extraction obtained by standard calculations. All varieties deteriorated badly over the 9-week period, with an average loss in sugar yield of 26 lb per ton of cane per week. Varietal differences were noted.

Influence of pre-harvest burn intensity on cane quality. D. G. Holder and R. P. DeStefano. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 58-60. — Comparison was made between cane burning in early morning and late afternoon, and between "hot" rapid burning in a 6-mph wind, which created high flames and intense heat, and "cool" burning against the wind, which took 4 hr to burn all the cane in a 18.5-acre block as opposed to 5 min with the hot burn. The mill juice from the cool burnt cane was of higher Brix and sugar content than that from the hot burnt cane, while cool burning yielded 5% more sugar. Cane burnt in the early morning was of higher quality than that burnt in the late afternoon, with a higher juice Brix and sugar content and yielding more sugar.

Variations of non-sucrose solids in sugar cane. I. Potassium. J. E. Irvine. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 61. — Crusher juice samples of sugar cane from replicated variety trials were analysed for K^+ by an ion-selective electrode. Despite wide variations within tests, differences in the K content were statistically significant among the seven varieties and nine locations involved. CP 61-37 cane contained least K, while L 61-67 contained the most. However, the range of differences among locations was six times greater than among varieties, possibly a result of fertilizer practices. Juice from cane tops contained nearly double the amount found in the lower stalks, but the concentration decreased in the tops as the harvest season progressed, while that in the stalks remained unchanged.

Variations of non-sucrose solids in sugar cane. II. Starch. J. E. Irvine. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 62. The crusher juice of seven varieties grown in nine replicated trial fields was analysed for starch by a colorimetric technique based on anthrone. Statistically significant differences in the starch contents were observed between varieties, N:Co 310 containing least starch and L 61-67 the most. Highly significant differences were also found between locations, the range of differences being greater among locations than among varieties — this may have been due to lodging, poor growth or the inclusion of tops in mechanically harvested cane. Cane tops contained much more starch than stalks in one test, but varietal differences in the starch content of tops were not distinct.

Production differences between plant and ratoon crops of Florida sugar cane. G. Kidder. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 67-70. — Average differences in cane yield and sugar yield between plant and ratoon crops were calculated from published research data, showing that sugar yield from 1st and 2nd ratoon cane was, respectively, 86.0% and 78.2% of that obtained from plant cane, while the corresponding cane yields were 80.6% and 73.2% of the plant cane yields. In a comparison of commercial production records, the differences between crop years calculated from experimental data were smaller than those calculated from commercial data. Estimates were made of sugar production from plant, 1st, 2nd and subsequent ratoon crops in Florida during 1968-75.

Controlling *Equisetum prealtum* Raf. in field drainage ditches of southern Louisiana. R. W. Millhollon. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 116. — The title perennial weed (horsetail) grows in damp soil and reproduces from both spores and rhizomes. In recent years, it has become a problem in drainage laterals, where it impedes water flow. In trials on its control, herbicides were divided into two groups: those that kill weeds when applied to the foliage at relatively low rates, and those that sterilize the soil when applied at high rates. Asulam, applied at 4 lb.acre $^{-1}$, Glyphosate, at 6 lb.acre $^{-1}$, Amitrole, at 4 lb.acre $^{-1}$ and Picloram, at 1 lb.acre $^{-1}$, were not effective as foliage treatments; Bromacil, Tebuthiuron, sodium chlorate and DPX 3674 [3-cyclohexyl-6-(dimethyl-amino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione] were more effective as soil sterilants, excellent control being given by the first two at 15-30 lb.acre $^{-1}$, and by DPX 3674 at 10-20 lb.acre $^{-1}$, while sodium chlorate at 600 lb.acre $^{-1}$ gave only about 50% control.

SUGAR CANE MECHANIZATION

Design parameters for sugar cane equipment for use in developing countries. J. A. Giardina, D. J. Corbett and M. L. Hinds. *Sugar y Azúcar,* 1980, **75,** (3), 21-22, 24. Problems that have to be faced in the design and operation of cane machinery in developing countries are discussed, including the limitations imposed by harvesting of green cane. Lack of personnel training, long hours of operation of the equipment under rigorous conditions of climate and soil, and inadequacy of maintenance facilities are factors that require consideration. Automatic control should be incorporated wherever practical and operation made as simple as possible.

The first 90 years. The development of mechanical cane harvesting in Australia. C. Morton. *Australian Canegrower,* 1979, **1,** (5), 46-51; (6), 25-31; (7), 33-39; (8), 21-25; (9), 43-46; (10), 47-50; 1980, **2,** (1), 26-30. — With the aid of numerous photographs, the author traces the history of cane harvester development in Australia from the earliest attempts to develop a machine in 1889 to trials in 1979 with a Cannavan harvester manufactured by Hodge Industries, of Mackay, Queensland.

A progress report on mechanically planted sugar cane in Florida. B. R. Eiland and J. E. Clayton. *Proc. Amer. Soc. Sugar Cane Tech.,* 1977, 47-51. — Yields from three field experiments, planted over a 2-year period, were determined for different planting methods: (1) conventional whole-stalk planting, (2) manual planting of mechanically harvested seed material, and (3) mechanical planting of mechanically harvested seed cane. Planting rates for the mechanically planted cane were higher than with the other methods provided there was adequate cane. In one experiment, yields of mechanically planted cane were similar to those obtained from whole-stalk planted cane when planter skips were filled by hand using excess seed cane in the furrow. Application of this technique with mechanical planting is advocated until the performances of mechanical planters are sufficiently high. Optimum material for planting is described.

Varietal differences in sugar losses with two harvesting systems. B. R. Eiland, J. D. Miller and G. J. Gascho. *Proc. Amer. Soc. Sugar Cane Tech.,* 1977, 52-55. — Sugar losses in four varieties were measured 1, 2 and 5 days after harvesting by two methods: (1) whole-stalk, hand cutting, and (2) mechanical chopper harvesting. Sugar losses were not appreciable in the whole-stalk samples up to 5 days after harvesting. Loss rates in the mechanically harvested samples ranged from 3.2% per day for CP 68-1067 to 6.0% for CP 65-357 cane. Sugar content, purity, sugar per ton and pH all fell in the mechanically harvested cane with increase in the time after harvesting, the changes being much greater than with the whole-stalk samples.

Effects of harvesting systems on field yield and quality of sugar cane in Louisiana. B. L. Legendre. *Proc. Amer. Soc. Sugar Cane Tech.,* 1977, 86. — Comparison was made between the whole-stalk and chopper-type harvester as regards field losses and trash content of sugar cane. While the chopper-harvesters reduced apparent field losses by 44% compared with the whole-stalk harvesters, they increased the cane trash content by 27%. Field soil accounted for 20% of the trash in the chopped cane but only 12% in the whole-stalk cane. In three out of five tests, the sugar content and purity were respectively 10% and 3% lower in the chopped cane than in the whole-stalk cane.

Influence of farm mechanization on soil physical properties and sugar cane growth. S. J. Yang. *Taiwan Sugar,* 1980, **27,** 9-16. — Reference is made to investigations on soil compaction conducted over a number of years in Taiwan. It has been found that natural compaction is more severe than that caused by up to four cultivations in the early growth period. Most of the cane soils in Taiwan are alluvial, with a high silt content and a very low organic matter content, so that, after irrigation or heavy rain, a thin but compacted silt skin generally forms at the surface, causing a reduction in permeability and gas exchange between soil and atmosphere. Cane harvesters may cause substantial compaction, particularly under wet conditions, such compaction reaching to a depth of 30-40 cm. Compaction restricts germination, nutrient and water uptake and root growth, and recommendations are given on means of reducing it so as to maximize cane yield.

Further farming mechanization for cane field operations in Taiwan. C. Y. Feng. *Taiwan Sugar,* 1980, **27,** 18-21. Problems to be overcome in cane mechanization include autumn planting of cane, for which conventional planters are unsuitable because of the wet conditions; earthing-in, with the possible consequence of increase in the numbers of rats collecting in hollows formed in the cane harvesting ridges; soil compaction; and harvesting on hillsides, in fields reclaimed from river beds and hence containing much gravel, and in small plots. Solutions to these problems that are being studied are discussed, and mention is made of a transloader and continuous loader designed by Taiwan Sugar Corporation staff.

First new sugar cane harvester of the 1980's. R. J. Leffingwell. *Sugar y Azúcar,* 1980, **75,** (6), 80-81. — An illustrated description is given of the Stubenberg S-75 mat-type cane harvester designed for cutting green cane, chopping it into billets and loading into self-unloading infield cane "buggies" which have an inbuilt conveyor system for discharge to road trucks. The new system provides cane with a lower trash content than the whole-stalk cane of earlier harvesters (12-15% *vs.* 38%) and the billet cane allows a higher truck payload. The S-75 machine has a peak capacity of 90 tch but the average rate during operation is 45 tch.

Loads on the rails from cane bin wheels. C. R. Murry, R. D. Peirce and R. A. James. *Proc. Australian Soc. Sugar Cane Tech.,* 1980, 101-106. — Load cells were installed along the rail track used for cane transport to Victoria mill in order to measure the vertical, lateral and longitudinal components of the wheel-rail load. Measurements were made on level tangent track, level curved track of 420 m radius, descending curved track of 250 m radius and 0.77% gradient, and descending tangent track of the same gradient. No lateral forces or derailment ratios likely to cause derailments were recorded on level track, curved or tangent. The loads are greatly influenced by the detailed geometry, and more severe conditions may be revealed by the measurements on the descending sections which have yet to be analysed.

CANE PESTS AND DISEASES

Microplots for screening sugar cane varieties for tolerance to ratoon stunting disease. S. Matsuoka. *Paper presented to the 17th Congr. ISSCT,* 1980, 10 pp. — Tolerance of cane varieties to ratoon stunting disease (RSD) was evaluated in field plots comprising four plants 50 cm apart and at 1.5 m inter-row distance. Two trials were carried out in a split-plot design, using progeny of RSD-inoculated cane as the diseased plants. Three check varieties were included in both trials. The weight of stalks in the microplots were recorded for plant cane and first ratoons. The three check varieties were also tested, together with a fourth, in a comparative trial planted according to the current commercial system in normal-size plots; the results of this trial and the microplot trials showed close agreement. This indicates the validity of the microplot system for screening varieties for RSD tolerance. The method could be valuable for screening a large number of varieties with a minimum of labour, land and operating costs.

Feasibility of fungicidal control of yellow spot. C. Ricaud, J. C. Autrey and S. Sullivan. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. — Effectiveness of Benomyl sprays (270 g a.i. per ha) for controlling yellow spot disease in the profusely flowering susceptible variety S 17 was evaluated under severe epiphytotic conditions. Sprays applied with mist blowers at intervals of 1, 3 and 4 weeks were compared. There were no differences between treatments at 3- and 4-week intervals. Although they did not control infection as well as weekly sprays, they were nearly as effective in giving a substantial increase in sucrose content. Spraying also improved juice purity but had no effect on cane yield at harvest early in the season. There was a greater response to fungicide control in flowered than in vegetative canes at harvest time. In an industrial trial, four fungicide sprays with mist blowers at intervals of five weeks gave 57% control of infection and an increase in sugar yield of 1-2 tonnes.ha $^{-1}$. Disease control was also effective when Benomyl was applied above the leaf canopy with ultra low volume sprayers. Therefore, fungicidal control of yellow spot in sugar cane could be feasible and economical and can be a useful temporary measure to reduce losses in case of change of resistance in varieties, pending their replacement.

Commercial control of leaf scald disease by thermotherapy and a clean seed program. B. T. Egan and O. W. Sturgess. *Paper presented to the 17th Congr. ISSCT,* 1980, 5 pp. Leaf scald disease has been found on many farms in the Burdekin district of Australia since 1976 but thermotherapy and a clean seed program have been adopted on a commercial scale, for the first time in the world, and incidence should be reduced to very low levels by 1982. The methods employed for producing healthy cane include soaking seed cane at ambient temperature for 48 hours followed by hot water at 50°C for three hours; progeny is used to plant out secondary increase plots and the stubble ploughed out, while planting material sold to growers is obtained from the secondary increase plots.

Considerations of sugar cane rust disease (*Puccinia melanocephala* H. & P. Sydow) appearance in the Dominican Republic. F. A. Bernard. *Paper presented to the 17th Congr. ISSCT,* 1980, 5 pp. — Rust, observed for the first time in the Dominican Republic in July 1978, was originally attributed to *P. kuehnii* but the causal organism has subsequently been identified as *P. melanocephala.* Speculations are made on the origin of the disease and progress towards identifying suitable resistant varieties to replace the highly susceptible B 4362 cane is discussed.

Soybean (Glycine Max Merr.) and green gram (*Vigna radiatus* Wilczek) as local hosts for sugar cane mosaic virus. S. H. Farrag, T. K. Kandasamy and P. Narayanasamy. *Paper presented to the 17th Congr. ISSCT,* 1980, 5 pp. — A number of plants were tested and the two of the title identified as susceptible to cane mosaic virus so that they may be used as assay plants.

Uptake and translocation of certain systemic fungicides by the sugar cane plant and their control of rind disease. I. M. Mansour. *Paper presented to the 17th Congr. ISSCT,* 1980, 9 pp. — Growth of *Pleocyta sacchari,* the causal agent of rind disease, was completely inhibited *in vitro* by 10 ppm Fundazol, 10 ppm Bayleton and 50 ppm KWG 0519 15 DS 151 A. Juice extracted from different organs of cane plants grown in Fundazol-treated nutrient solution and/or soil was fungitoxic, the highest toxicity being detected in juice from roots grown from seed cuttings and lowest in the juice of seed pieces. Bayleton and the KWG fungicide were highly phytotoxic and inhibited or suppressed root formation and development, resulting in marked suppression of intake. In pot experiments, the three fungicides at 500 ppm on dry soil weight, added at planting time, completely controlled rind disease on seed pieces. Fundazol stimulated root production and germination. Fungicidal effects were persistent, remaining high after 120 days from treatment of the soil; the maximum toxicity was shown by Fundazol, followed by Bayleton and KWG.

Evaluating sugar cane smut resistance. S. A. Ferreira, J. C. Comstock and K. K. Wu. *Paper presented to the 17th Congr. ISSCT,* 1980, 14 pp. — A review of procedures for inoculation and varietal resistance evaluation in different countries suggests that different smut races may exist generally and that inheritance of resistance to one may be different to inheritance of resistance to another. Recommendations are made for standardizing certain smut testing procedures and for reporting varietal smut reactions which would help answer the question of the extent to which smut races exist and may provide data on smut race dynamics.

Foliar applications of Oxamyl to ratoon sugar cane for nematode control. F. E. Richardson and E. J. Watt. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — The harvest results of seven field trials using foliar spray applications of the systemic nematicide Oxamyl to ratoon cane are presented. Single and repeated split sprays were applied by knapsack sprayer to give an applied dose of 3.0 kg a.i. per hectare to ratoon regrowth 6-8 weeks after harvest. Good responses averaging an additional 2.5 tonnes of sugar per hectare were obtained and these were equal to responses from conventional soil applications of Aldicarb granules. The many advantages of using a foliar-applied nematicide on steep erodible hill slopes, and where trash and leaf residues are retained as a mulch, are discussed.

Reaction of *Miscanthus* germplasm to downy mildew and culmiculous smut of sugar cane. C. C. Lo, W. H. Chen, I. S. Shen and S. C. Shih. *Paper presented to the 17th Congr. ISSCT,* 1980, 2 pp. — An island-wide collection of sugar cane germplasm made in Taiwan included 129 clones of *Miscanthus* spp., 26 of which have been used in breeding experiments. The clones have been tested for reaction to downy mildew and smut; none were susceptible to smut and 111 were not infected by downy mildew, the remaining 18 only suffering a low percentage of infection.

Wallaby ear disease in sugar cane in Queensland. C. C. Ryan, L. Arkadieff and N. E. Grylls. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — A disease which caused gall formation on the abaxial surface of sugar cane leaves and, in some cases, severe stunting of stools was located in several cane-growing districts of Australia in 1976. Similar symptoms were also observed in several grasses growing near affected cane fields. Investigations showed that *Cicadulina bimaculata,* after feeding on diseased sugar cane, could produce symptoms in maize assay plants which were similar to those caused by the maize wallaby ear virus (MWEV). Spherical particles, similar in size to those of MWEV (about 45 nm), were seen in extracts from infected maize assay plants but not in extracts from infected cane. This is the first record of wallaby ear disease occurring naturally in sugar cane in the field. The structure of galls on cane caused by MWEV and Fiji disease were compared. Galls on sugar cane affected with MWEV were apparently formed mainly by proliferation of parenchyma cells.

The biology of *Tumidiclava* sp. (Hymenoptera: Trichogrammatidae), a parasitoid of the sugar cane giant borer *Phragmatoecia gumata* Swinhoe. Y. C. Pan and G. T. Lim. *Paper presented to the 17th Congr. ISSCT,* 1980, 4 pp. — Information on this parasitic wasp is described. Its life cycle, from egg to adult emergence, averaged 13.6 ±2.9 days. The mean longevity for starved and fed females was 3.4 ±0.5 and 3.5 ±0.9 days, respectively, and for males 3.4 ±0.8 and 3.6 ±0.5 days, respectively. The mean fecundity of starved females with single and multiple copulation was 114.7 ±51.7 and 106.8 ±53.1 eggs, and for fed females it was 124.9 ±41.3 and 119.8 ±31.8 eggs, respectively. The sex ratio was 1:2.69 male:female and host:parasitoid ratio was 1:4.29. The mean percentages of parasitism and emergence were 66.4 and 88.1. The parasitoid seems to be monophagous.

Biology of *Phragmataecia castanae* Hubner, the giant borer of Sumatra, Indonesia. B. Wirioatmodjo. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — *P. castaneae* is the principal stem borer attacking cane and is widespread through the Eastern Hemisphere. It has been studied in the laboratory and an account is given of its biology. The mean life cycle was 107 days from egg to adult and an average of 330 eggs were laid per female.

Control of ant damage to polyethylene tubes used in drip irrigation systems in Hawaiian sugar cane fields. V. C. S. Chang and A. K. Ota. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — Three methods may be used to counter ant damage to drip irrigation tubing: reduction of ant population by injection of an insecticide into the system; use of ant-resistant tubing; and varying of agronomic practices. Mirex-containing bait gave effective and economical control but its use is no longer permitted. Injection of Heptachlor into the system at 75 g per 1000 m of tube gave effective protection for at least 12 weeks. Tubes made of polypropylene or polybutylene were less damaged than the lower density polyethylene. Thick-walled tubes (>0.25 mm) often have fewer holes made in them by ants, while tubes with slit orifices were attacked less frequently than those with round holes. Incorporating toxic chemicals into tube material could eliminate ant damage for more than three months. A short, frequent watering schedule is preferable to one with long watering periods and long intervals, since ants cannot attack the tubing when the system is operating.

Entomofauna of sugar cane in Malaysia. G. T. Lim and Y. C. Pan. *Paper presented to the 17th Congr. ISSCT,* 1980, 22 pp. — A total of 360 insect pests and 120 species of natural enemies are recorded, based on collections in plantations of several states in Malaysia. Of the insects, 32 are considered important pests of sugar cane. The economic importance of the various groups and control measures are briefly discussed.

Fauna of white grubs in sugar cane fields of Okinawa and their relative importance as pests of sugar cane. M. Nagamine. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — Surveys of white grubs showed there to be 17 species, all but three attacking cane. *Anomala albopilosa* is the most important in respect of numbers and plant damage. *Melolontha masafumii* and *Tricholontha papagena* are also important although their occurrence is localized at present.

Integrated control of sugar cane borers in the north-west peninsula of Malaysia and Lampung, Sumatra, Indonesia. S. W. Tan and H. L. Koh. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — Borer populations and cane damage have been reduced to acceptable limits in north-west Malaysia and in Lampung, principally by the introduction of egg parasites and by trapping and releasing local natural parasites in heavily infested areas. Other cultural practices which avoid the need to use insecticides include burning before harvest, clearing trash from harvested fields, planting clean cane and roguing infested cane.

Natural control of *Diatraea saccharalis* (Fabr. 1794) eggs in sugar cane fields of São Paulo. F. O. Terán. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. Observation of the fate of freshly laid eggs of *D. saccharalis* showed an average of 76.16% natural control, with differences between locations and years. Predators appeared as the major component of this natural control (63.64%) with parasites accounting for only 3.90% and the remainder being attributed to other causes, including adverse climate, mechanical damage, disease, etc. The rate of parasitism may have been higher in fact, since predators destroyed both healthy and parasitized eggs.

Losses from *Mahanarva posticata* in sugar cane. E. J. Marques, A. M. Vilas-Boas and O. Nakano. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. Losses caused by the leaf froghopper were measured under controlled conditions in Pernambuco, Brazil, with plots exposed to natural infestation and others treated with insecticide. In the first test, cane yield was reduced by 11.2% and sugar yield by 14.9%; the population per stalk was 6.43 of the 3rd and 4th instars, 3.75 of the 5th instar and 0.81 of adults. In the second test, the respective decreases in cane and sugar yields were 13.9 and 16.9%, with an average leaf froghopper population of 2.87 nymphs and 0.68 adults per stalk.

Control of sugar cane scale insects with foliar spray of insecticide in Gujarat. A. H. Shah, M. S. Purohit, K. R. Patel and N. V. Vaghela. *Paper presented to the 17th Congr. ISSCT,* 1980, 4 pp. — Trials with four chemicals over three years showed that Phosphamidon, at 3 kg a.i. per hectare, was the most effective and economical for control of the scale insect, *Melanaspis glomerata* Green.

Correlation between the intensity of infestation and population index of the sugar cane borer *Diatraea saccharalis* **(Fabr., 1794).** A. C. Mendes, P. S. M. Botelho, N. Macedo and N. A. Lavorenti. *Paper presented to the 17th Congr. ISSCT,* 1980, 16 pp. — Linear regression and simple correlation studies were used to develop a method for estimating the population index or relative populations of larvae and pupae of *D. saccharalis* from the intensity of infestation. The latter was measured by observations in nine mill areas totalling almost 180,000 ha and a high positive correlation found between it and Population Index. Equations were developed each year from 1976 to 1978 and another to cover observations from the total period. In order to reduce the error involved more studies will be necessary to include a greater number of environmental variations.

The ecology of white grub of sugar cane, *Cochliotis melolonthoides* **Gerst. (Coleoptera: Melolonthoides) with notes on light trap captures of the adult beetles.** J. N. Waiyaki. *Paper presented to the 17th Congr. ISSCT,* 1980, 5 pp. — Although previously regarded as a minor pest in northern Tanzania, *C. melolonthoides* has caused heavy losses in the past several years and a study has been made of its biology. Light trap catches have shown that it swarms twice each year, during the long and short rainy periods March-May and September-December. It has three larval instars, the last causing the most damage. Storks were found to be good predators but the only grub parasite observed was the fungus *Cordyceps* sp. The March-April larval population suffered heavy mortality during the cold, wet periods of March-July.

Aspects of the population dynamics of *Apanteles flavipes* **(Cameron) and support capacity of its host** *Diatraea saccharalis* **(Fabr.).** P. S. M. Botelho, N. Macedo, A. C. Mendes and S. S. Neto. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. — A study under field conditions showed that the average dispersion capacity of *A. flavipes* was 34.38 metres and the area of discovery, according to the Nicholson model, was 0.031 m^2. The population of searching parasites in the following generation, resulting from the release of some 24,600 females, was 1838 cocoons in an area of 1.13 ha. The average mortality of *A. flavipes* adults directly increased in relation to the instar of the *D. saccharalis* host, and this borer presented a support capacity to the parasite from the 3rd instar on, being superior in the 5th and 6th instars.

Potential bio-control agent against sugar cane stem borers found in Negros Island, Philippines. M. C. Alba and B. R. Estioko. *Paper presented to the 17th Congr. ISSCT,* 1980, 9 pp. — Four egg parasites have been identified on the island of Negros, two of the genus *Trichogramma* (*T. australicum* Cirault and *T. chilotraeae*) and two of the genus *Trichogrammatoidea* (one of which is *T. nanum* Zehnt). The last is specific on eggs of the borer *Tetramoera schistaceana* in both field and laboratory but the other three may be reared on eggs of *Coreyra cephalonica* Stainton. In the field, the most efficient control of *Chilotraea infuscatellus* (76.5% parasitism) was obtained with *T. chilotraeae,* while the best control of *Tetramoera schistaceana* (91% parasitism) was obtained with *T. nanum.*

Preliminary analysis of spatial distribution patterns of sugar cane bud injuries due to white grubs and wire worms. N. Hokyo. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — Linear regression was applied to analysis of the spatial distribution of damage by the title pests to the underground parts of cane stools. In both cases damage was slightly different from random, as was the distribution of white grubs in the soil, while that of wire worms indicated an overdispersion of individuals. Implications for successful ratooning are discussed.

Report on damage to sugar cane by the dynastid beetle, *Heteronychus licas* **(Klug).** K. E. Cackett. *Paper presented to the 17th Congr. ISSCT,* 1980, 13 pp. — The population of *H. licas,* previously considered a minor pest in Rhodesia, rose markedly following above-average rainfall in 1974-78 and led to extensive cane damage. The life cycle of the insect has been studied to provide a basis for control. Adults feed underground on shoots and stalks of all ages during the wet summer months, reducing the stand and killing stools. Control with Dieldrin has been suggested pending the results of long-term trials with various suitable insecticides.

Estimation of recoverable sugar losses caused by the sugar cane borer *Diatraea saccharalis* **(Fabr.) and pathogens in cultivar H32-8560.** G. Ayquipa A., E. Angulo A., S. Risco B. and J. Sirlopu R. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. — Recoverable sugar losses caused by the title borer at Casa Grande cooperative in Peru were measured during 1972-77 by analysis of damaged and undamaged cane samples. The estimated average loss was 0.025 kg per tonne of cane per 1% of bored internodes. As the number of harvests increased, i.e. with later ratoons, the incidence of bored internodes decreased.

The assessment of economic damage caused by *Aeneolamia varia saccharina* **(Dist.) (froghopper) on sugar cane in Trinidad.** W. G. des Vignes. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. — Experiments carried out in 1976/79 to assess the economic importance of the froghopper were unsuccessful, but observations at one estate showed that the blight produced by the adult pest resulted in reduced Brix, pol and purity of cane juice and reduced cane weight and fibre content. There was difficulty in quantifying blight, however, and it is suggested that the froghopper-days criterion may be more suitable for damage or loss assessment.

The effects of nematicides and rainfall on the population densities of soil-borne nematodes in Fiji. T. Narain and M. Krishnamurthi. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. — Nematode population densities were reduced and cane yield improved by the application of nematicides, Temik proving superior to Furadan. Under natural conditions, the population density increases with dry weather and decreases with rainfall; in Fiji, cane is grown under rain-fed conditions so that drier conditions adversely affect the crop.

Population approach to selection of varieties for sugar cane beetle borer resistance. S. C. Prasad, J. Subarmaniam and A. S. Masilaca. *Paper presented to the 17th Congr. ISSCT,* 1980, 4 pp. — Selection over a period of four years has resulted in the identification of 16 *Saccharum officinarum* varieties (out of an original 356) which are resistant to the beetle borer *Rhabdoscelus obscurus* Boised. The resistant varieties may be used as a source of germplasm for breeding purposes.

CANE BREEDING AND VARIETIES

Clonal selection across environments in sugar cane. J. A. Mariotti. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — In Argentina selection work has been conducted only at one location (Famailla) and studies have been made on repeatability and correlation of results obtained with 80 clones at this and three other locations. The results showed that cane yield repeatabilities within sites were strongly affected by seasonal and residual clonal effects, while apparent selection efficiency within certain sites may be influenced by environmental components. Nevertheless, Famailla showed advantages for the selection of both cane and yield quality, although the high degree of genotype x environment reaction justifies increasing the number of sites for simultaneous clonal selection.

The interactions of genotypes with planting dates and harvest cycles in sugar cane. R. Espinosa and G. Galvez. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. Fourteen cane varieties were grown in two harvest cycles (12-14 months and 16-17 months) using two planting dates, and harvesting a plant crop and two ratoons. Factorial analysis of the results showed significant differences among varieties for cane yield, pol % cane, sugar yield and the cane:pol ratio. From the interactions analysed, those of planting date x harvest cycle proved to be highly significant for all four characters, the most effective combination being that of October planting and a 16-17 months harvest cycle. Juice quality and the cane:pol ratio were the characters with the highest degree of genetic determination.

Suitability of augmented design in sugar cane breeding trials. S. Shunmughasundaram, M. B. G. R. Batcha, K. V. Bhagyalakshmi and S. S. Narayanan. *Paper presented to the 17th Congr. ISSCT,* 1980, 13 pp. — The efficiencies for selection of the augmented randomized block design and the lattice design were compared by selection from two sets of genotypes in two locations over two years. The top 10% selected on the basis of statistical analysis were almost the same in both cases and, while it is not equal to the lattice design, the augmented R.B.D. is economical and very useful, especially when breeders need to evaluate a large number of genotypes as precisely as possible.

Fertility, seed storage and seed viability in sugar cane. P. S. Rao. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. — Analysis of seed from four open pollinated hermaphrodite clones and two biparental crosses showed an average of 2013 florets per gram of fuzz and seed set between 3.1 and 22.7%. Seed stored at 28°C and 90% R.H. lost 90% of viability within 80 days although when stored with silica gel in polyethylene bags, the seed retained most of its viability. This was also the case when storage was in a refrigerator at 10°C and 65% R.H., while with silica gel (changed twice during the storage period) in a refrigerator at 10°C or in a freezer at −10°C viability was little reduced even by storage for two years.

Copersucar breeding program. J. Y. J. Miocque. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — An account is given of the Copersucar breeding program which started in 1968 with the establishment of the Camamu Experiment Station in Bahia state where conditions are favourable to cane flowering and seed production. The seed is germinated and selection carried out at other stations in São Paulo state and the first SP varieties, resistant to smut and mosaic, were released in 1978.

Genetic divergence in sugar cane. H. N. Singh and S. B. Singh. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. — A total of 48 cane varieties from different geographical sources were grouped in eight clusters according to their genetic similarity and their divergence studied using Mahalanobis's statistical distance. Varieties belonging to clusters having maximum genetic distance are promising for hybridization to improve yield and quality.

Sugar cane protoplast. M. Krishnamurthi. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — Protoplast culture offers new possibilities to produce hybrid material asexually and also will enable plant breeders and geneticists to modify plant characteristics through gene modifications. Culture of the protoplast is a difficult process, however, and the reasons behind the difficulties encountered have been studied with the help of scanning electron microscopy.

Improved growth of sugar cane seedlings in soil mixtures containing coconut fibre waste. A. F. Donelan. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. Greenhouse experiments showed that better growth of cane seedlings was obtained when coconut fibre waste was added to the soil mixture used in the flats. The improvement is attributed to better physical properties, drainage and aeration.

Emasculation of sugar cane flowers: steam method. N. S. Divinagracia. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — Sugar cane flowers were emasculated by steam using three temperatures (40°, 45° and 50°C), two durations (5 and 10 min) and two methods (self and cross). Steam treatment at 50°C for 10 minutes was effective in emasculating the flowers without interfering with stigma receptivity and seed setting. Arrows that were cross-pollinated after the treatment gave germination comparable to that of the unemasculated cross as control. The seedlings produced were significantly taller than the control and all self-pollinated seedlings. All cross-pollinated arrows gave significantly better seed germination and taller seedlings than self-pollinated arrows receiving the same treatment.

Relationship between flowering and some characters in different sugar cane varieties. A. H. Nour, M. A. El-Mahaly, R. A. Eskandar and S. G. Ibrahim. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. Relationships were studied between flowering and some morphological and physiological characters of cane but there were no significant differences between those varieties which flowered and those which did not. When grouped according to the stage of flowering reached by different varieties two significant correlations were observed but only in the varieties which flowered, viz. between cane weight and length and between cane diameter and number of internodes. There were some negative correlations among the varieties which did not flower.

***Effect of various auxins and gibberellic acid on sugar* cane callus formation and their subsequent influence on differentiation and on chromosome number of sugar cane plantlets** *in vitro*. C. Linga Morales and R. C. Barba. *Paper presented to the 17th Congr. ISSCT,* 1980, 10 pp. — All four auxins (gibberellic acid, naphthalene acetic acid, IAA and 2,4-D) were found to promote callus formation at certain concentrations, 2,4-D being the most potent, The highest number of plantlets generated from the callus tissue occurred with 5 $mg.l^{-1}$ of 2,4-D, a smaller number with 1 $mg.l^{-1}$ and a further reduction with 20 $mg.l^{-1}$. A similar pattern was found with naphthalene acetic acid. The occurrence of albino variants with 2,4-D depended on the amount, while the higher concentrations of 2,4-D and NAA caused variation in the chromosome number of the plants produced.

Design and statistical analysis of experiments on the selection of optimum culture medium in the sugar cane tissue culture technique. T. M. Wang. *Paper presented to the 17th Congr. ISSCT,* 1980, 21 pp. — A description is given of the confounding techniques employed in experimental design in order to assess the importance of combinations of eight components in the tissue culture medium for use with sugar cane callus.

Leaf removal as a means of delaying flowering in sugar cane breeding. T. L. Chu and J. L. Serapion. *Paper presented to the 17th Congr. ISSCT,* 1980, 9 pp. — It was found in trials on the effectiveness of leaf removal for delaying flowering that the most critical factors were the date and pattern of floral initiation in the variety concerned. Optimum results were produced by the absence of expanding and younger leaves for a period of ten days, beginning the 7th-10th day after floral initiation had taken place. Specific stages during tassel development responding to leaf removal effects on flowering delay, and the potential usefulness of the leaf trimming technique in a cane breeding program are discussed.

Further studies on leaf flavonoids as chemotaxonomic markers in evolutionary studies on *Saccharum officinarum* L. J. Daniels, N. H. Paton, P. Smith and C. A. Williams. *Paper presented to the 17th Congr. ISSCT,* 1980, 21 pp. — Further data have been collected on the leaf flavonoids of *Saccharum* and allied genera and are used as a basis for suggesting the area and nature of the evolution of *S. officinarum*.

The effect of various planting dates on flowering of sugar cane varieties. M. A. El-Manhaly, A. H. Nour, N. M. El-Talkhawy and Y. M. Tawfik. *Paper presented to the 17th Congr. ISSCT,* 1980, 5 pp. — Tests were carried out on fourteen cane varieties in Egypt and it was found that their date of flowering could be altered by changing the planting date, so affording the possibility of crossing between varieties which could not otherwise be achieved.

Triploidy in *Saccharum officinarum*. T. V. Sreenivasan and K. G. Somarajan. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. — One triploid plant with $2n = 120$ chromosomes was isolated from a S_1 population of *S. officinarum* clone 28 NG 264 ($2n = 80$). The morphology and cytology of the triploid was studied. It was more robust than the diploid and at meiosis showed a preponderance of bivalents and univalents, while trivalents were rare, The plant was fertile on the male and female side and, on selfing, produced 35 seedlings which showed wide variation in morphology. The cytology of four of these seedlings was studied.

Evaluation of sugar cane clones and its relationships with their parents for resistance to stem borer. C. R. Bastos and C. V. Pommer. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — A study was made of 30 clones grown in Brazil and the degree of infestation by *Diatraea saccharalis* correlated with the parentage of each. It was found that crosses with Co 419 and IAC 52-179 in their parentage showed the highest resistance to the borer while those with CB 40-69 in the parentage were the most susceptible. Crosses derived from CB 40-35 presented a wide range of susceptibility and resistance to *D. saccharalis*. The results are considered useful in the screening of material to be used in breeding for borer resistance.

Association between some characters of sugar cane (*Saccharum* spp.) growing in four localities in the north-east of Brazil. C. E. L. S. Pires and E. F. S. da Costa. *Paper presented to the 17th Congr. ISSCT,* 1980, 5pp. Correlations were measured between cane yield, stalk diameter, stalk length, pol % cane and fibre % cane for six varieties of cane grown in four areas in the north-east of Brazil. The correlation coefficients were different for each area, however, and are considered to indicate a genotype-environment interaction.

Relationship of pollen and pistil characteristics to setting of true seeds in sugar cane crosses. S. Nagatomi and P. H. Dunckelman. *Paper presented to the 17th Congr. ISSCT,* 1980, 19 pp. — A study was conducted at Houma, Louisiana, to investigate the association between setting of true seed and the characteristics of floral organs in sugar cane crosses. A positive correlation was found between breeding generations, size and variability of pollen grains. The more highly nobilized the generation, the larger and more variable were the pollen grains. Seed sets increased exponentially with pollen maturity of male parents and was closely associated with anther dehiscence and shedding of pollen. Tubes of pollen grains germinated in artificial media were shorter than those germinated naturally and were shorter than the pistils so that they were unable to accomplish fertilization. Better seed sets can be expected in interspecific crosses when mature pollen grains of male parents exceed 60% and the stigmas of female parents are fully expanded outside the glumes. Seed sets in intergeneric crosses were apparently governed by sexual incompatibility of the parents rather than by characteristics of the floral organs. Certain possibilities of attaining intergeneric crosses more easily are discussed.

Thailand's *S. spontaneum* **hybrid progeny as a new germplasm source in Hawaii.** D. J. Heinz. *Paper presented to the 17th Congr. ISSCT,* 1981, 10 pp. — A collection of late-flowering clones of *Saccharum spontaneum* from Thailand was made in 1955 and have been subsequently used for irradiation and crossing experiments which are described. Chromosome counts, yield data and disease resistance ratings have been measured for the progeny and it is concluded that the Thailand clones have the potential of producing high-yielding progeny under Hawaiian conditions when hybridized with *S. officinarum* or commercial varieties.

SUGAR BEET AGRONOMY

A new problem weed: annual mercury *(Mercurialis annua).* — Garburg, R. Geutnagel and G. Niehörster. *Die Zuckerrübe,* 1980, **29,** (2), 44-46 *(German).* Herbicide trials to control annual mercury are reported. No lasting success was achieved in pre-emergence treatment, only Tramat applied to the soil having any effect, but this was short-lived. The best of the post-emergence treatments (giving some 80% destruction of the weed) was Betanal, applied at 4 $l.ha^{-1}$ at the cotyledonous stage, followed by Betanal + Tramat (5 $l.ha^{-1}$ + 5 $kg.ha^{-1}$) applied when the first pair of foliage leaves had formed.

Mode of action and possible means of application of Goltix. G. Becker. *Die Zuckerrübe,* 1980, **29,** (2), 48, 50 *(German).* — The advantages of Goltix systemic herbicide and when and how to apply it in the beet crop are discussed.

Sugar beet weed control. W. Bray. *British Sugar Beet Rev.,* 1980, **48,** (1), 26-28. — Information is given on herbicides available in the UK for application in beet fields. The major weeds and weed types controlled are indicated, and recommendations are given on time of application.

The case for growing beet in a bed system. K. Jaggard. *British Sugar Beet Rev.,* 1980, **48,** (1), 43-44, 64. A population of 75,000 plants per ha will give maximum sugar yield with uniform distribution along the row; however, when seeds are drilled to a stand, seedling establishment may be so poor that spacing becomes irregular. Sowing more seed while maintaining a row spacing of 50 cm (to give the target 75,000 plants per ha) would be unpractical because of the possible production of a large number of small roots that could not be harvested by normal mechanical means. One answer to the problem is the sowing of much greater numbers of seeds in beds having row spaces of only 25 cm. With a much higher population than 75,000 per ha, there should be no reduction in sugar yield. Trials at Broom's Barn Experimental Station showed that the system gave no more sugar per ha than did the normal system when seed establishment was high, but gave significantly more sugar when seed establishment was low (32%). While the bed system would also reduce green aphid and virus yellows incidence (through reduction in gappiness) as well as late-germinating weeds, disadvantages include the need for more seed and greater reliance on herbicides, which would have to be sprayed overall.

A new cleaning mechanism for sugar beet harvesters. P. Billington and F. Brown. *British Sugar Beet Rev.,* 1980, **48,** (1), 48-49, 52. — Reference is made to experimental work on the design of a suitable cleaner for use on harvesters. Some success was achieved with a system incorporating a cylindrical cage, made up of evenly spaced rods, rotating in conjunction with an oscillating roller placed at a height above and after it, so that soil adhering to beets was removed as well as trash. The system has been installed in two 3-row, self-propelled harvesters.

Tests on introduction of ^{14}C into sugar beet plants. H. Zaorska and S. Zalewski. *Gaz. Cukr.,* 1980, **88,** 31-33 *(Polish).* — In tests in which individual beet plants were maintained in an atmosphere to which $^{14}CO_2$ had been added, the changes in the radio-activity of leaf sections were determined during nine days. It was found that up to 25% of the ^{14}C absorbed remained in the leaf, while almost all of the remainder entered the root, especially in the form of labelled sucrose.

Acceleration of sugar beet maturation by planting of seedlings. E. Jaszczolt. *Gaz. Cukr.,* 1980, **88,** 36-39 *(Polish).* — The ripening of beets was accelerated by some two weeks, by comparison with controls, by planting 4-weeks-old seedlings rather than sowing seed. The method also increased sugar yield.

Effect of sowing and harvesting dates on the response of sugar beet to nitrogen fertilizer. D. A. Analogide. *Hellenic Sugar Ind. Quarterly Bull.,* 1980, (4), 9-31 *(Greek).* — Ten field experiments were conducted at a number of sites over a 7-year period in a study of the inter-relationship between N application rate, sowing date and harvesting date. While postponement of the harvest from the end of July to the end of October did not increase response to N (although it gave considerable increases in root and sugar yields), an early harvest did limit the crop response to N when the growing season was exceptionally short (<90 days), while it also increased the adverse effect of N on sugar content (to a greater extent than late sowing). The sugar content was unaffected by N with a late harvest. Early sowing (mid-March) and a growing period of at least 160 days increased the root and sugar yield responses to N by comparison with sowing at end-April. However, there was no clear evidence of a need for more N under these conditions. It is suggested that the greater crop response to N with early sowing could be due to a faster leaf development in early spring, leading to increased interception of solar energy.

The biology and control of *Cyperus.* K. N. Giannopolite. *Hellenic Sugar Ind. Quarterly Bull.,* 1980, (4), 33-54 *(Greek).* — While two species of nut grass, *Cyperus rotundus* and *C. esculentus,* are to be found in Greece, the former is far more common; its increase in irrigated crops, including sugar beet, is attributed to greater use of herbicides with a resultant change in the weed population from annuals to perennials. Information is given as an aid to distinguishing Cyperaceae from Gramineae and the two species from other sedges. Their biology is also described. Control depends on repeated use of pre-emergence herbicides such as Ro-Neet (Cycloate) and. Dual (Metolachlor).

Thoughts on systematic post-emergence weed control in sugar beet. —. Ottermann, —. Steenken and —. von Olfers. *Die Zuckerrübe,* 1980, **29,** (3), 18, 20 *(German).* While, in West Germany, the tendency is to concentrate on pre-emergence weed control and use post-emergence treatment merely as an adjustment, it is considered that there is now a much greater need of post-emergence herbicide application; moreover, it is now possible to carry it out as a single treatment without pre-emergence treatment. Arguments for and against post-emergence spraying as a single treatment are examined, and advice is given on how to obtain optimum results.

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BEET BREEDING AND VARIETIES

Growth patterns in sugar beet production. J. C. Theurer. *J. Amer. Soc. Sugar Beet Tech.*, 1979, **20**, 343–367. – Some of the general characteristic patterns of beet growth and sucrose accumulation are summarized, and data obtained in recent years on these patterns in inbreds and hybrids are discussed. Relationships between inbreds and hybrids in regard to the characteristics are indicated. Desirable characteristics of an ideal beet are considered to include: early development of a maximum leaf area to an index of 3–4 early in the growing season; smaller leaf numbers and a leaf orientation that favours more effective light utilization by the canopy, with vertical leaves in the upper part of the canopy strata; large root:shoot ratios early in the season; a high sucrose concentration in the dry matter of the root; roots in which cell multiplication dominates over cell expansion for a longer development period; and a large number of developed rings in the root, with broad zones of vascular tissue and narrow bands of parenchyma.

Selecting for taproot to leaf weight ratio and its effect on yield and physiology. F. W. Snyder, G. E. Carlson, J. E. Silvius and J. A. Bunce. *J. Amer. Soc. Sugar Beet Tech.*, 1979, **20**, 386-398. – Beet yield depends on photosynthesis and subsequent accumulation of photosynthate in the taproot. Both production and distribution of photosynthate are governed by environment and genetic factors; an attempt was made to exploit genetic variation in the distribution so as to increase the economic yield. Selections were made for weight of leaves and taproot of 21-day-old seedlings, using the taproot leaf weight ratio (TLWR) as indicator of partitioning where TLWR = (Taproot + hypocotyl fresh weight)/(leaf blade fresh weight). Considerable variation in TLWR was found among plants within the same breeding line or hybrid at any given time in a given environment, as well as among thirty unselected populations examined. Assuming that leaf area remained adequate and other plant functions were not adversely affected, it is suggested that beet yield would be improved by increasing the proportion of photosynthate in the taproot, although work needs to be carried out to evaluate TLWR as selection criterion, determine how the beet controls photosynthate distribution, produce a hybrid in which both pollinator and the male-sterile female lines have been selected primarily for high TLWR, and determine optimum management practices (e.g. spacing and fertilization) for lines differing in TLWR.

Seedling physiology and sugar beet yield. D. L. Doney. *J. Amer. Soc. Sugar Beet Tech.*, 1979, **20**, 399-418. Stages of development in the beet seedling are described. It is stated that most genetic differences in growth pattern occur in the first 30 days, and photomicrographs of the cross-section of a root at 9, 13 and 20 days demonstrate the stages of differentiation. In view of this, it was thought possible to measure important growth parameters in the seedling stage rather than wait until harvest, provided it was possible to control environmental factors. Greenhouse investigations were carried out in which much of the environmental variation was controlled. It was found that the hypocotyl diameter as a means of predicting root yield was effective as a basis for selection. Details are given of the greenhouse technique used in the studies. Other important parameters suggested as tools in selection include photosynthate partitioning, root diameter, osmotic pressure and cell size.

Some new techniques for sugar beet improvement. P. S. Carlson. *J. Amer. Soc. Sugar Beet Tech.*, 1979, **20**, 419-425. – While manipulation of beet cells, using callus cultures, holds great promise for beet improvement through breeding, there are limitations to the application of other molecular biological techniques, since regeneration of whole plants from single cells is essential for *in vitro* genetic manipulation (and this has not yet been accomplished with beet), while production of genetic variability via cellular mutation or hybridization is of little use, as the ability to recognize and recover useful recombinants is the limiting factor in crop improvement, not the availability of genetic variability. Many agronomic traits are tissue-specific, their expression often not being found in cells cultured *in vitro*; another difficulty involves the polygenic nature of trait inheritance, since mutant selection systems and DNA manipulations allow modification of single gene traits, and small additive, stepwise modifications would be difficult to recognize with polygenes. Such traits include drought and heat tolerance, total yield, and time of maturity.

Can we break present barriers to improvements in sugar beet yields? R. E. Witters. *J. Amer. Soc. Sugar Beet Tech.*, 1979, **20**, 426-433. – Breeding varieties that will grow vigorously and start to store sucrose early in the season is suggested as one approach to improvements in beet performance. The importance of avoiding moisture stress during the period of rapid sucrose accumulation, when temperatures often rise above the optimum for the plants, is indicated; alternatively, the aim should be to breed genotypes able to withstand such conditions. The question of nitrogen management is also briefly discussed.

Optimum levels of some characters for genetic improvement of sugar-yielding ability of sugar beet (*Beta vulgaris* L.). I. Inbred lines and open-pollinated populations. R. K. Agrawal, P. S. Bhatnagar and B. Raj. *Indian Sugar Crops J.*, 1979, **6**, 59-63. – Two inbred lines and two open-pollinated varieties were used in a study in which the beets were grown in eight plots and their top weight, total soluble solids content, sugar content and root weight recorded. Regression equations were used to calculate optimum levels of the parameters for maximum sugar yield; these were found to be a top weight of 0.65 kg, a root weight of 2.52 kg, a total soluble solids concentration of 21.85% and a sugar content of 17.7%.

Comparative varietal trials with 12 varieties in 1978. L. Lukács, F. Pócsy and J. Zana. *Cukoripar*, 1980, **33**, 1-3 (*Hungarian*). – Trials with 12 beet varieties (of which 8 were imported) at 10 locations are reported. Root and sugar yield and beet sugar, potassium, sodium and amino-N contents were determined and compared with values for Beta poli M-102, a well-established Hungarian variety.

CANE SUGAR MANUFACTURE

A study of continuous low-grade crystallizer performance. P. W. Rein. *Paper presented to the 17th Congr. ISSCT,* 1980, 15pp. — A mathematical model used to represent crystallization in a pilot plant crystallizer is extended to represent continuous C-crystallizers. The model is compared with factory data and used to show how changes in the design and operation affect crystallizer performance. Results of tracer test studies are given and the effects of deviations from plug flow are investigated. The important contribution of pan exhaustion to overall exhaustion is highlighted.

Pilot plant studies on the exhaustion of low-grade massecuites. R. E. Lionet and P. W. Rein. *Paper presented to the 17th Congr. ISSCT,* 1980, 20 pp. — The results of a pilot plant investigation of factors affecting crystallization of C-massecuites are presented. A mathematical model is used in the analysis of the results to separate solubility and crystallization rate information. The importance of the non-sucrose:water ratio as regards massecuite characteristics and solubility coefficients is emphasized.

Core sampler procedure and analysis as a method for cane payment. W. J. Landry. *Paper presented to the 17th Congr. ISSCT,* 1980, 4 pp. — Criteria for a cane payment system acceptable and fair to both grower and processor are listed. Achievement of an impartial and representative sample is now achievable by means of a core sampler while a standardized sample analysis method and evaluation of the cane is proving acceptable to both parties in Louisiana and elsewhere, while realization of the penalties arising from the inclusion of trash, soil and stale cane is encouraging the growers to deliver cane of better quality.

Ion exchange in cane sugar purification — a processing aid and energy saver. F. X. McGarvey, F. X. Polio and J. Ungar. *Paper presented to the 17th Congr. ISSCT,* 1980, 16 pp. The use of ion exchange resins with the object of energy saving is discussed in respect of removal of scale-forming materials from juices, to give higher thermal efficiency in evaporators and pans, and the decolorization of mill juices or refinery liquors to avoid the need for heat regeneration of activated carbon or bone char.

An appraisal of the use of dextranase. P. A. Inkerman. *Paper presented to the 17th Congr. ISSCT,* 1980, 13 pp. Considerable benefits in factory performance and sugar quality have resulted from the application of dextranase for hydrolysis of dextran in juice from deteriorated cane. Although clarified juice turbidity is improved dramatically, the filtrabilities of the resultant raw sugars are still below normal. Hydrolysis of cane dextran to a M.W. of about 10^4 (designated "complete removal") produces a marked reduction in the percentage of elongated sugar crystals, whilst problems arise in this regard and with fine grain when removal is only partial, although other sugar quality parameters and viscosity of high-Brix factory products are about normal. Initial enzymic studies indicated a surprising similarity in molecular size and type of dextrans in deteriorated cane juices from a wide range of sources in Australia, although this may not apply to other countries. The low incubation temperature of 60°C for commercially available dextranases dictates that the enzymic addition point is mixed juice and future developments should be directed towards providing a cheaper enzyme possessing a higher temperature optimum. Haze analysis remains the most suitable method for estimation of dextran under factory conditions.

Influence of gum on molasses exhaustion. J. Bruijn, S. Koenig and M. Wolff. *Paper presented to the 17th Congr. ISSCT,* 1980, 13 pp. — Target purities were measured using a laboratory crystallizer apparatus in which molasses and added sugar are stirred with the temperature reduced over a period of 48 hours to give a viscosity of 3-4000 poises. The mother liquor was then separated through a screen plate in the apparatus by means of compressed air and analysed for purity. Measurements were made with molasses from which gum had been removed and with samples to which different amounts of isolated gum were added. It was concluded from the results that, at normal gum contents (1-4%), the influence on target purity was small and the effect was only appreciable at high gum contents (6%). On the other hand, gums had a large influence on viscosity.

A possible method for detection of molasses frothing. S. A. Brooks and P. D. Smith. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — The frothing or spontaneous decomposition of molasses is due to a complex of chemical reactions involving various constituents. In order to study the relationship between amino-nitrogen in the molasses and its propensity to frothing, the amino-N content of weekly composite samples of molasses from the 1976, 1977 and 1978 crops in Barbados were measured and the samples then held at 40° and 43°C for 10 days. The results indicated that reaction occurred at 43°C if the amino-N level was 0.6% or higher, but that a molasses with 0.6% amino-N would remain stable if the temperature remained at 40°C or below. Consequently molasses must be at a temperature of 40°C or below to be received by the rum distillery, and the amino-N content is monitored for all molasses produced so as to identify the deliveries which might be subject to frothing if the temperature rose too high.

Sucrose loss in the manufacture of cane sugar. M. A. Clarke, E. J. Roberts, M. A. Godshall, M. A. Brannan, F. G. Carpenter and E. E. Coll. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — A survey is presented of losses caused by micro-organisms and thermal degradation of sucrose in raw sugar manufacture and refining.

Phenolic content during clarification of cane juice. S. C. Sharma, P. C. Johary and G. S. C. Rao. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — A positive correlation has been found between the total phenolic compounds (TPC) in clarified cane juice and the colour of plantation white sugar produced from it, while a negative correlation exists between the colour of clarified juice and the extent of removal of TPC during clarification. Observations show that about 60% of TPC passes into clarified juice since they are not eliminated by clarification processes, although the double carbonatation process is more effective than simple defecation or sulphitation and the extent of TPC removal is increased by higher dosages of milk-of-lime, and by pre-liming at pH 6.8.[1]

[1] See also *I.S.J.*, 1981, **83**, 215.

Percolation behaviour of a cane diffuser. D. J. Love and P. W. Rein. *Paper presented to the 17th Congr. ISSCT,* 1980, 30 pp. — The percolation behaviour of a cane diffuser has been investigated and correlations have been developed from the pilot plant experiments which relate the percolation rate at which flooding occurs to the bed height, specific surface, mean particle size and fibre content of the cane. The dispersed plug flow model was found to fit the results of tracer tests on both the pilot plant and full scale diffusers, providing measures of the percolation velocity and the dispersion coefficients.

A simulation model of a sugar cane supply system. C. O. Lee. *Paper presented to the 17th Congr. ISSCT,* 1980, 19 pp. — A computer simulation model was constructed to reflect the operational characteristics of the loading and transport system used by the cooperative farms to deliver cane to Frome sugar factory in Jamaica. The results of operating the model showed very close association (>80%) between simulated and observed data. The model was used to predict the potential output of systems with various combinations of wagons, in-field tractors, road haulage tractors and one loader. These showed that the current policy of restricting the daily quota allotted to each farm to 320 tons led to under-utilization of the equipment for most travel distances. Rental and owning costs considerations were used to identify systems with the lowest total cost for various travel distances, and the distance at which various combinations became cheapest to operate. Other results indicated that transport units travelling for distances greater than 5 miles to the factory should be given priority at the cane yard and that adding a second in-field tractor only marginally increased the potential output of systems with one tractor under the conditions studied.

The Lotus roll. J. Bouvet. *Paper presented to the 17th Congr. ISSCT,* 1980, 9 pp. — See *I.S.J.,* 1980, **82,** 23.

A sampled-data juice flow controller for a two-tandem mill. G. E. Sloane, K. C. Chiu and K. H. Paik. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. — Control of juice flow to process in proportion to its extraction rate is particularly difficult in the case of a factory with two milling tandems from which juice is weighed in batch scales which discharge at different intervals, resulting in large fluctuations in supply tank level. A control system developed by the authors largely avoids the disturbing effect of two tank scales discharging in rapid succession; when the interval is less than a pre-specified minimum, the controller simply ignores the level change resulting from the second discharge. The controller utilizes solid-state operational amplifiers and discrete logic elements of the CMOS type to perform the control functions and has resulted in a substantial improvement in juice flow uniformity at a Hawaiian sugar factory for more than a year, with attendant improvements in pH and control.

Investigations into the fundamentals of bagasse combustion in step-grate furnaces. B. W. Lamb. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. Investigations of bagasse burning rate in an experimental apparatus showed that burning rate is not affected by radiation from furnace walls and flames above the bed but is highly dependent on the small fraction of the primary air stream that transpires through the bed. Uniform bed permeability is most important for steady burning conditions and the effects of bed thickness, voidage, average particle size and under-grate pressure on this are indicated. The roles of fuel moisture content, ash content and air preheating are also discussed.

Sugar storage in Weibull silos. B. Akermark. *Paper presented to the 17th Congr. ISSCT,* 1980, 66 pp. — The history of the development of raw sugar and white sugar storage in Sweden since the 1920's is described and the characteristics of sugar for suitability for bulk storage and silo design criteria to achieve satisfactory long-term storage are also explained. Factors influencing the Swedish Sugar Company's choice of storage systems are discussed, including space requirements, mobility, handling costs, and temperature and humidity control. Silo installations for raw and white sugar are described.

Mathematical equation as a test for extraction milling adjustment. —. Soewarno. *Paper presented to the 17th Congr. ISSCT,* 1980, 16 pp. — Regression analysis was applied to the results from six Indonesian sugar factories in order to develop an equation relating the mill adjustment, expressed as arc sin for a fibre content reduced to 12.5%, to the fibre indexes at the individual mills; the equation has 9 terms for a 4-mill tandem and 11 terms for a 5-mill tandem. Regression coefficients were worked out and the applicability of the equation assessed.

Individual bagasse drying system. L. E. C. Maranhao. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. An account is given of the development of dryers for bagasse which use stack gases from the boilers to reduce bagasse moisture by 10-15% from an initial 46-55%, thereby increasing steam production by 15.5-18.3%.

Separation process to produce high quality sugars and high value co-products from sugar cane. C. K. Laurie. *Paper presented to the 17th Congr. ISSCT,* 1980, 17 pp. — An extensive account is given of the Tilby cane separation process and the characteristics of the fractions — epidermis, rind and pith — described. Utilization of the fractions for the preparation of panel boards and isolation of sugar are discussed and the advantages of the process in this respect are explained. It is considered to offer economic advantages where the cane sucrose content is to be converted to ethanol. Use of the pith fraction for animal feeding is discussed as is the possibility of breeding cane varieties with new selection criteria made possible by the process.

Optimum design of evaporation drying plant for bagasse in a sugar mill. P.N. Roy, D. Yadav and N.L. Kachhara. *Paper presented to the 17th Congr. ISSCT,* 1980, 22 pp. — A bagasse dryer which uses the heat content of flue gases to reduce its moisture content (and thus raise its calorific value) is described and aspects presented of its design, cost and operation.

Application of economic-mathematical modelling as a management tool in Central Camilo Cienfuegos. A. Morales P. *CubaAzúcar,* 1979, (April/June), 3-12 (*Spanish*). — After a pilot study in 1977, mathematical modelling and use of electronic computers were applied to processing at the title sugar factory. An account is given of this work, estimated to permit a saving of $100,000 per season.

Transient heating, a technique for reheating of massecuites. K. S. G. Doss. *Indian Sugar,* 1979, **29,** 521-522. — In a search for a more economical means of reheating massecuite than resistance heating, the author explains the theory of "transient heating", whereby the massecuite is heated rapidly to a required temperature under conditions of minimum turbulence. A full-scale

heater based on this principle is being manufactured and will be described later.

Bagasse burning at Raceland. D. Martinez. *Sugar Bull.*, 1980, **58**, (11), 16-18. — After natural gas had been used for some years to fire the boilers at the Raceland factory of South Coast Sugars Inc. and all of the bagasse had been sent to an associate company, Celotex, for processing, an increase in the price of the gas caused the management to decide to use only a minimum of gas and burn bagasse, while still providing as much surplus as possible for Celotex. Initially, two boilers (A) were used, with bagasse pre-drying systems but without water walls; since these provided only 40% of the total steam requirement, another boiler (B) was installed which was provided with a conventional preheated air system and burnt undried bagasse direct from the mills. Comparison of the two types of boiler is made. In the case of boilers (A), considerable quantities of clinker form, particularly when both bagasse and gas are burnt (the problem is attributed to the absence of water walls), whereas combustion of the pre-dried bagasse is much better than in boiler (B), with the result that the stack is cleaner; clinker formation is minimized by ensuring that the bagasse moisture content does not fall below 40% (38-44% has been found to be ideal for burning). Pre-drying also causes considerable erosion of the pneumatic equipment and high maintenance and operating costs, as well as a dust problem in the conveying and transferring of the bagasse, especially on windy days. In the case of boiler (B), there is much more water entering the furnace (at a bagasse moisture content of 52%), while incomplete combustion leads to a small amount of particle emission. Improvement in bagasse burning was brought about by installing a shredder after the first knife set.

History of Santa Elisa new mill tandem. G. Aleman. *Proc. Amer. Soc. Cane Tech.*, 1977, 136-138. — Information is given on the Zanini-Farrel 6-mill tandem installed at Santa Elisa factory in Brazil. The mills, which have 42 x 84 inch rollers, are individually driven by steam turbine, and the nominal daily capacity of the tandem is 8500 tonnes of cane.

Suggestions for reducing total organic carbon for improved boiler operation. P. R. Arellano and J. S. Rauh. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 139-144. — The total organic C content in condensates, boiler feedwater and boiler water was determined at several Florida sugar factories during a number of crops. Various laboratory experiments were carried out in order to reduce the content and so decrease foaming and improve boiler operation. Results indicated that incondensables (volatile organic contaminants) can be removed by improvements in venting or flashing of evaporators, vacuum pans and deaerators, although the improvement in operation must be balanced against possible increases in operational costs, in order to determine the most appropriate method.

Report on operating the W. R. Cowley Sugar House. D. Avrill and S. Valle. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 145. — Aspects covered in a report on operations at this Texas cane sugar factory include the use of a CF & I fiberizer, including the use of tungsten carbide wear pads; juice recycling for last mill maceration to maximize sugar production; mill roller welding to assist mill feeding; the use of MgO in clarification to prevent scaling in evaporators, with an explanation of the organic-type scale deposited on juice heaters and pre-evaporators when cane of variety CP 52-68 is being processed; and vapour bleeding from the two pre-evaporators operated in parallel.

Municipal solid waste as supplementary fuel in the cane sugar industry. C. S. Fang and J. D. Garber. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 147. — In view of the high cost of natural gas, atmospheric pollution control regulations and official rulings on energy use, the future of energy supply for the cane sugar industry is uncertain. One potential solution to the problem is extraction of energy from shredded municipal solid waste which has a calorific value similar to that of bagasse. Engineering problems and their solutions, including steps in preparation of the solid waste for combustion in existing furnaces and control of atmospheric pollution, are discussed and the economics analysed.

Electronic cane juice samplers at Glades Sugar House. L. Gandia. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 148-150. — Details are given of the electronic system used to identify each cane trailer load received at the dumper station, to identify the juice sample received at the laboratory and to provide a continuous visual picture (through the use of light-emitting diodes and a mimic panel) of the progress of the cane loads along the two cane carriers towards the first mill. The system is highly flexible and adaptable to different cane carrier configurations and size through the use of programmable digital counters and shift register modules.

Some notes about fuel economy in the raw sugar factory. D. Isasi-Batlle and J. Copes. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 151. — The utilization of heat in excess process steam and the conservation of high- and low-pressure steam, in order to minimize use of auxiliary fuels in steam generation, are discussed.

Saving energy in sugar mills. J. A. Polack and H. S. Birkett. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 167-172. Those areas in a factory where heat losses occur and where improvements should be possible are surveyed. Savings are possible by improving bagasse fuel quality, reducing excess air in furnaces, recovering waste heat from stack gas and using it to preheat air or dry bagasse, reducing the quantity of unburnt fuel, raising boiler and turbine ring pressures, and balancing the high-pressure and exhaust steam requirements. Future investments could be necessary in improving firebox design, in heat recovery equipment, instrumentation for optimum control, high-pressure boilers and additional evaporator effects, although these would ultimately lead to a self-sufficiency in energy.

Processing of total, close-spaced cane. J. A. Polack and H. S. Birkett. *Proc. Amer. Soc. Sugar Cane Tech.*, 1977, 173-179. — In a series of experiments at Audubon sugar factory, comparison was made between the processing properties of (1) total cane (including tops and leaves), grown at a 1-ft inter-row spacing and grown at a conventional 6-ft spacing, (2) total cane and clean stalks as well as tops and leaves milled separately, and (3) total green cane and conventional burnt cane. Results indicated that the close-spaced cane suffered only a slight drop in juice quality and sugar yield per ton (which may not have been statistically significant) which was more than offset by the increase in plant yield. Total cane yielded more bagasse than clean cane, but juice yield and quality were lower as was predicted sugar yield. Tops and leaves contribute mainly fibre, and there seems to be little justification to include them in the mill feed. If the wish is to recover them to provide fibre, it is probably best to handle them separately.

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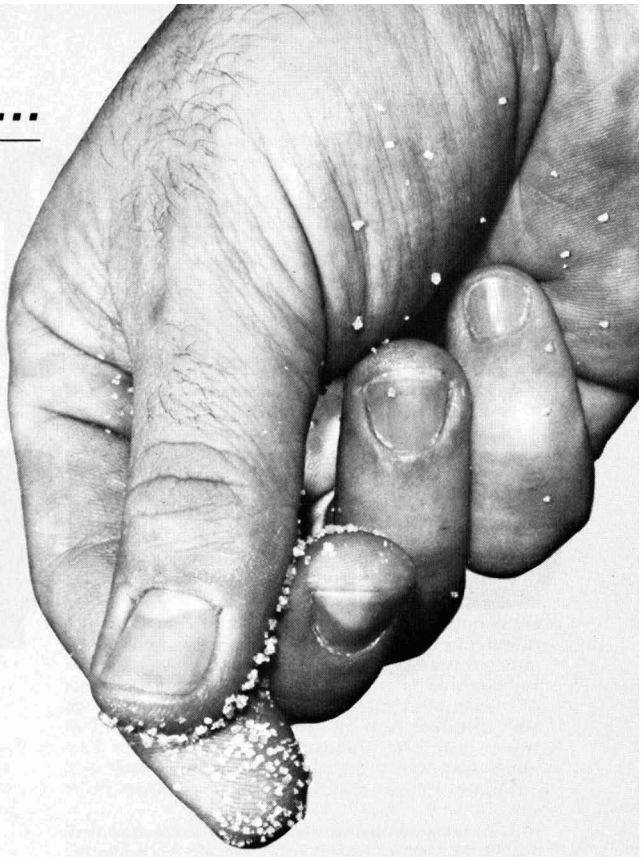

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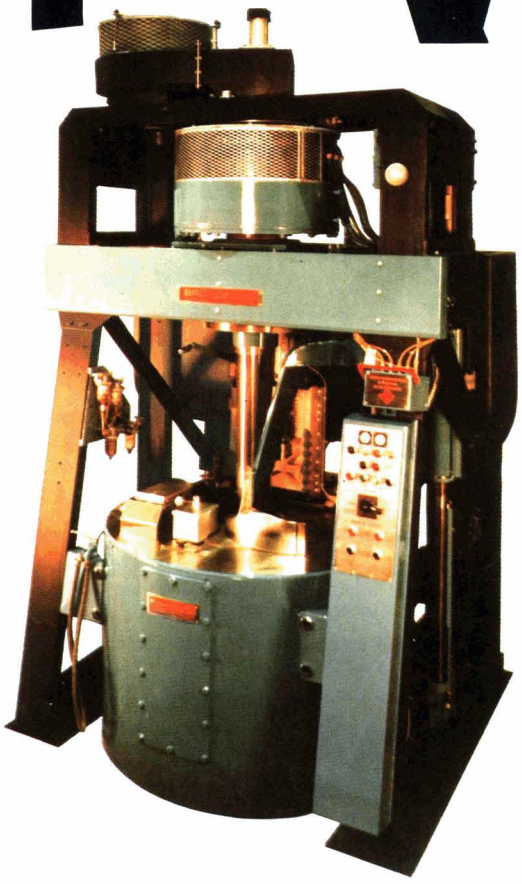

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BEET SUGAR MANUFACTURE

Coordination of mass flow using a MERA – 400 minicomputer. P. Slugocki. *Gaz. Cukr.*, 1980, **88**, 56-58 *(Polish)*. – An algorithm has been developed for coordination of mass flow in a sugar factory. It is based on compromise between a number of target values for each process station and minimizes the selected function in accordance with a given situation and within variable limits.

Production of sulphur dioxide gas and direct use of liquid SO_2. Z. Kalata. *Gaz. Cukr.*, 1980, **88**, 58-60 *(Polish)*. – The disadvantages of using SO_2 in liquid form for diffusion water and juice or syrup treatment are indicated, and types of sulphur burner for production of SO_2 gas are described, and their merits and demerits discussed.

A new station of AWO-1000 automatic batch centrifugals for white sugar. S. Zalewski. *Gaz. Cukr.*, 1980, **88**, 60-63 *(Polish)*. – Descriptions are given of the AWO-1000 centrifugal and of its performance in handling *A*-massecuite of 94 purity.

Technological and mechanical aspects of the design of stirrers for vacuum pans in the sugar industry. K. Kipke. *Zuckerind.*, 1980, **105**, 231-234, 242-244 *(German)*. – Parameters affecting circulation in a vacuum pan provided with a massecuite stirrer are: stirrer design, stirrer diameter, rotary speed, diameter ratio between the stirrer and downtake, and the diameter ratio between the downtake and the vacuum pan. Criteria used in the choice of a given stirrer-downtake geometry are discussed, two cases being considered; where both stirrer and downtake diameters are very small, and where both are very large. The mechanical design of stirrers (as basically governed by capacity, torque and hydraulic thrust) is also discussed.

Effect of stirrer operation on sugar crystal quality – experiences at CSM. P. W. van der Poel. *Zuckerind.*, 1980, **105**, 237-240, 242-244 *(German)*. – Reference is made to early work at the British Sugar Corporation on the use of massecuite stirrers, particularly with the aim of improving the storage properties of sugar that contained too much moisture after drying. Use of stirrers reduced the water included in the crystals and allowed improvement in non-sugar separation in the centrifugals, with a fall in ash and colour. On the basis of these and other experiences, massecuite stirrers were installed in pans at one CSM factory (in Holland) and resulted in a reduction in conglomerate formation and in the ash content (which was half that of sugar when no stirrers were used). Photomicrographs demonstrate the advantages of stirrers.

Experiences with stirrer-equipped vacuum pans at Ochsenfurt sugar factory. K. Tesch. *Zuckerind.*, 1980, **105**, 240-244 *(German)*. – Because of the height of the pan station (at the 26 m level) at Ochsenfurt, it was not practical to install large-capacity pans when the need for expansion arose. To compensate for this, there was need to increase the throughput of smaller pans by raising the evaporation rate and boiling at as high a Brix as practical, e.g. 77°. The decision was made to install pans provided with massecuite stirrers, and details are given of experiences in boiling since the conversion. The major advantages of the stirrers were improvement in crystal quality, with a considerable reduction in conglomerate formation, while total pan volumetric capacity requirements decreased.

Recovery of beet soil and water from flume and wash water. G. Vernois. *Zuckerind.*, 1980, **105**, 254-255 *(German)*. – Treatment of flume-wash water in quiescent tanks has the disadvantage of permitting the mud to act as a source of micro-organisms which are then carried into the factory with clear water, unless liming to pH 10-11 is carried out, which also aids settling. The use of one or more settlers is more suitable since the water is separated from the mud before ponding. Water can also be separated by centrifuging of the mud as at Frauenfeld factory, where 10-11 tonnes.hr^{-1} of soil of 55-56% solids content was removed during the 1978/79 campaign using a S 5-1 KHD Humboldt Wedag AG machine of 50 $m^3.hr^{-1}$ throughput. After the campaign, the centrifuge showed no signs of wear and had operated without any problems on a 24-hr basis. The Neyrtec Tasster is also of use for mud dewatering; the mud is flocculated and continuously thickened, so that it is finally discharged in compact or shovellable form. Hydrocyclones are also applicable for water treatment.

Treatment of waste water and methane fermentation. J. P. Lescure and P. Bourlet. *Sucr. Franç.*, 1980, **121**, 85-91 *(French)*. – Reference is made to the anaerobic treatment installations at Vauciennes[1-3], Goussainville and Brugelette, and studies conducted on a laboratory, pilot plant and industrial scale are reported, which showed that the method is applicable to vinasse treatment. As a means of after-treatment of effluent so as to permit direct discharge into waterways, the method reduced BOD by 77% and COD by 67% on average at Goussainville; at Vauciennes it also reduced the N content from an initial 30 mg.l^{-1} (27.6 mg.l^{-1} in the form of ammoniacal N) to 2-4 mg.l^{-1} as Kjeldahl N, 0.3-2 mg.l^{-1} as nitrite N and 19-23.5 mg.l^{-1} as nitrate N, 3-6 mg.l^{-1} being lost by denitrification.

A special process for demineralization of sugar factory products by electrolysis. J. C. Giorgi, R. Gontier and B. Richard. *Sucr. Franç.*, 1980, **121**, 93-101 *(French)*. Investigations are reported in which *B*-syrup of 50°Bx containing 12% of the non-sugars as K (w/w) was treated by electrodialysis, with molasses of 55-60°Bx used as concentrate. Application of 1.3 V per cell (made up of an anionic and a cationic membrane) to the twenty cells in the unit and passage of 22-26 mA.cm^{-2} permitted a 40% K elimination during a 45-min cycle at 40°C; purity rise was of the order of 4.5 units. It is calculated that treatment of all the *B*-syrup in a factory would permit recovery of one-third of molasses sugar, but experiments are needed to verify this.

Determination of losses by microbial infection in diffusion. –. Belcadi. *Sucr. Maghrébine*, 1980, (24), 9-26 *(French)*. The literature on micro-organisms and their effects on losses in diffusion is briefly surveyed, and details given of

[1] *I.S.J.*, 1979, **81**, 121.
[2] *ibid.*, 1980, **82**, 182.
[3] *ibid.*, 344.

lactic acid determination by enzymatic means. Application of the method to loss determination at Sidi Allal Tazi factory is reported and results given in tabular form. Comparison between the results and measurements by the resazurine method showed that the latter were lower.

A computer approach to technical records in the beet sugar factory laboratory. B. L. Karren and M. K. Faviell. *Sucr. Belge,* 1980, **99,** 63-80. — See *I.S.J.,* 1979, **81,** 278.

Screen presses. F. Kastner. *Listy Cukr.,* 1980, **96,** 57-63 (*Czech*). — Details are given of various types of screen press applicable to mud dewatering, and results are given of tests on dewatering flume-wash water mud with a Bellmer screen press after sedimentation and thickening using flocculants. A mud solids content of approx. 60% was achieved by treating mud of about 7% initial solids at a rate of 6 $m^3.hr^{-1}$ using 0.6 kg of Nalco 625 or BASF AF 400 flocculant per tonne of mud solids.

Some questions concerning reduction in fuel consumption. A. Bracjun and G. Sturc. *Listy Cukr.,* 1980, **96,** 63-67 (*Czech*). — It is stated that the average fuel consumption in Czechoslovakian sugar factories is much higher, at 6% on beet, than in some factories (3-3.5% on beet) in other countries. The experiences outside Czechoslovakia are used as a basis for discussion of ways in which fuel consumption can be reduced.

The effect of diffusion feed water quality on change in the pH of the diffusion medium. N. V. Kulinich, V. G. Yarmilko and B. N. Valovoi. *Sakhar. Prom.,* 1980, (4), 55-60 (*Russian*). — Investigations showed that, while the pH of diffusion water did not affect the pH of raw juice, it did affect the quantities of pectin and reducing sugars in the juice as well as the pressing properties of the exhausted cossettes. Differences between untreated fresh water and demineralized condensate as regards the pH pattern throughout the diffuser were attributed to the higher buffering capacity of the untreated water and hence greater quantity of reagent needed to bring it to optimum pH, which was found to be 6.34 for demineralized water and 6.15 for fresh water. While divergence from the optimum caused an increase in juice pectin content with both types of water, the effect of change in pH of demineralized water, especially increase in the value, was less noticeable than with fresh water. For minimum reducing sugars content, the optimum pH was 7.0 for demineralized water and 7.5 for fresh water (corresponding to average values for the extraction medium of 6.37 and 6.79). Allowing for a compromise between the optima for pectin content and sugar losses by inversion, the minimum diffusion costs for white sugar production occur at a demineralized water pH of 6.7-6.8 and a fresh water pH of 6.4-6.5. Inversion losses will rise when processing of sub-standard beet necessitates greater acidification of the water.

Experiences with operation of the DC diffuser in Hungary. K. Hangyál. *Cukoripar,* 1979, **32,** 161-164 (*Hungarian*). The performances of DC continuous diffusers (made in Poland under licence from DDS) at nine Hungarian sugar factories are reported, and optimum operating conditions are indicated.

Molasses desugaring by ion exclusion chromatography. A. Vigh. *Cukoripar,* 1979, **32,** 171-173 (*Hungarian*). Details are given of the Finnsugar-Pfeifer & Langen molasses ion exclusion process.

Experiences in the use of a scale inhibitor. K. Csajághy and G. Pál. *Cukoripar,* 1979, **32,** 181-182 (*Hungarian*). Tests with two Stockhausen scale inhibitors applied to the evaporators at Kaposvár and Szerencs sugar factories are reported. Tabulated data for the latter factory indicate the beneficial effects of the inhibitors on the heat transfer rate. Polystabil VZ W 25596 proved more effective than Polystabil VZ S 571.

The state of disinfection in diffusion during 1976-79. K. Magyar. *Cukoripar,* 1979, **32,** 218-227 (*Hungarian*). Factors governing the bacterial population in diffusion juice and hence disinfectant requirements are discussed, including beet dirt tare, putrefaction and mould formation during storage, and washing efficiency. The amounts of formalin used at 11 factories in 1978/79 were, in many cases, much higher than in 1975/76. The pattern of use during a campaign at a factory equipped with DDS-type diffusers is discussed, with details given of quantities of formalin used (expressed in kg and as % on beet), juice pH and numbers of bacteria. Experiments with Antiseptol showed that it was no better than formalin as a disinfectant. Details are given of the technique used to determine optimum disinfectant dosage with the aid of the Nash reagent and a Contiflo automatic analyser.

Mechanical damage to sugar beet and the consequent sugar losses. K. Vukov and G. Pátkai. *Cukoripar,* 1979, **32,** 202-206 (*Hungarian*). — See I.S.J., 1980, **82,** 345.

Documentation of the calculation procedures and programs drawn up for a HP 97 computer. M. Tegze, A. Zsigmond and J. Gerse. *Cukoripar,* 1979, **32,** 211-218 (*Hungarian*). — Details are given of the programming procedure used for a Hewlett Packard HP 97 computer to be used as basic central data handling unit in the Hungarian sugar industry. The program and its suggested use are described.

Lime addition at the purification station on the basis of raw juice non-sugars. L. G. Belostotskii, V. V. Suprunchuk, R. Ts. Mishchuk, K. D. Skorik, V. M. Leshchenko and Zh. I. Katrokha. *Sakhar. Prom.,* 1980, (5), 33-34 (*Russian*). For calculation of the optimum quantity of lime to add to raw juice relative to the non-sugars content, a nomogram is reproduced which is based on a purity range of 80-90, a Brix of 10-20° and a lime dosage which is 80%, 100% or 120% on non-sugars according to the condition of the beet being processed. Hence, % CaO in juice is given by

$$(0.8,\ 1.00,\ 1.20) \times \frac{Bx\ (100 - \text{purity})}{100}.$$

Trial of a clarifier for 1st carbonatation mud thickening at No. 2 "Petrovskii" sugar factory. V. T. Rud' *et al. Sakhar. Prom.,* 1980, (5), 37-40 (*Russian*). — Trials with an Enviro-Clear rapid clarifier are reported, in which a settling rate averaging 9.5 $cm.min^{-1}$ was achieved at a polyacrylamide flocculant usage of 8.2% (optimum solution concentration was found to be 0.1%). At an average retention time of 20 min (representing a daily throughput of 200 tonnes of beet), the clarifier gave a completely transparent juice that required no check filtration. The solid phase content was lower than in filtrate from FiLS-60 filter-thickeners operating in parallel with the clarifier. The thickened mud had a density averaging 1.16 $g.cm^{-3}$. Even with juice from poor-quality beet, the throughput fell by no more than 10%, while the clear juice was still of high transparency. The clarifier lends itself well to automation, and requirements for conversion to automatic control are briefly indicated.

LABORATORY STUDIES

The quantitative analysis of phenolic acids from sugar liquors by high performance liquid chromatography. J. H. Curtin and N. H. Paton. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. — A method for the identification and quantitative analysis of the main phenolic acid constituents in sugar cane process samples has been developed using high performance liquid chromatography. The extracted phenolic acids are separated on a μ-Bondapak/C18 reverse-phase chromatography column using 5% acetic acid as solvent. This technique offers greater sensitivity, speed and selectivity than classical methods such as paper or thin-layer chromatography. A range of samples from the processing of cane sugar has been analysed by this technique.

Direct cane fibre determination by the press method. S. G. Gandana. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. — Determination of cane fibre content using the relatively cheap Hafico hydraulic press[1] were compared with corresponding figures obtained by the Hawaiian method. A very significant correlation was found between the two sets of results. The advantages of the press are described and it is recommended as simple, quick and accurate and giving reproducible measurements.

Size dependency of growth of sugar crystals. A. VanHook. *Paper presented to the 17th Congr. ISSCT,* 1980, 4 pp. Microscope measurements and single crystal weighings were employed to supplement size distribution studies of the change in rate of growth of sugar crystals as they became larger. It was found that the rate of growth of crystals at 0° and 30°C is virtually independent of their size, but increases slightly as the crystals grow larger at 60°C. More fundamental quantitative work is called for in the transport-dominated region as well as on crystals below 0.1 mm in size, the nucleation and grain development region.

Degradation of reducing sugars fluorescence in reactions. N. Martinez. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — Fluorescent products are formed in the acid and alkaline degradation of reducing sugars and it has been found that development of fluorescence depends only on the reaction conditions and not on the presence of other agents such as amino-acids or oxygen, as demonstrated by the lack of effect when asparagine or dissolved oxygen is added. At least two types of fluorescent compound were formed.

The microbiology of sugar cane bagasse. J. Lacey. *Paper presented to the 17th Congr. ISSCT,* 1980, 20 pp. — The structure and composition of bagasse are described and the counts of fungi (15 species), yeasts and actinomycetes (8 species) in a total of 90 wet-baled bagasse samples, 17 dry-baled samples and 50 propionic acid-treated samples are tabulated. A survey of micro-organisms in cane before harvest, in the mill and in wet bagasse is made and tables presented showing micro-organisms and their cellulolytic activity. Health hazards from such micro-organisms are discussed and their significance in relation to utilization of the bagasse explained.

A new polysaccharide isolated from high viscosity final molasses — structural study. J. A. Cremata and L. R. Orozo. *Paper presented to the 17th Congr. ISSCT,* 1980, 13 pp. — Samples of final molasses of high viscosity from a Cuban sugar factory were treated to separate the polysaccharides, employing a fractionation technique developed by Scott[2] involving selective precipitation of complexes formed with cetyl trimethyl ammonium bromide in the presence of 0.05M borax at pH 8.5. The non-precipitable fraction was studied and found to contain a polysaccharide composed of glucose, galactose and arabinose in a proportion of 3:1:1. Analysis by nuclear magnetic resonance and methylation analysis indicates a probable structure in which the main glucopyranose chain is formed by 1→3 bonds with 1→6 bonds in galactopyranose branches and arabinofuranose groups at the ends of the branches.

Detection and properties of sucrose-splitting enzymes in sugar beet. M. Burba and U. Nitzschke. *Zuckerind.,* 1980, **105,** 149-155 (*German*). — See *I.S.J.,* 1980, **82,** 347.

Growth of sucrose crystals. A. Valicić and S. Nikolić. *Glas. Khem. Drush.,* 1980, **45,** (1/2), Abs. III-19 *(Serbo-Croat).* The effects of the dominant dislocation groups on sucrose crystallization kinetics were studied at temperatures in the range 10-40°C. Results obtained earlier at 30°C permitted determination of activity ε, and the rate of growth R was then calculated as a function of saturation σ. Curves of R *vs.* σ were constructed for the different values of ε and temperature, and from the results the energies of activation were determined as well as the value of parameter σ_1 for the different temperatures and activities. σ_1 was found to fall with temperature. The results obtained agree with the BCF theory.

A comparison of reflectance measurement and visual evaluation of white sugars. L. Wieninger and G. Rösner. *Zuckerind.,* 1980, **105,** 245-253 (*German*). Comparison was made between reflectance values (as obtained with a Hunterlab D 40 photoelectric reflector) and visual evaluation (in accordance with official EEC instructions) based on the Braunschweig colour series. The whiteness calculated from a combination of the grey and yellow scales for the reflector was in close correlation with the Braunschweig colour types ($r = 0.998$). Comparison of 94 white sugar samples from a number of factories showed that reflectance measurements of fine crystals give higher whiteness grades than visual evaluation, while the opposite was true for large crystals. In the size range 0.4-1.0 mm for small crystals and 0.5-1.0 mm for large crystals there was linearity in the whiteness grade-crystal size relationship. The difference in overall mean values for 94 samples between the two methods was only 1.43% relative. Hence, it is considered that visual evaluation gives sufficiently accurate results and is less expensive while requiring less time than reflectance measurement.

Evaluation of the coefficient of surface tension at the crystal-solution boundary. V. M. Kharin. *Izv. Vuzov, Pishch. Tekh.,* 1979, (6), 119-121 *(Russian).* — Since there are no known direct methods of determining the coefficient of surface tension σ, it is often determined from the crystal nucleation rate, which still involves some difficulties and is unreliable. From thermodynamic analysis of the hydration of ions during dissolution of ionic crystals,

[1] H. Fischer & Co. KG, Postfach 1106, Industriestrasse 26/30, D-4041 Norf über Neuss. Germany.

[2] *Methods in Carbohyd. Chem., 1965, 38.*

an equation has been developed which includes the number of molecules of water per hydrated ion, n; since determination of n is difficult, the equation has been simplified by using the relationship between the solubility of a solid particle and its size, as expressed by the Gibbs-Thomson equation. By extrapolation, the modified equation is given as: $\sigma \simeq 0.31 (\rho_k N_A/M)^{2/3} kT \ln (\rho_k/C_\infty)$, where ρ_k is crystal density (kg.m^{-3}), N_A is Avogadro's number, M is the mass of the crystalline substance (kg.kmole^{-1}), k is Boltzmann's constant, T is the absolute temperature (°K), and C_∞ is the equilibrium concentration of the solution for particles of an infinitely large radius (kg.m^{-3}). Among tabulated values calculated by the new formula is that for sucrose (1.2×10^6 kj.m^{-2}) at 50°C, which compares with a range of $0.78\text{-}0.92 \times 10^6$ kj.m^{-2} as found by Kharin *et al.*[1] and with a value of 2.2×10^6 kj.m^{-2} established by Popov[2].

Polarographic studies on the formation of metal complexes of caramels. S. K. D. Agarwal, K. V. Gupta and S. K. Upadhyaya. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, G.1-G.2. — Polarographic studies are reported in which caramel, produced from sucrose by heating and from alkaline degraded reducing sugars, formed complexes with Cu^{++}, Cd^{++}, Ni^{++}, Co^{++} and Zn^{++}. Complexes were also formed between the metal ions and the main colorant isolated from the caramel by dialysis.

Modified phenol-sulphuric acid method for estimation of fructose in the presence of glucose. G. Majumdar and S. Bose. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, C.1-C.7. — The method of Dubois *et al.*[3] has been modified by (i) using, as reagent, 10 ml of a 5% concentration of phenol solution made up by dissolving the phenol in a 1:1 aqueous dilution of glacial acetic acid, and (ii) using 3 ml of conc. sulphuric acid instead of 5 ml. These modifications eliminate possible interference of glucose in the characteristic colour formation. Comparison of experimental values of both fructose and glucose as measured at 490 nm with known quantities in mixtures of varying proportions showed good agreement.

Improving the quality of beet. M. Loilier. *Sucr. Franç.,* 1980, **121**, 77-84 (*French*). — Where successive beet brei samples become mixed on their passage along a tarehouse analysis line, it may be necessary (if the mixing is too great) to determine the extent of "contamination" of the one sample by the other. Analysis should be carried out twice in succession and only the second set of results retained. The method adopted consists in measuring a water blank, then two samples C_1 and C_2 of equal concentration a, followed by a sample having double the concentration (C_3), and finally a sample C_4 of concentration a. The "coefficient of contamination" q is given by

$$\frac{C_4 - C_2}{C_3 - C_1}.$$

Values of q for K, Na and α-N (expressed as % mixture) have been found for a Venema and an Electro-Synthèse line (as well as for pol for the Venema line only). These show that by far the greatest contamination was in α-N determination (17.4% and 18.2% for the Venema and Electro-Synthèse lines, respectively), while the errors were considerably greater with the Venema line. Check measurements at the start and end of the day on a diluted syrup sample (four measurements each time) showed that hourly verification is needed. Beet varietal trials in 1979 and nitrogen trials in 1978 are mentioned. Where growers applied no N, while the official recommendation was 99 kg.ha^{-1}, the amount of recoverable sugar and the net return were lower than would have been the case where the recommended amount was applied, but they were not as low as when too much N was applied (an average of 171 kg.ha^{-1} N). Of various fungicide mixes in which damaged beets were steeped in tests on storage fungal growth prevention, the most effective was Benlate + Rovral at 0.8 + 1.5 g.l^{-1}, which reduced losses (expressed as g CO_2 per tonne/day) by 30% over a 40-50 day period.

Methods of analysis. R. Detavernier, M. Groult and J. Roger. *Sucr. Franç.,* 1980, **121**, 103-107 (*French*). Investigation of evaporator tube corrosion and scale formation in several factories is reported. Corrosion determination was based on the Fe content in the juice, while scale formation was determined on the basis of juice Ca and Si contents. Results are discussed. Some problems in juice sampling are indicated. While the sucrose content of raw juice as determined enzymatically has been found to be lower than pol values in all cases, for molasses the reverse was true, and a purity of 56 found enzymatically contrasted with one of 54.32 expressed as pol at the start of the campaign and another of 57.73 at the end. An automatic analyser to determine acids formed by sugar degradation in juice was tested. It operates on the basis of dialysis of the juice, addition of ferric chloride to the dialysate in which colour forms as a result of ferric lactate formation, and measurement of absorbance, which is proportional to acid concentration. Between this Lactamatic and the sampling point a screen was installed as well as a juice circulation pump and a cooler to reduce the juice temperature to 45°C. Results of both continuous and batch measurements for various juices, including raw juice, are tabulated and indicated that the system is suitable provided it is used under the conditions of the tests, although it is stressed that the analyser requires very careful use and should be regularly maintained. Some improvements are considered necessary.

Liquid chromatography and the sugars. S. R. Bushman. *Proc. Amer. Soc. Sugar Cane Tech.,* 1977, 146. — A brief description is given of liquid chromatography and its applications, and preliminary experiments leading to development of methods for sugar mixtures in various materials are summarized. While more work is considered necessary before liquid chromatography procedures can be recommended, preliminary work has shown that high-performance liquid chromatography is very rapid and highly sensitive in the determination of monosaccharides, sucrose and polysaccharides in raw sugar factory products.

Variation in the content of some anions in beet during storage. C. A. Accorsi, G. Vaccari, G. Sgualdino and G. Mantovani. *Ind. Sacc. Ital.,* 1980, **73**, 1-12 (*Italian*). Phosphate, chloride and sulphate ions as well as a considerable number of organic anions were measured in beets of two varieties, harvested on two different dates and stored by two methods, over a period of 12 days, using a gas chromatographic technique on an extract from the root samples. The results, indicated in graph form, are discussed. They show the advantage of storage for no longer than two days and were similar for both varieties except in the case of malic acid.

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[1] *Kolloidn. Zhurn.,* 1969, **31**, (1), 147.
[2] *Pishch. Prom.,* 1973.
[3] *Anal. Chem.,* 1956, **28**, 350.

BY-PRODUCTS

Is ethanol the fuel of the future for sugar cane producing territories of the third world? J. M. Paturau. *Paper presented to the 17th Congr. ISSCT,* 1980, 17 pp. Consideration of a cane sugar factory producing fermentation alcohol from cane juice or molasses indicates that production costs are more favourable with the latter. Cane-producing countries of the third world which have an annual sugar production of 100 kg per caput are in a favourable situation to replace imported oil-based petrol by locally-produced ethanol. Disposal of the distillery waste may prove a serious problem, however, and concentration to 60% dry matter and utilization as animal feed or fertilizer appears to be the preferable solution. The merits of ethanol as a fuel for internal combustion engines are discussed and it is calculated that, with presently available technology, one litre of ethanol could replace 0.73 litres of petrol. It is concluded that sugar producing countries with a significant production per caput should progressively manufacture ethanol as a partial or total replacement fuel, especially if enough molasses is available at a reasonable price.

Fermentation alcohol from cane molasses by fast fermenting yeast and its cell recycling. S. S. Dhamija, S. Sharma, D. S. Dahiya, M. C. Bardiya and P. Tauro. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. — A total of 24 yeast strains, including *Saccharomyces cerevisiae, S. beticus, S. ellipsoideus* and *S. bayanus* strains, were screened in order to identify fast-fermenting strains and one, a strain of *S. cerevisiae* found to ferment quicker than the remainder. It was used for studies on yeast recycling. Addition of urea and phosphate was found to enhance the rate of fermentation as did operation at 37°C as compared with 30°C.

Sugar cane wax oxidation with O_3/O_2. S. Menendez C. *Paper presented to the 17th Congr. ISSCT,* 1980, 14 pp. Sugar cane contains an amount of wax varying between 0.1 and 0.3% so that the world cane crop is a major source of vegetable wax. Because of the variation in the source, the isolated wax varies in colour because of the pigments present in the cane. Experiments have been made on liquid phase ozonolysis and oxidation of cane wax in order to reduce its colour and obtain a stable quality. The kinetics of the treatment at temperatures between 80° and 160°C have been studied and it was found possible to obtain refined, decolorized waxes of similar properties irrespective of the initial wax colour.

A study on utilization of fusel oil in the preparation of amino resins for surface coatings. H. C. Huang. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — Resins were prepared by condensation of fusel oil and formaldehyde with either melamine or urea and were used as constitutents of coating materials. These were found to have characteristics comparable with those produced using resins in which butanol had been incorporated instead of fusel oil. Abrasion resistance was less in the fusel oil-based coatings, however.

The designing of a new autonomous distillery with reference to steam, electricity, water, raw material and equipment used. P. O. R. Thiel and C. R. B. du Coudray. *Paper presented to the 17th Congr. ISSCT,* 1980, 9 pp. In order to produce fuel alcohol in large quantities, Brazil has inaugurated the construction of "autonomous" distilleries in which the cane is converted only to alcohol and no sugar is produced. Steam, water and power production and consumption are factors which are quite different from those of a sugar factory and a method is described for achieving maximum use of bagasse to avoid the need to purchase external energy.

Some aspects of depithing and storage of bagasse in Cuba. J. A. Lois, R. Suarez and O. L. Garcia. *Paper presented to the 17th Congr. ISSCT,* 1980, 10 pp. — The development of bagasse utilization for paper and board is briefly mentioned and a survey presented of bagasse depithing, storage and utilization, with emphasis on current and future operations in Cuba.

Deterioration of bulk-stored bagasse and its preservation by chemical treatment. K. Walter. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — Bagasse is a useful raw material for pulp and board production but deteriorates under microbial action, which limits its application. A survey was carried out and analysis of 110 cultures from fresh bagasse revealed mostly bacteria but also yeasts, actinomycetes and fungi. The efficiency of 33 preservative substances was tested by measuring the temperature curve of treated fresh bagasse in a pile simulator. According to the results, chemical treatment of the bagasse appears to be economical and, in some cases, effective in preventing moulds on boards produced from the treated bagasse.

High yield pulp from bagasse. G. Villamil L. and C. Aguero T. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. — Mechanical and chemical-mechanical pulps were prepared from bagasse, bleached, and their physical properties determined. A modified cold soda process and an alkaline sulphite pre-treatment were used in preparation of the chemical-mechanical pulp; it was found that the latter gave a brighter pulp than the soda and mechanical pulps. Pre-treatment influenced the pulp quality, especially the fibre flexibility and consequently the pulp properties. The bonding effect was also better. By comparison with mechanical pulp, for the same degree of milling, the chemical-mechanical pulp process gave substantial improvements in a number of important properties such as tear factor, fibre length, and content of shives.

Research experience in bagasse pulp bleaching. N. Fernandez, M. E. Naranjo, J. Alvarez, O. Sardinas and M. Serante. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. — Investigations in Cuba on the multi-stage bleaching of bagasse pulps with a number of chemicals, including hydrogen peroxide, hydrosulphite, sodium hypochlorite, chlorine dioxide and oxygen/alkali are reported, the last being the most important of the new technologies developed.

The fuel value of bagasse pith and developments in pith burning at leading bagasse pulp and paper mills and/or sugar mills. J. E. Atchison. *Paper presented to the 17th Congr. ISSCT,* 1980, 16 pp. — With the recent increase in utilization of bagasse fibre for pulp, paper and board production, the pith which is separated at the initial stage must be utilized. Small amounts have found application as animal fodder and for other purposes but most must be

used as a fuel either at the paper factory or at the sugar factory which served as the source of the bagasse. The present status of pith burning technology is discussed and steps which have been taken to aid efficient burning of pith are reviewed including burning in combination with whole bagasse, fuel oil, natural gas and coal. The various types of boilers which can be considered for pith burning are also described briefly.

Progress in the establishment of mini paper plants based on surplus bagasse by the Indian sugar factories. P. J. M. Rao. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. The author propounded the idea of small-scale paper plants at sugar factories, having a paper output of up to 30 tons per day, at the 16th ISSCT Congress and progress in India towards setting up such units is described. Three plants are reported to be working successfully and plans have been made for the establishment of many more.

Microbial protein produced from bagasse pith. IV. Production of fungal protein by shake culture. L. H. Wang, Y. C. Kuo and C. Y. Chang. *Paper presented to the 17th Congr. ISSCT,* 1980, 13pp. — Production of microbial protein by shaken culture of bagasse pith with *Trichoderma viride* QM9414 has been studied. The best nitrogen source was $(NH_4)_2HPO_4$ or a mixture of this with urea and the optimum pith:N:KH_2PO_4 ratio, in grams per litre, was 30:1.05:6. Vinasse from alcohol fermentation was found to be much better than proteose-peptone as a growth factor for mycelial protein production, providing the Mg^{++}, Mn^{++}, Co^{++}, Zn^{++} and Fe^{++} ions required. A simple medium consisting per litre of bagasse pith (30 g), N sources (1.05 g N), KH_2PO_4 (6 g), $CaCl_2$ (0.3g) and vinasse (200 ml at 13°Bx) could produce 5 g/litre of mycelial protein after shaken culture for 48 hours. Pre-treatment of bagasse pith with ammonia improved the yield four-fold, compared with the untreated control but required time and space. Alkali pre-treatment produced almost as great an improvement but this requires washing of the bagasse after the treatment. A number of other micro-organisms were tested for addition to the culture and it was found that 10% more protein could be produced by inoculation of *Aspergillus oryzae* 48 hours after *T. viride.*

Effects of the thickness of the layer and concentration of molasses medium on citric acid fermentation. T. I. Maslova and V. A. Smirnov. *Prikl. Biokhim. Mikrobiol.,* 1977, **13,** 545-551; through *S.I.A.,* 1980, **42,** Abs. 80-188. Two beet molasses samples of stated composition were fermented at an initial sugar content of 100-220 $g.l^{-1}$ by *Aspergillus niger* strain R-1, as a layer 8-19.5 cm deep, for 5-9 days. Yields of citric acid are tabulated as $g.m^{-2}$/day and % on sugar, together with the final biomass, unfermented sugar concentration and yields of gluconic and oxalic acids (% on total acids) for each set of conditions. Optimum conditions appear to be 9 days' fermentation and, for high quality molasses, a 16 cm layer containing 130 $g.l^{-1}$ sugar, rather than 12 cm and 140 $g.l^{-1}$; for poor quality molasses, they are 12 cm and 120-130 $g.l^{-1}$.

Lysine fermentation experiments using cane sugar molasses. B. Janzsó, A. E. R. M. Khalaf-Allah and K. Sümegi. *Proc. Hungarian Ann. Meeting Biochem.,* 1977, **17,** 69-70; through *S.I.A.,* 1980, **42,** Abs. 80-190. Media based on 5-20% cane molasses + 0.5-2.5% corn steep liquor (CSL) were fermented by an auxotrophic mutant (species not stated) lacking biotin and thiamin and dependent on methionine and threonine; growth was diauxic, with two stages of extracellular L-lysine production. In shake-flasks, 18 $g.l^{-1}$ lysine was generated from 9% molasses + 1% CSL; in a laboratory fermenter, 15% molasses + 2.5% CSL gave approx. 25 $g.l^{-1}$ lysine; optimum conditions are said to give 30-40 $g.l^{-1}$.

Newer lysine fermentation experiments using sugar cane molasses. B. Janzsó, A. E. R. M. Khalaf-Allah and L. J. Abayomi. *Proc. Hungarian Ann. Meeting Biochem.,* 1978, **18,** 157-158; through *S.I.A.,* 1980, **42,** Abs. 80-191. Results of further tests (see preceding abstract) are summarized with some graphs. Preferred conditions for lysine biosynthesis were: pH 6.3-7.3 rather than 7.3-8.3; aeration at 3-5 $l.min^{-1}$ rather than 7-9; 15% molasses rather than 20%, with a further addition about halfway through the fermentation period (approx. 2 days). Lysine yields reached 35-45 $g.l^{-1}$; a feed concentrate was prepared from the fermented broth by stabilizing, evaporating and spray-drying.

Rapid ethanol fermentation of cellulose hydrolysate. I. Batch *versus* continuous system. II. Product and substrate inhibition and optimization of fermenter design. T. K. Ghose and R. D. Tyago. *Biotech. Bioeng.,* 1979, **21,** (8), 1387-1420; through *S.I.A.,* 1980, **42,** Abs. 80-203, 80-204.

I. Bagasse was milled to 150 μm, delignified by autoclaving in 1% NaOH (w/v) at 120°C for 1 hr, and hydrolysed with cellulase from *Trichoderma reesi* QM 9414. The hydrolysate contained 6-7% (w/v) total reducing sugars, of which approx. 70% was glucose; it was concentrated to 10-20% glucose (w/v) in a rotary vacuum evaporator. A medium based on this solution was fermented to ethanol under anaerobic conditions by a strain of *Saccharomyces cerevisiae* in batch and continuous cultures at pH 4.0 and 30°C with cell recycle. With 23.6 $g.l^{-1}$ initial biomass, 9.7% ethanol (w/v) was produced in 6 hr. In continuous aerobic culture with cell recycle and 0.127 volume of air/volume per min, 48.5 $g.l^{-1}$ biomass was obtained and the maximum ethanol productivity was 32.0 $g.l^{-1}.hr^{-1}$, approximately 7 times that in a continuous process without cell recycle or aeration. Ethanol yield on glucose in the hydrolysate was 95-97% of theoretical.

II. In the fermentation of ,bagasse hydrolysate, the inhibition of yeast growth and of ethanol production with increasing concentrations of reducing sugars and of ethanol in the medium was studied. Kinetic equations which can be used in the design of optimum fermentation systems were derived. Substrate inhibition was greater than in the fermentation of pure sugars to ethanol.

Biological ensilage of sugar cane tops. IX. Buffering capacity of the tops before and during ensilage. D. A. Callieri, E. I. Moreno and O. E. Molina. *Rev. Ind. Agríc. Tucumán,* 1979, **56,** (1), 61-71 (*Spanish*). — The buffer capacity of fresh cane tops was almost constant during harvesting, but some fluctuations were observed during the first 3-4 months of growth of the cane. During ensilage the buffer capacity increased rapidly during the first 3-4 days, owing to formation of acetic and lactic acids and establishment of buffer systems based on these acids. The increase then slowed down and stopped after 80-100 days. The influence and inter-relationships of the acids and the available cations on buffer capacity have been studied.

New uses of bagasse. J. C. L. S. Fong. *Rev. Agric. Sucr. Maurice,* 1979, **58,** 158-161. — A brief review of the literature on bagasse utilization is presented (with 30 references). Particular attention is paid to means of degrading the lignocellulose to produce glucose.

EEC sugar exports, 1980[1]

	1980		1979		1978	
			tonnes			
Origins	Raw sugar	White sugar	Raw sugar	White sugar	Raw sugar	White sugar
Belgium	61,362	432,935	31,947	496,515	52,203	311,804
Denmark	278	129,922	7	118,756	5	187,963
France	226,112	2,056,671	139,857	1,718,595	210,955	1,707,070
Germany, West	44,397	677,190	7,353	522,288	65,710	516,351
Holland	39	144,225	52	193,654	49	173,719
Ireland	0	28,140	0	10,599	1	3
Italy	23,609	64,535	10	4,831	4	179
UK	33,787	53,091	20,830	46,417	741	80,078
	389,584	3,586,709	200,056	3,111,655	329,668	2,977,167
Destinations						
Afghanistan	0	1,200	0	413	0	300
Algeria	0	88,253	0	126,099	0	31,018
Andorra	1	516	0	3,019	43	907
Bahrein	0	17,501	0	12,006	0	11,565
Bangladesh	0	0	0	3,667	0	0
Benin	0	5,646	0	3,615	0	3,276
Bulgaria	0	0	0	6,000	0	10,630
Burundi & Rwanda	0	828	0	8,487	0	7,272
Cameroon	0	4,334	0	15,442	0	23,268
Canary Is.	0	0	0	0	0	1,000
Cape Verde Is.	0	0	0	0	0	6,003
Central African Rep.	0	948	0	2,672	0	4,504
Chad	0	309	0	5,209	0	10,015
Chile	0	2,070	29	24,475	29,206	23,050
China	0	0	0	91,779	13,636	72,887
Comores Is.	0	11	0	1,126	0	525
Congo	0	7,065	0	10,780	0	6,152
Cyprus	0	8,829	0	19,566	0	12,126
Djibouti	0	709	0	483	0	35,974
Dubai	0	18,751	0	9,051	0	9,450
Dutch Antilles	0	0	0	1,098	0	378
Egypt	10,505	120,310	0	4,192	0	101,196
Faeroe Is.	44	997	0	1,126	0	1,109
Finland	13,226	984	14,503	0	1	0
French Polynesia	0	4,027	0	4,789	0	5,552
Gabon	0	13	0	7,508	0	2,807
Gambia	0	14,668	0	26,097	0	21,206
Germany, East	0	6,638	0	0	0	0
Ghana	0	17,008	0	40,280	0	25,151
Greenland	8	1,313	5	1,471	4	1,921
Guinea Republic	3	2,666	0	5,322	1	3,208
Iceland	14	10,180	10	10,347	16	9,920
India	0	1,155	0	592	0	736
Indonesia	0	0	20	12,995	0	14,942
Iran	0	613,609	0	564,095	0	511,187
Iraq	0	133,470	0	44,541	0	2,745
Israel	1	117,027	0	126,772	0	158,035
Ivory Coast	0	6,411	0	6,790	0	27,793
Japan	0	48	0	56	0	2,686
Jordan	0	60,732	0	66,060	0	27,867
Kenya	0	1,700	0	27,641	1,880	37,271
Korea, North	0	0	0	0	0	23,068
Kuwait	0	30,841	0	74,469	0	37,850
Lebanon	15,117	9,102	56,857	34,483	28,422	39,962
Liberia	0	4,122	0	6,480	0	6,015
Libya	0	25,871	0	13,150	0	0
Maldive Is.	0	4,550	0	0	0	300
Mali	0	3,703	0	5,893	0	4,329
Malta	0	11,704	0	15,290	0	14,482
Martinique	14	3,672	50	2,628	22	518
Mauritania	0	5,966	0	31,605	0	26,376

(Continued overleaf)

[1] F.O. Licht, *International Sugar Rpt.*, 1981, **113**, 394 – 397.

EEC sugar exports, 1980 — *continued*

Mexico	0	16,650	0	0	0	0
Morocco	35,567	26,111	31,501	24,352	75,378	26,453
New Caledonia	0	2,113	0	2,034	0	2,062
Niger	0	6,592	0	5,308	0	5,240
Nigeria	0	625,028	0	442,674	300	497,048
Norway	351	110,822	104	116,348	124	131,112
Oman	0	3,100	0	9,375	0	9,600
Pakistan	0	29,050	0	455	0	550
Papua-New Guinea	0	8,928	0	6,604	0	4,884
Poland	0	24,780	0	0	0	0
Portugal	66,518	4,000	53,650	0	32,304	17
Qatar	0	243	0	3,000	0	12,300
Rumania	0	2	0	4,220	0	0
Saudi Arabia	0	98,956	0	66,088	0	74,445
Sierra Leone	0	13,197	0	22,901	0	26,184
Singapore	0	117	0	977	0	1,516
Somalia	0	1,959	0	1,225	0	37,282
Spain	1,187	2,415	0	24,605	0	26,121
Sri Lanka	0	19,071	0	230	0	59,100
Sudan	0	62,832	0	145,284	0	69,750
Surinam	0	2,440	0	3,200	0	6,728
Sweden	40,030	39	31,990	43	11,562	57
Switzerland	282	120,832	276	159,350	210	167,274
Syria	0	47,271	0	95,156	0	62,321
Tanzania	0	6,725	0	13,824	0	10,551
Togo	0	18,754	0	23,010	0	11,768
Tunisia	20,874	53,923	10,500	110,943	36,098	112,964
Turkey	0	167,768	0	50	0	0
United Arab Emirates	0	19,851	0	29,543	0	18,512
USA	24	1,140	40	691	59,483	15,951
USSR	183,734	648,620	0	225,053	40,144	1,500
Vatican City	0	499	0	1,601	0	1,820
Venezuela	0	0	0	250	0	59,500
Vietnam	0	1,219	0	1,531	0	0
West Indies	0	754	0	1,096	0	600
Yemen, North	0	44,251	0	53,815	0	86,417
Yemen, South	0	1,035	0	6,028	0	33,751
Zaire	0	6,978	0	10,913	0	10,890
Other countries	2,084	19,187	521	20,309	834	14,366
Total	389,584	3,586,709	200,056	3,111,655	329,668	2,977,167
Total, raw value	4,288,181		3,582,290		3,565,718	

New sugar consultancy. — Sugar Knowledge International Ltd. is the name of a new UK-based consultancy formed by a group of highly-experienced specialists including N. A. Birrell (project finance and administration), D. S. Hughan (sugar cane agriculture), A. M. James (raw sugar manufacture and refining, and by-product development), and J. C. Wilkinson (civil engineering and infrastructure). Potential clients should get in contact with SKIL at Willards Hill, Etchingham, East Sussex TN19 7DB, England (Telephone: 058081-243; Telex: 943763 Crocom G).

Sugar Industry Technicians Inc. Meade Award. — The Award Committee of Sugar Industry Technologists Inc. have awarded the George & Eleanor Meade Award to the authors of two papers presented to the 1981 Meeting of S.I.T. They are Herbert C.Wilson and John A. Richmond of Holly Sugar Corporation, for their paper "Operation of a small refinery in the Los Angeles area", and D. J. Bardwell, H. R. Delaney and D. T. Hawkins of CSR Ltd., for their paper "Colour development and separation in refined pan house operation". The award plaques will be presented at the 1982 Meeting in Atlanta, Georgia, in May 1982.

Brazil alcohol program. — Proálcool, the Brazilian Government program for production of alcohol as a fuel, envisages an output of 10,700 million litres per year by 1985, and this will require a considerable increase in the number of distilleries to no less than 400. An estimated 4300 million litres of alcohol is expected from the 1981/82 harvest and, of this, 3400 million litres will be produced in distilleries supplied by the Dedini Group. The distillery plant is supplied by Codistil (Constructora de Distilarias Dedini S.A.) and milling plant for the autonomous distilleries by M. Dedini S.A. Metalúrgica, both of Piracicaba, SP, Brazil.

UK Government sells its shares in the British Sugar Corporation. As part of its policy of reducing State involvement in private industry, the British Government sold its 24% stake in the British Sugar Corporation on July 22. The shares were sold to some 150 institutions and fetched £44 million, corresponding to a price of 305p per share against the final offer during the Berisford bid of 335p, and a market price of 318p at the close of business on July 21.

Australian sugar industry strike threat. — In early July sugar industry unions began a state-wide campaign following piecemeal protest action by industry workers over a State Industrial Commission decision[1]. The Commission had awarded sugar industry workers a $A 15 per week increase for all classifications with an extra $A 8.10 for tradesmen. The unions had sought an increase of $A 80 per week. A union leader said that mass meetings of the sugar workders rejected the Commission decision and agreed to take industrial action. Cane growers supplying Central Queensland's eight factories said they would not supply those which laid off workers or were unable to crush normally during the dispute[2]. Unharvested cane could remain in the fields until the strike is over without loss in quality, whereas during the last strike, some farmers lost heavily through cane which had been burnt and deteriorated in the field, and cane which had been harvested but which could not be accepted by the factories. The unions resumed work later in the month during a 14-day cooling-off period during which it was hoped the dispute could be settled.

[1] *Queensland Newsletter*, July 8, 1981.
[2] *Public Ledger's Commodity Week*, July 11, 1981.

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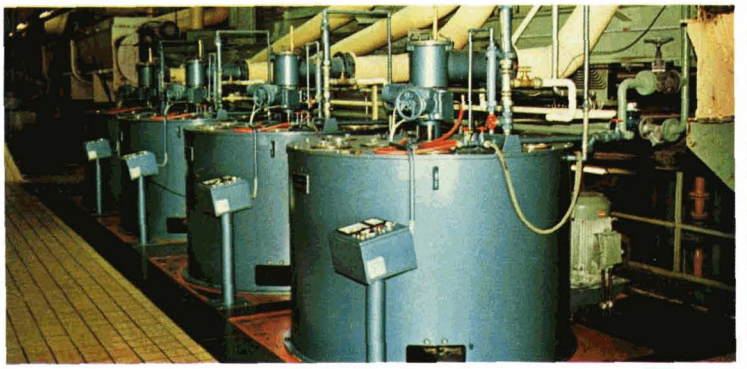

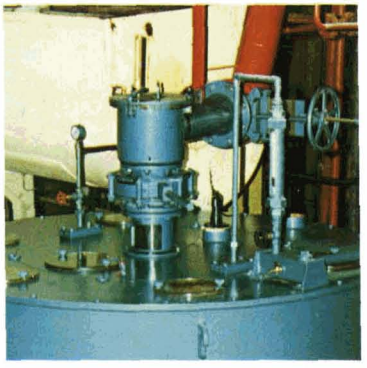

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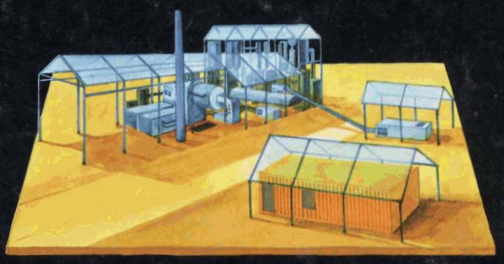

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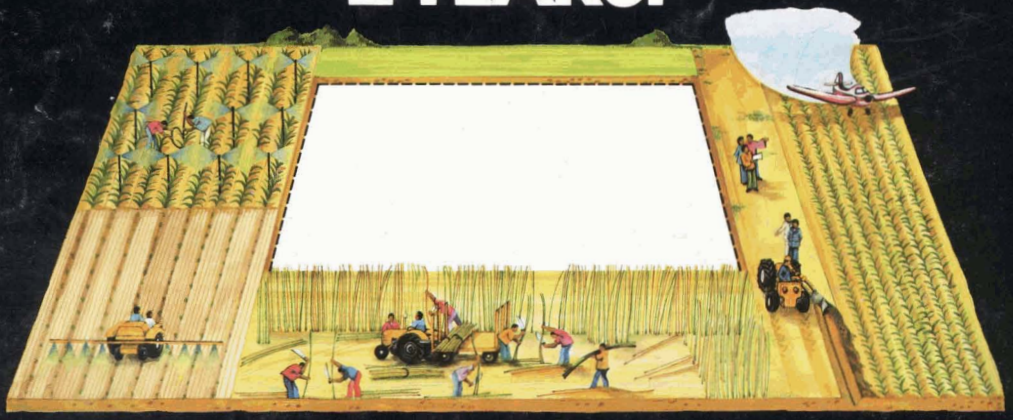

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